Point Reyes National Seashore

National Park Service
U.S. Department of the Interior

Coastal Dune Restoration Environmental Assessment

January 2015

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EXECUTIVE SUMMARY

PURPOSE AND NEED FOR ACTION

Introduction

Point Reyes National Seashore ("park" or "Seashore"), a unit of the National Park Service (Park Service) is preparing a compliance document for restoration of coastal dunes at the Seashore to benefit native coastal dune ecosystems, natural dune processes, and federally and non-federally listed species that live in or use these ecosystems. Habitat would be restored by removing highly invasive, non-native plant species that have greatly altered dune structure, natural processes such as sand movement, vegetation communities, and habitat function for native plants and animals uniquely adapted to this coastal environment. This document leverages previous National Environmental Policy Act (NEPA) compliance efforts conducted by the park for past dune restoration projects, including the Environmental Assessment (EA) prepared for the Abbotts Lagoon Coastal Dune Restoration Project in 2009.

Purpose and Need

– The ***Purpose*** of this action is to improve and restore up to 600 acres of native coastal dune ecosystems in the Seashore through removal of non-native or invasive plant species and to, thereby, assist with recovery efforts for the highly imperiled endangered and rare species associated with these ecosystems.

Restoration is ***Needed*** for the following reasons:

Invasive Species Threaten Habitat

The Seashore preserves some of the last remaining high quality coastal dune habitat in the United States. However, this habitat is seriously threatened by the rapid encroachment of at last two invasive, non-native plant species, European beachgrass (*Ammophila arenaria*) and iceplant (*Carpobrotus edulis*). By 2009, more than 60% (1,400 acres) of the park's roughly 2,200 acres of coastal dune, bluff, and scrub habitat was estimated to be dominated by European beachgrass and iceplant (NPS 2009; Figure ES-1).

Rare Species Impacted by Invasive Species

The Seashore's dunes provide habitat for up to 11 federally listed species, however, the primary species using the dunes are the threatened Western snowy plover (*Charadrius alexadrinus nivosus*), the endangered Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*), and the endangered plants, beach layia (*Layia carnosa*) and Tidestrom's lupine (*Lupinus tidestromii*). Other federally listed species that occur in or near dunes or occasionally frequent dune areas include California red-legged frog (*Rana draytonii*; dune swale wetlands; FT), Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*; wetlands in or near dunes; FE), California least tern (*Sternula antillarum*; FE), and Willow flycatcher (*Empidonax trailii extimus*; FE).

These rare species and associated habitat types are imminently threatened by both physical and ecological changes associated with the presence and spread of European beachgrass and iceplant. Recognition of these impacts led the U.S. Fish and Wildlife Service (USFWS) in its 1998 Recovery Plan for Seven Coastal Species to call for restoration of dune habitats

Coastal Dune Restoration Environmental Assessment
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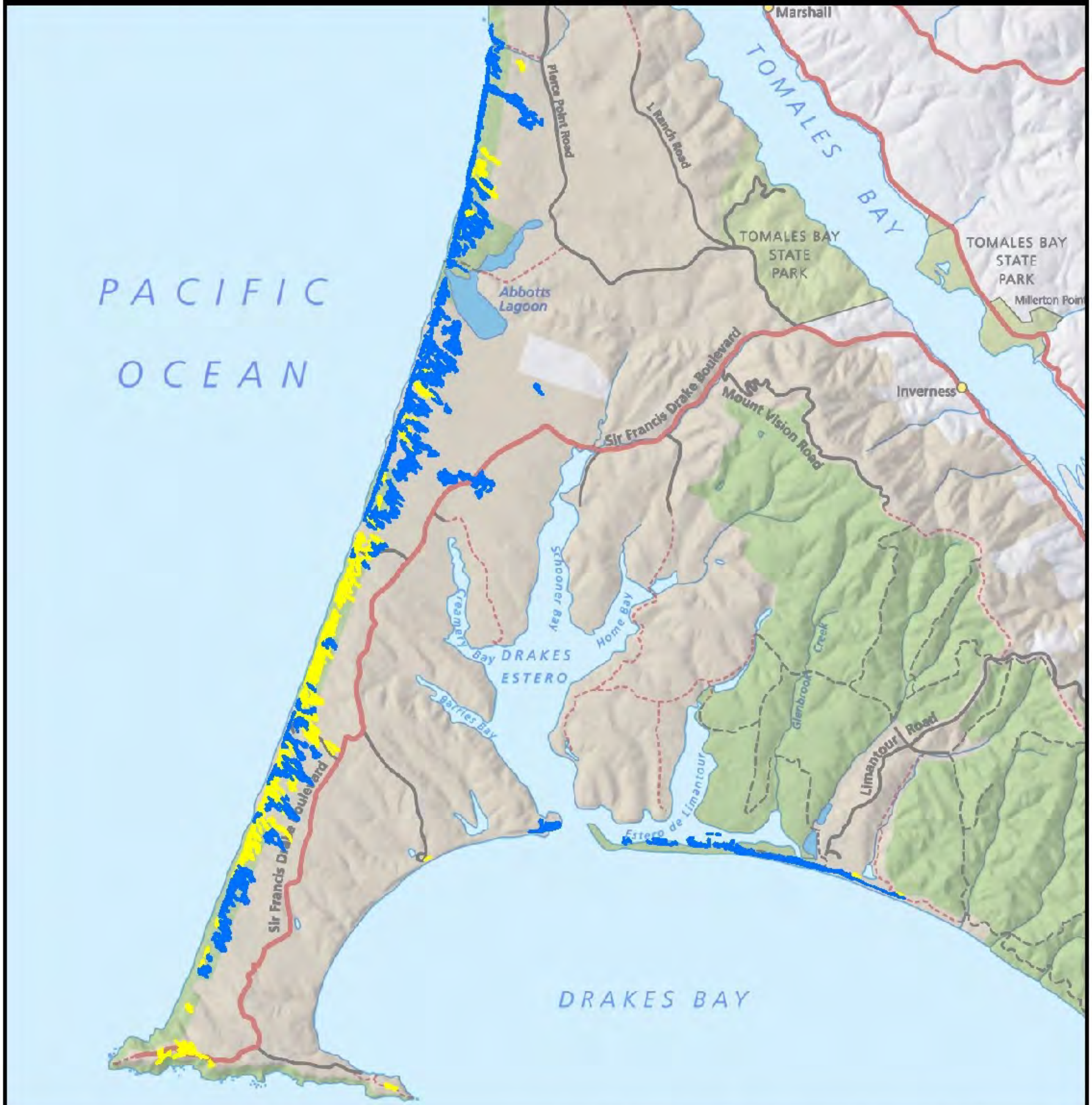

National Park Service
Point Reyes National Seashore
Marin County, California

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Figure ES-1. Beachgrass and Iceplant Extent as of 1994 Vegetation Mapping Effort in Seashore

European Beachgrass

Iceplant

S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\ES1_Beachgrass and Iceplant.mxd through an "aggressive program to control non-native invasive plant species" (USFWS 1998). In Management Policies, Park Service units are required to "survey for, protect, and strive to recover all species native to national park system units that are listed under the Endangered Species Act." (NPS 2006, Section 4.4.2.3).

Natural Dune Processes and Conditions Impacted by Invasive Species

Both European beachgrass and iceplant form dense, monotypic mats or stands. These dense stands alter sand dune structure and function by slowing sand movement and changing sand deposition patterns. In natural communities, dunes continually change in response to sands transported into these systems by waves and wind, typically forming morphologically and floristically distinct foredune and backdune communities. Non-native species and their deep root and rhizome systems armor dune systems and prevent natural migration, which leads to overly large and steeply sloped foredunes and backdunes (Cooper 1936, 1967, Pickart and Sawyer 1998). In Management Policies (2006), Park Service units are required to "reestablish natural functions and processes in parks unless otherwise directed by Congress…." (NPS 2006, Section 4.1.5).

Wilderness Impacted by Invasive Plant Species

The National Wilderness Preservation System was established by Congress in 1964 to ensure that some lands of the United States would be preserved and protected in their natural condition for the permanent good of the people. Within the Seashore's coastal dunes, wilderness is primarily located along the beach areas, with many of the dunes themselves not incorporated into wilderness although there are a few exceptions near the mouth of Abbotts Lagoon, A and B Ranches, and Limantour Beach. Acres of wilderness within project areas ranges from 0 acres at AT&T and Davis to 190 acres at Limantour, with 40- to 90 acres of wilderness at North Beach and A and B Ranches. Planting of European beachgrass and iceplant prior to establishment of the park has impinged on the "untrammeled" and "Natural" nature of wilderness, because the dunes are not unhindered and free from modern human control or manipulation."

Resiliency to Climate Change Impacted by Invasive Species

Coastal environments are considered among the most vulnerable to changes from climate change, including direct changes (e.g. changes of temperature and precipitation) and indirect changes, e.g. sea level rise, wind and water circulation, increasing frequency of storm events (U.S. Environmental Protection Agency (USEPA) 2013). With rising sea levels, there will be more frequent and more serious flooding of low-lying coastal areas by extreme tides, storm surges, and wave effects (USEPA 2013). Coastal dunes offer a buffer against storm extreme tides and storm surges (Pries et al. 2008). This buffering capacity, however, is minimized and potentially eliminated when dunes are over-stabilized by invasive plant species or other alterations. Over-stabilization makes dunes more susceptible to loss from erosion by not enabling them to move or migrate naturally in response to sea level rise and changes in erosional patterns (Millington et al. 2009).

Objectives

Objectives are specific statements of purpose. Alternatives are not considered reasonable unless they are able to meet, to a large degree, primary objectives and resolve purpose and need for action. These objectives largely draw from the extensive scoping of project purpose and objectives conducted during the earlier Abbotts Lagoon planning process, as these objectives continue to remain very relevant to future dune restoration efforts.

The ***primary objectives*** related to dune restoration at the Seashore include:

– Remove non-native, invasive plant species from dune habitat where they interfere with natural physical processes such as sand movement and hydrology.

– Remove non-native, invasive plant species from dunes to create conditions under which native plant and wildlife species can flourish.

– Minimize potential for non-native species reinvasion of restored habitat.

– Increase potential coastal dune habitat for target threatened and endangered species affected by non-native, invasive plant species. The USFWS Recovery Plan for endangered dune plant species calls for expanding population numbers and ranges through restoration and protection of dune habitats, with restoration to be focused on an "aggressive program to control non-native invasive plant species."

Secondary objectives are goals that the park would like to achieve in taking action, but that do not define whether an alternative is reasonable. In other words, fulfilling these goals is desirable, but not required.

The **secondary objectives** related to dune restoration at the Seashore include

– Increase visitor understanding of natural dune processes.

– Use adaptive management to inform and improve subsequent dune restoration efforts.

– Increase opportunities for research into understanding the restoration of coastal California dunes.

ALTERNATIVES

Alternatives Included for Analysis

The alternatives incorporated for analysis are strongly related to those that were analyzed as part of the Abbotts Lagoon Coastal Dune Restoration Project EA. However, there have been some changes. First, this document is intended to be a compliance effort for several high-priority dune restoration areas within the Seashore and not just focus on restoration of one area, as the 2009 EA did. These areas – AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour – have been prioritized for dune restoration, because they support park objectives of increasing the extent of unfragmented restored coastal dune habitat and preventing listed plant and animal species from becoming locally extinct (Figures ES-2; ES-3; and ES-4). These species include Tidestrom's lupine (FE), beach layia (FE), western snowy plover (FT), and/or Myrtle's silverspot butterfly (FE).

Secondly, the Seashore has learned more from its own and others' restoration experiences: Alternatives have been altered to reflect this increase in the knowledge base. Third, the earlier Abbotts Lagoon project area does not support extensive stands of iceplant, so only one alternative action was contemplated for treatment of iceplant – manual removal. Other areas within the park have much more extensive stands of iceplant that may necessitate other techniques. Lastly, other invasive or potentially habitat-altering plant issues other than European beachgrass or iceplant also need to be addressed.

This document will evaluate an alternative that would not involve near-term restoration at these high-priority areas (No Action or *Alternative A*) and three action alternatives. This Executive Summary does not represent all the actions proposed under these alternatives: The alternatives are described in much greater detail in Chapter 2.

- Under *Alternative A,* no near-term restoration efforts would occur within AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, but restoration could occur in the future under separate compliance. Also, already permitted projects within these dune system areas would proceed.

- The three action alternatives differ in terms of which methods would be used primarily for initial treatment: *Alternative B* (Manual Removal), *Alternative C* (Chemical Control), and *Alternative D* (Mechanical Removal).

- However, *Alternatives C* and *D* would actually rely on a combination of techniques, such as manual removal of beachgrass in wetlands and mechanical removal of beachgrass in wetland and organic pasture buffers in Alternative C, or hand removal of iceplant in *Alternatives C* and *D*.

- In addition, re-treatment may not be the same as the initial control methods. For example, hand removal or spot spraying of re-sprouts may take place after mechanical removal (*Alternative D*), and hand removal may also occur after initial chemical control (*Alternatives C* and *D*).

- *Alternative C* may also involve some pre-treatment measures to reduce thatch and stimulate re-growth such as prescribed burning or mowing. Mowing may also be conducted after herbicide treatment or for constructability reasons such as to decrease potential for use of beachgrass by wildlife while construction is being implemented.

- Acreage of wilderness varies within project areas from 0 at AT&T and Davis Property to 190 acres at Limantour. Under the alternatives, the minimum tool necessary to accomplish restoration objectives varies, with *Alternative B* incorporating use of UTVs to haul and dispose of invasive plant biomass. Alternatives C and D incorporate different intensities of heavy equipment use, with use of excavators and bulldozers much more intense under *Alternative D*, which uses mechanical excavation to remove invasives. Under *Alternative C*, mowing and prescribed burning proposed as potential pre-treatment measures may not be conducted within wilderness, as they are not actions that are essential for successful implementation of dune restoration.

- Costs are addressed under each alternative for a representative project where costs could be different depending on the removal approach employed.

Alternative A – No Near-Term Action

According to Director's Order 12 (sec. 5.2), EAs must fully describe and analyze the No Action alternative. The analysis of the No Action alternative "sets a baseline of existing impacts continued into the future against which to compare impacts of action alternatives" (Director's Order 12, Section 2.7). For project-level documents, No Action typically means that the proposed action doesn't take place.

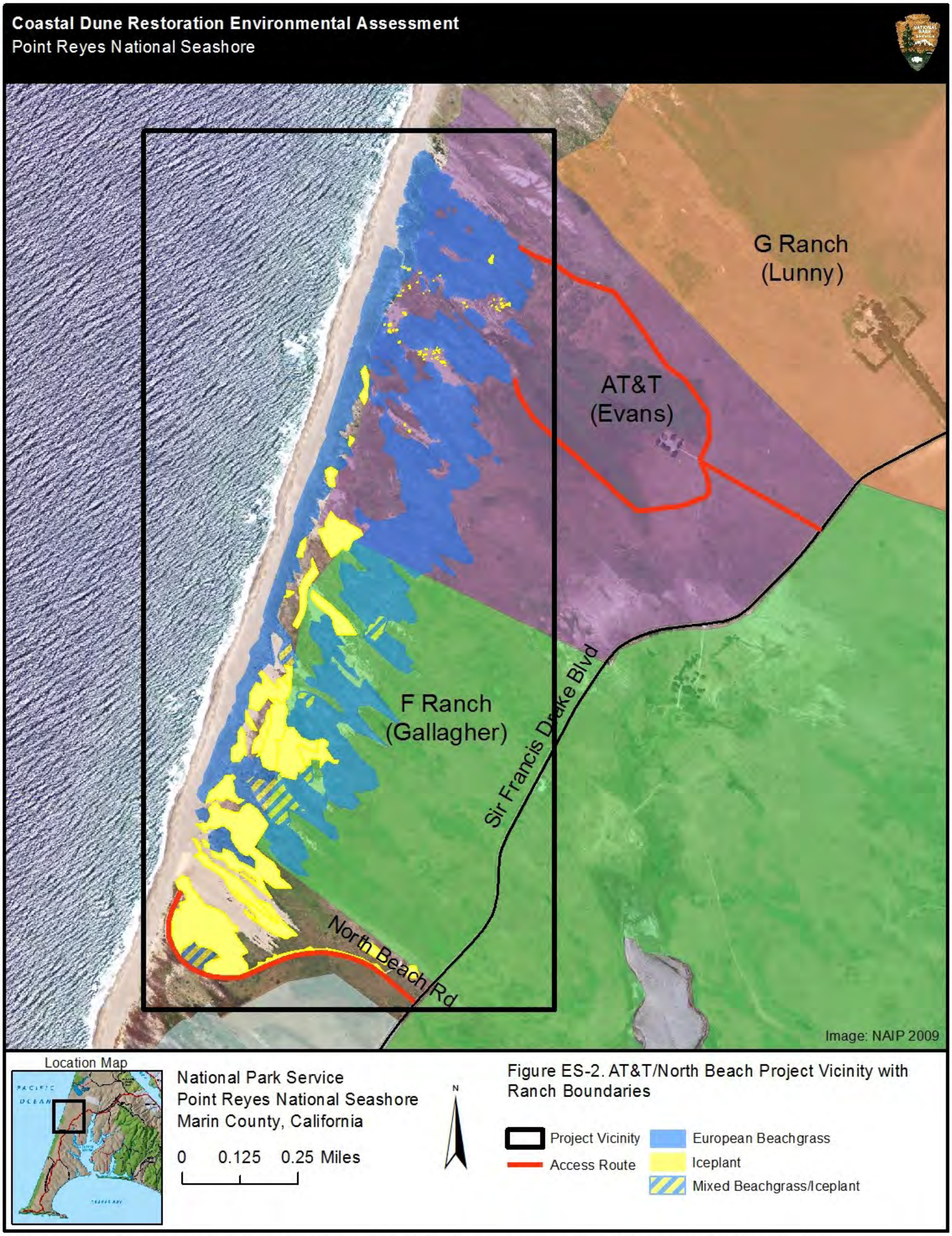

Figure ES-2. AT&T/North Beach Project Vicinity with Ranch Boundaries

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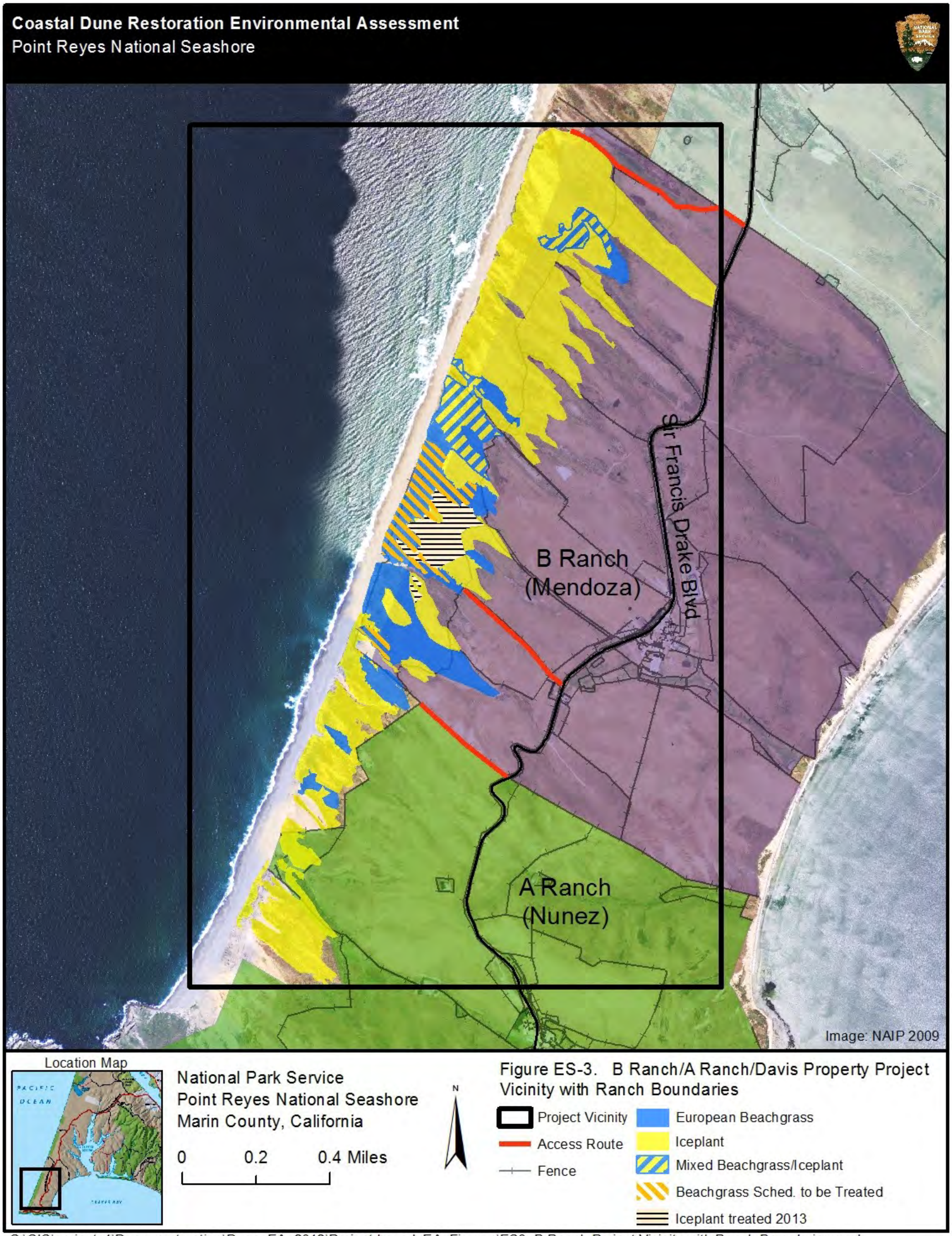

Figure ES-3. B Ranch/A Ranch/Davis Property Project Vicinity with Ranch Boundaries

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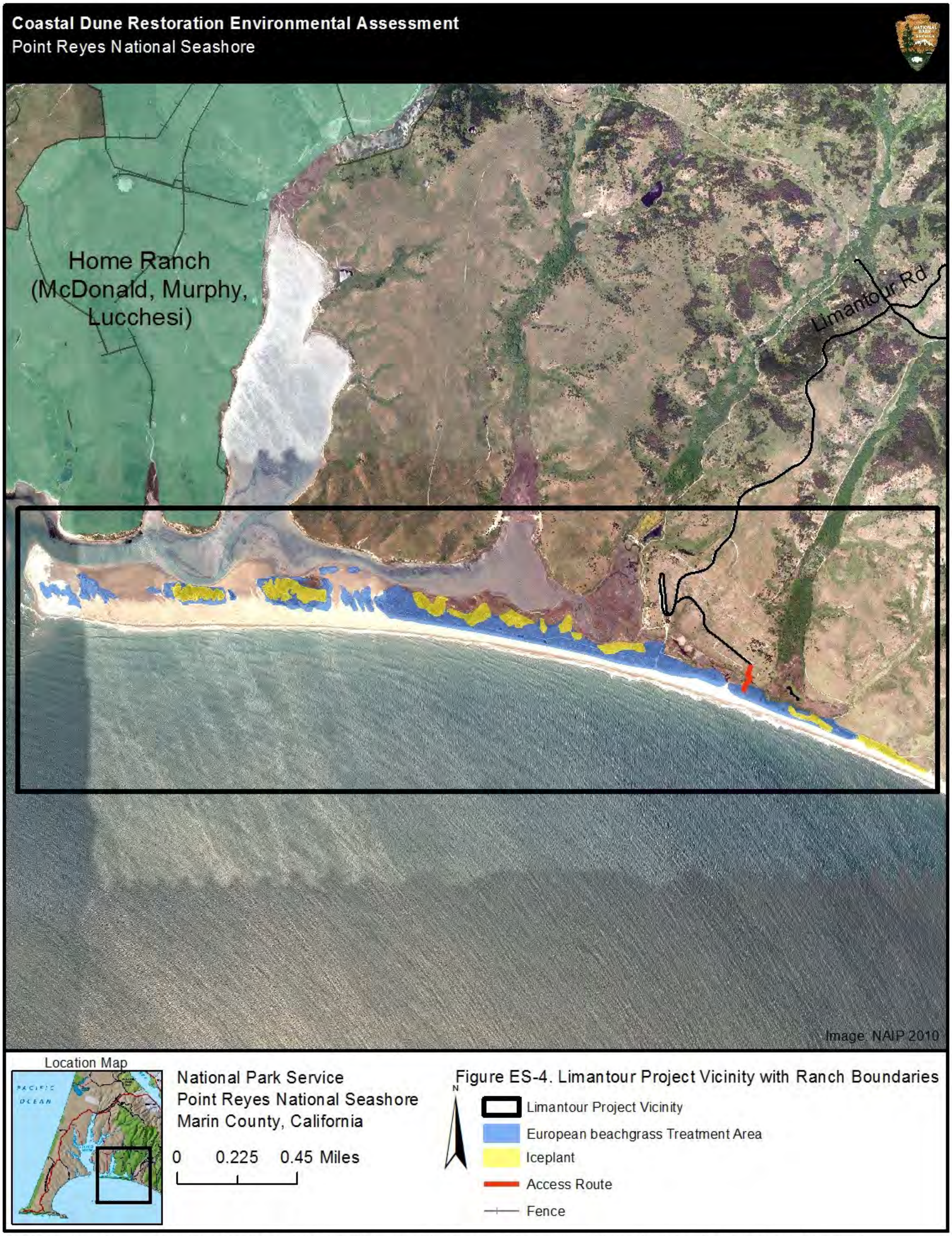

Figure ES-4. Limantour Project Vicinity with Ranch Boundaries

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Under this alternative, these projects may not be necessarily conducted in the near-term or immediate future, but it is possible that dune restoration could be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour at some later point under a new compliance effort. This alternative would also not preclude dune restoration from being conducted elsewhere in the Seashore under separate compliance efforts. Under this alternative, projects that have been previously permitted under separate compliance – including removal of up to 12 gross acres of iceplant and 21 gross acres of European beachgrass in the foredunes at B Ranch – would proceed.

Actions Common to All Action Alternatives

In addition to some common restoration activities, staging and access, monitoring and environmental protection measures, the following actions would be common to Alternatives B, C, and D:

- Restoration actions and associated activities (e.g., staging, access) would be designed to be the most ecologically effective, cost-efficient, and ecologically sensitive methods for achieving the purpose and objectives while also taking into strong consideration adjacent land uses, visitor enjoyment and safety, and other park resources.

- Coastal dune restoration adjacent to actively managed or grazed pastures within the Seashore would be designed to minimize movement of sand from the dunes onto adjacent pastures through activities. When adjacent ranchlands border proposed dune restoration areas such as AT&T, North Beach, B Ranch, and A Ranch, restoration plans would emphasize minimizing movement of sands following restoration into adjacent pastures. Methods for achieving this plan would include one or more of the following: 1) focusing on oceanward portions of the dune system initially; 2) active revegetation of backdune areas; 3) tapering backslopes if mechanical removal is used; 4) phasing restoration in the backdunes to allow time for native vegetation to recruit into the backdunes and assist with soil stabilization; 5) use of some type of sand stabilization technique such as straw bunches (straw planting), mechanical straw crimping, or other proven technique; and/or 6) other avoidance and minimization measures.

- Restoration efforts would be coordinated closely with adjacent ranchers or other property owners.

- All work would avoid, minimize, or mitigate impacts to federally, state, or locally listed species, with every effort made to avoid "take" where possible.

- All work would avoid, minimize, or mitigate loss of jurisdictional wetlands from implementation of restoration, with every effort made to avoid loss where possible.

- All restoration efforts would require long-term follow up to reduce invasive plant cover at less than 1%.

- Resource protection measures that are specific to certain action alternatives are discussed in greater detail in Chapter 2.

Restoration Activities

Ultimately, the size of projects undertaken at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour could vary to some degree under the different action alternatives in extent and size of treatment depending upon the funding available and treatment approach selected, as some methods are more expensive than others.

Project planning efforts for all of these projects would be similar and include mapping of current invasive plant boundaries and verifying boundaries of wetlands and special status plant species populations within proposed project areas. The park would coordinate planning efforts with ranchers to ensure the least amount of impact to ranch operations from implementation activities such as access, staging, and removal.

As noted earlier, most of the alternatives involve a combination of removal techniques for European beachgrass and iceplant. However, only the manual removal approach for these species is common to all action alternatives. Hand removal of European beachgrass would be performed using hand-held tools that will minimize disturbance to surrounding native plants. For example, when working in areas dominated by shrubs, a narrow-bladed hand tool would minimize impacts on the roots of adjacent shrubs and make it easier to insert the blade deeply into the soil to sever just the beachgrass roots.

Staging and Access

Moderate- to large-scale dune restoration projects at AT&T/North Beach, B Ranch/A Ranch/ Davis Property, and Limantour will require staging and access routes. In some cases, projects could require construction trailers, power and telephone drops to provide services to the trailers, and water. Access routes would either need to be created or would use existing access roads, including ranch and park maintenance and visitor roads. Access routes would be needed to travel to the site, as well as travel within the site. Minor improvements may be needed to make ranch and park maintenance and visitor roads suitable for transport or travel of heavy equipment and trucks. At two of the three areas prioritized for potential future dune restoration (AT&T/North Beach and B Ranch/A Ranch/Davis Property), staging would involve either use of existing ranch dirt access roads with possible minor, temporary improvements (e.g., rocked culverted swale crossing; AT&T) or crossing through pastures along existing two-track routes (B-Ranch, A Ranch, Davis Property). At Davis property, access may also occur via a controlled access park road on the north of the Davis Property. At North Beach, access may also occur via a park-maintained public access road and the North Beach parking lot. At Limantour, primary access would be from secondary parking lot at Limantour and the park maintenance access road south of Limantour Pond.

Primary staging areas at AT&T, B Ranch, and A Ranch would be located in on the inland edge of the dune system where staging would not impact any sensitive resources or ranching operations. At AT&T, contractors might use the paved area at the radio station facility to locate a construction trailer: All use of this area would need review by park Cultural Resources staff to ensure historic resources or uses are not impacted. At North Beach, access and staging may occur in the North Beach visitor parking lot, while at the Davis Property, staging could occur at the end of the park access or maintenance road. At Limantour, primary staging would be located in secondary parking lot.

Staging areas may need to be temporarily fenced to provide security for refueling equipment, storage containers, and parked vehicles, as well as to keep people and livestock out of staging area. Upon completion of this project, all staging areas and access routes would be reclaimed to their former condition; temporary fences would be removed, and all materials that were not previously present at the site would be removed.

Monitoring

Treatment effectiveness focuses specifically on evaluating whether the quality of performed work meets specifications. In the case of herbicide treatments, sprayed areas are surveyed during and immediately after work is performed to ensure that more than 99% of plants appear to have been treated based on the visible evidence of blue dye on the leaves. Hand removal and mechanical removal areas are also visually inspected to ensure that more than 99% of aboveground biomass of European beachgrass and iceplant has been removed. Park Service personnel inspect hand removal work while being performed to ensure that the proper amount of belowground roots and rhizomes are being removed.

Plants installed in the backdune plots adjacent to ranchlands would be monitored to assess mortality of plantings and overall species establishment. This would involve counting of container plants remaining by the summer following initial installation, as well as a visual assessment of overall cover within the backdune plot to determine whether additional plantings or seed broadcasting is necessary.

Monitoring of existing restoration projects would continue as funding allows to determine the success in determining level of re-treatment necessary, as well as success in restoring native vegetation communities and progress toward recovering listed and rare species. Efforts to track the number of rare plants, western snowy plover nesting sites, nesting success and health of each plover, as well as the presence of the Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) population would continue as funding allows.

Resource Protection

Coastal dune restoration typically takes place in areas of high ecological and other resource importance, where the avoidance or minimization of adverse impacts to species of special concern, rare vegetation communities, wetlands, cultural, and adjacent land use resources is very important. Current actions taken to protect these and other resources from impacts of removal are described in Chapter 2 and summarized in Table 1 in Chapter 2. These measures are applied to all current Seashore dune restoration projects and would be considered the core or standard set of measures for other action alternatives proposed in this document.

Alternative B – Dune Restoration Using Manual Control Methods

Restoration in this alternative would primarily use manual control methods to remove non-native invasive or potentially habitat-altering species such as European beachgrass, iceplant, and potentially other species such European searocket (*Cakile maritima*) and bush lupine (*Lupinus arboreus*) at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. The techniques employed for this restoration approach are discussed – along with the common staging and access, monitoring, and environmental protection measures – above under *Actions Common to All Action Alternatives*.

This method would use manual techniques for both initial treatment and follow-up treatments. Initial treatment would remove roots from a depth of 1.5 feet down regardless of rooting depth in dune habitats. (Beachgrass is more deeply rooted in foredunes than backdunes.) Based on projects where manual removal of beachgrass appears to have had some success (e.g. Lanphere-Christensen Dunes; Pickart and Sawyer 1998), follow-up treatments would need to be conducted at least eight (8) times during the first year every two to four weeks, with re-treatment moving decreasing in frequency over time. Iceplant would also be removed to a consistent depth of 6 inches and re-treated every six months for two years.

The specifics of manual removal techniques – and how they might vary for at least European beachgrass depending on surrounding vegetation and density – are described in *Actions Common to All Action Alternatives*.

Dune Restoration Approach

- *Alternative B* would include all pertinent measures discussed under *Actions Common to All Action Alternatives*.
- Under this alternative, the park would initially treat European beachgrass and iceplant and potentially other invasive species within AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour using manual removal methods.
- The park would also re-treat European beachgrass, iceplant, and potentially other invasive species using manual removal methods. Manual re-treatment of European beachgrass would be expected to take at least five (5) to eight (8) return visits during the first year. Full re-treatment of iceplant would be expected to take two years, with at least two (2) re-treatment events each year. Full re-treatment for other species would be expected to take two years, with at least two (2) re-treatment events each year.
- For comparative evaluation purposes, based on estimated costs of eradication using this method and current funding availability, selection of this alternative could result in treatment of approximately 5- to 7 acres at AT&T, along with 2 acres of iceplant. There are no current funding proposals approved for the other proposed restoration areas.

A more detailed explanation of manual removal techniques used in *Alternative B* are discussed in *Actions Common to All Action Alternatives* in Chapter 2.

Time and Cost

Manual removal costs are difficult to estimate, particularly as more re-treatment is required for this technique. However, based on 1997 numbers provided by Pickart and Sawyer (1998) for dune restoration in Humboldt and escalated by 3.5 percent annually to 2012, manual removal could cost $52,879/acre. This number includes at least eight (8) re-treatments spread over several years. Unfortunately, none of the other numbers available reflect treatment to eradication, so it is difficult to compare the Humboldt numbers with those from past park projects.

Staging and Access

Staging and access operations would be as described above for *Actions Common to All Action Alternatives*.

Alternative C – Diverse Mix of Restoration Methods, with Emphasis on Chemical Control for Initial Treatment (Preferred Alternative)

Restoration in this alternative would primarily use herbicide control methods at the identified high-priority dune restoration areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, although it would incorporate manual and mechanical removal potentially, as well. Herbicide may also be used for iceplant, but smaller infestations would probably be removed by hand. Manual removal would be primarily used for European beachgrass plants that occur in regulated wetlands, with the potential exception of mechanical being used for heavier infestations, and also for species such as European searocket and bush lupine. Mechanical or manual removal may be used in buffers adjacent to wetlands or organic pastures. Herbicide treatment areas may be pre-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and to reduce the amount of herbicide needing to be applied: Mowing may also be used after treatment to speed up decomposition of European beachgrass and establishment by native species.

Alternative C is the preferred alternative. The preferred alternative was identified by assessing and comparing potential benefits and impacts associated with four alternatives, with the preferred alternative being the one that offers the most benefits with the least impact to resources. *Alternative C* appears to have fewer implementation-related impacts to natural and adjacent land use resources than *Alternative D* and more long-term benefits to natural dune processes and native ecosystems and species than *Alternative B*. With costs of both mechanical and manual removal of European beachgrass being 10 times higher than chemical control, the total area of coastal dune that could be restored at AT&T (or any other of the proposed restoration areas) under *Alternatives B* and *D* would probably be much lower than under *Alternative C*. *Alternative C* is also the alternative deemed by the Seashore to be environmentally preferable.

In addition to common staging and access, monitoring, and resource protection objectives and measures described above under *Actions Common to All Action Alternatives*, *Alternative C* includes the following actions:

Dune Restoration Approach

- *Alternative C* would include all measures discussed under *Actions Common to All Action Alternatives* in Chapter 2.

- Initial treatment of European beachgrass in coastal dunes would be conducted using herbicide and backpack sprayers with calibrated wands or wicking techniques (Table 1). The aquatic-label herbicides proposed for use are glyphosate (AquaMaster®; currently marketed as Round-Up Custom®) and imazapyr (Habitat®). These would be used in combination at concentrations of 2% and 1%, respectively, which either meets or is lower than label recommendations for "a robust, perennial grass at the heavily-established" infestation qualifier-level.

- Pre-treatment of European beachgrass herbicide treatment areas would be potentially conducted through use of prescribed burning or mowing. These treatments reduce thatch and encouraging re-growth of new shoots, thereby increasing efficacy of herbicide application and reducing the volume of herbicide needing to be applied.

- Re-treatment of European beachgrass would be conducted either through either manual removal or spot-spraying herbicide on missed or undertreated plants. Full re-treatment with herbicide would be expected to take two to three (2) additional spray events, with the number of plants to be treated dramatically reduced even after initial treatment. Manual re-treatment of European beachgrass would be expected to take at least five (5) to eight (8) return visits during the first year.

- Manual removal of European beachgrass would be primarily conducted in wetlands and in some upland buffer areas buffers to wetlands and organic pastures, with five (5) to eight (8) re-treatment events during the first year.

- Mechanical removal would be potentially used to remove European beachgrass in buffer areas to wetlands, heavily infested wetland areas, and organic pastures.

- Initial treatment of iceplant in coastal dunes would be conducted using either manual removal or herbicide backpack sprayers with calibrated wands. The aquatic-label herbicide proposed for use is glyphosate (AquaMaster®; currently marketed as Round-Up Custom®). This would be at a concentration of 1.5%, which meets label recommendations for this species.

- Re-treatment of iceplant would be conducted through manual removal. Full re-treatment would be expected to take two years, with at least two (2) re-treatment events each year.

- Initial and re-treatment of other species such as bush lupine and European searocket would be conducted using manual removal methods. Full re-treatment would be expected to take two years, with at least two (2) re-treatment events each year.

- Following treatment, mowing may be used in European beachgrass areas to speed decomposition of European beachgrass and establishment by native species.

- For comparative evaluation purposes, based on estimated costs of eradication using this method and current funding availability, selection of this alternative could result in treatment of approximately up to 77 acres of beachgrass and 1.5 acres of iceplant at AT&T using chemical control, along with manual or mechanical removal of another 3 acres of beachgrass and manual removal of 0.5 acre of iceplant. There are no current funding proposals approved for the other proposed restoration areas.

Techniques used in *Alternative C* are discussed below, except for manual removal technique, which is discussed in *Actions Common to All Action Alternatives*, and mechanical removal, which is discussed under *Alternative D.* Staging and access, monitoring, and environmental protection measures are also discussed above under *Actions Common to All Action Alternatives.*

Herbicide use on lands managed by the Park Service requires initiation and approval of a Pesticide Use Proposal or PUP. PUP requests are reviewed and approved by the Pacific West Regional Integrated Pest Management (IPM) Coordinator or by officials at the Washington D.C. office (WASO). Approvals require tracking of quantities and areas where pesticides are used. All herbicide application would be in compliance with manufacturers' labels and would occur only under appropriate weather conditions.

Time and Cost

Based on past park projects, approximately 0.20 to 2.0 acres of European beachgrass and iceplant can be treated per day depending on ruggedness of terrain and weather conditions. Mechanical removal rates range from approximately 0.20 acre in the foredunes and 0.5 to 0.9 acre in the backdunes. Treatment of buffer areas may be slower than open areas due to the expanded amount of "edge" present relative to non-buffer areas. Rates for manual removal are discussed under *Alternative B*.

Estimations of cost for herbicide treatment depend on many factors, including site conditions, topography, distance from urban areas, and whether retreatment is included, etc. Based on past projects within the Seashore and elsewhere, contract costs for initial herbicide treatment costs during the past five (5) years have ranged between $1,500 and

$3,000/acre, with higher costs per acre often including one re-treatment event. Costs per acre could range up to approximately $4,500 per acre for initial and re-treatment costs. For iceplant, contract costs can be lower, closer to between $1,000 and $2,000 per acre. Mechanical removal costs using contractor crews and equipment ranged from $25,000 to $30,000 per acre for the Abbotts project depending on the location within the dunes (e.g., foredunes, backdunes). Costs for manual removal and mechanical removal are discussed in more detail under *Alternative A* and *Alternative D*, respectively. Some follow-up by hand or by spot-spraying would be required, which could bring total costs per acre to approximately $28,000 to $33,000 per acre.

Staging and Access

Staging and access operations would be as described above for *Actions Common to All Action Alternatives*.

Alternative D – Diverse Mix of Restoration Methods, with Emphasis on Mechanical Removal for Initial Treatment

Alternative D would restore dune habitat at the identified high-priority dune restoration areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour by using primarily a mechanical approach to remove European beachgrass. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas. Manual removal would be used for European beachgrass plants that occur in wetlands and also for species as European searocket and bush lupine. Manual removal may also be used in buffers adjacent to wetlands or organic pastures.

In addition to common staging and access, monitoring and resource protection objectives and measures described above under *Actions Common to All Action Alternatives*, *Alternative D* includes the following actions:

Dune Restoration Approach

– Initial treatment of European beachgrass in coastal dunes would be conducted using mechanical removal with teams of excavators and bulldozers. Different types of mechanical approaches may be used, but the most common one would involve flipping of "dirty" or rhizome-contaminated soils with "clean" sand from below such that dirty material is capped at least 3 feet down with clean sand.

– Potential pre-treatment of European beachgrass mechanical removing areas would be conducted through use of mowing. This treatment reduces and helps to compacts the volume of aboveground biomass.

– Re-treatment of European beachgrass would be conducted either through either manual removal or spot-spraying of herbicide. During the first six (6) months to one (1) year, retreatment by manual means would need to be conducted monthly due to the fact that it takes time for the buried rhizomes that are still alive to emerge. Spot spraying would involve very limited volumes of herbicide due to the success documented with initial treatment using mechanical removal.

– Manual removal of European beachgrass would be primarily conducted in wetlands and in some upland buffer areas buffers to wetlands and organic pastures. Manual re-treatment would be expected to take at least five (5) to eight (8) return visits during the first year.

- Initial treatment and re-treatment of iceplant in coastal dunes would be conducted using manual removal. Full re-treatment would be expected to take two years, with at least two (2) re-treatment events each year.

- Initial treatment and re-treatment of other species such as bush lupine and European searocket would be using manual removal methods. Full re-treatment would be expected to take two years, with at least two (2) re-treatment events each year.

- For comparative evaluation purposes, based on estimated costs of eradication using this method and current funding availability, selection of this alternative could result in treatment of approximately up to 9- to 10.5 acres of beachgrass would be removed at AT&T, along with manual removal of 2 acres of iceplant; and approximately up to 17 acres of removal of beachgrass, some of which is intermixed with iceplant, at Limantour. There are no current funding proposals approved for the other proposed restoration areas.

The mechanical removal technique used in *Alternative D* (and, to a lesser extent, in *Alternative C*) is discussed below. Manual removal, staging and access, monitoring, and resource protection objectives and measures are discussed in *Actions Common to All Action Alternatives*. Chemical control and mowing methods are discussed under *Alternative C*.

As discussed under *Alternative C*, herbicide use on lands managed by the Park Service requires initiation and approval of a Pesticide Use Proposal or PUP. PUPs are reviewed and approved by the Pacific West Regional Integrated Pest Management Coordinator. Approvals require tracking of quantities and areas where pesticides are used. All herbicide application would be in compliance with manufacturers' labels and would occur only under appropriate weather conditions.

Several different methods for mechanically removing European beachgrass were developed during Phase I of the Abbotts Lagoon Coastal Dune Restoration Project, including horizon flipping, dune push, and valley fill. The primary technique used is typically horizon flipping, although, in some areas, either a dune push or valley fill technique could be more suitable. These techniques are discussed in more detail in Chapter 2.

Time and Cost

Time and cost for manual removal and chemical control are discussed under *Alternatives B* and *C*. Production estimates for the fall 2004 mechanical removal at Abbotts Lagoon ranged from 0.07 acre/day for the foredunes to 0.22 acre/day in the backdunes (Peterson 2004). Production rates improved for the Abbotts Lagoon Phase I project. Approximately 0.20 to as much as 0.90 acre per day were restored, with rates in the foredunes much lower than those in the backdunes, because excavation depths in the foredunes were deeper for this particular project.

Initial estimates on cost of mechanical removal for the earliest Abbotts Lagoon project ranged from $10,808/acre in the foredunes to $6,814/acre in the backdunes. For the Abbotts Lagoon Phase I project, mechanical removal costs using contractor crews and equipment ranged from $25,000 to $30,000 per acre depending on the location within the dunes (e.g., foredunes, backdunes). In addition to inflation, differences in costs between the earlier and later Abbotts projects resulted from the fact that in-house crews and rented equipment were used for the 2004 project, while contractors were hired for the 2011 one. For this document, costs are estimated at $28,000 to $33,000 per acre, as some follow-up by hand or by spot-spraying would be required.

Staging and Access

Staging and access operations would be as described above for *Actions Common to All Action Alternatives*.

AFFECTED ENVIRONMENT/ENVIRONMENTAL CONSEQUENCES

Impact topics are the resources or values that could be affected, either beneficially or adversely, by implementing one of the proposed alternatives. The relative impact of each of these problems or opportunities is examined in the *Environmental Consequences* section of this EA. The following issues were developed initially by Park Service staff and consultants, although they have been refined through public scoping comments from both the prior Abbotts Lagoon EA and the current EA development processes.

Other issues raised during scoping were determined to not have the potential for significant adverse effect: the discussion of the potential effect of these impact topics is addressed under *Impact Topics Considered, but Dismissed, from Further Analysis*.

Certain impact topics such as climate change have the potential to affect multiple resources such as air quality, hydrology, vegetation, wildlife, and others: in this instance, it will be addressed principally under *Natural Physical Processes and Soils*. (See next section for more detailed discussion on rationale for this decision). Because wetlands include unique vegetation and hydrology, these aspects are discussed both under *Vegetation Resources* and *Water Resources*.

Vegetation Resources

Invasion of non-native species has dramatically altered native dune vegetation communities, which support a number of critical threatened and endangered plants and wildlife species. These clonally-spreading invasives have not only directly impacted native dunes through establishment of expansive, monotypic stands that oust native species, but indirectly through changes in water availability, nutrients, soil biota, and even numbers of herbivores. Additionally, the Seashore's dunes contain the largest remaining expanses of two uncommon native foredune habitat types–American dunegrass (*Elymus mollis* ssp. *mollis*) and beach pea (*Lathyrus littoralis*).

Removal of invasive plants could involve manual or hand removal, mechanical removal and use of heavy equipment, chemical control or use of herbicide, and pre- and post-treatment measures such as mowing or prescribed burning. In addition, projects typically require set-up of staging areas, access roads, construction trailers, and other temporary facilities. All of these actions have the potential to result in destruction of native vegetation or rare plants, if impact avoidance and minimization measures are not employed. Impacts to native dune vegetation and rare plants such as curlyleaf monardella (*Monardella undulata*; CNPS List 4.2) could negatively affect Myrtle's silverspot butterfly (FE), which relies on these species as nectar sources.

Impacts such as these are generally avoided or minimized through implementation of a number of mitigation measures, including thorough pre-restoration surveys, flagging of work areas and access routes, use of backpack sprayers and spot spraying to limit drift, and strict weather and wind restrictions on spraying and prescribed burns. Over the long-term, changes in sand movement could impact remnant native dune vegetation communities, rare plants, and wetlands. Because wetlands include unique soils, vegetation and hydrology, these aspects are discussed under several impact topics.

Potential benefits to vegetation resources include the restoration of coastal dunes now dominated by European beachgrass and iceplant to ecosystems supporting native coastal dune vegetation communities. In addition, the distribution of native plants, including several listed and rare species and two rare foredune habitat types, could expand.

Based on these factors, *Alternatives B-D* could have negligible to moderate beneficial effects on vegetation resources, particularly coastal dune and scrub resources, at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with *Alternative C* having the highest potential benefits. For resources such as coastal prairies and wetlands, however, *Alternatives B-D* may have adverse impacts ranging from negligible to minor. Access and staging and implementation-related impacts would range from negligible to minor adverse. Under *Alternative A*, there would be no implementation-related impacts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, because restoration would not be conducted in the near-term at these areas, except for previously permitted projects. However, there could be negligible to minor adverse long-term effects from continued expansion of invasive plant species.

Species of Special Concern

The Seashore's dunes provide habitat for up to 11 federally listed species, however, the primary species using the dunes are the threatened Western snowy plover, the endangered Myrtle's silverspot butterfly, and the endangered plants, beach layia and Tidestrom's lupine. Other federally listed species that occur in or near dunes or occasionally frequent dune areas include California red-legged frog (FT), Sonoma alopecurus (FE), California least tern (FE), and Willow flycatcher (FE). At least four of these species depend on coastal dunes or adjacent beaches for some portion of their life cycle, including snowy plover, Myrtle's silverspot butterfly, Tidestrom's lupine, and beach layia.

Removal of non-native invasive plants through manual, mechanical, or chemical control approaches could negatively affect special status plant and wildlife species. These impacts could either be direct ones – destruction of rare plants or wildlife habitat, mortality or harm to wildlife, or destruction of nests or breeding areas – or indirect. Indirect impacts include disturbance of wildlife by equipment or crews, including possible nest abandonment; drift of herbicide onto non-target vegetation or onto food sources for wildlife; direct ingestion of plants sprayed with herbicides by wildlife; and other impacts. Impacts such as these are generally avoided or minimized through implementation of a number of mitigation measures, including thorough pre-restoration surveys, buffers to breeding areas, use of backpack sprayers and spot spraying to limit drift, and strict weather and wind restrictions on spraying and prescribed burns.

Opportunities for improving species of special concern include removal of non-native European beachgrass and iceplant, which both directly and indirectly impacts species such as Tidestrom's lupine, beach layia, western snowy plover, and Myrtle's silverspot butterfly. Additional state- and CNPS-listed species would be expected to benefit from this project. Monitoring conducted as part of previous restoration efforts have documented benefits to almost all of these species, including range expansions for rare plants and increases in nesting attempts and nest success for plovers.

Based on these factors, *Alternatives B-D* could have negligible to moderate beneficial effects on species of special concern associated primarily with coastal dune habitat, with *Alternative C* having the highest potential benefits, followed by *Alternative D*. For species not primarily associated with dunes such as Sonoma alopecurus and California red-legged frog, dune restoration could potentially have impacts due to sand remobilization, with *Alternative D* having the highest potential impacts, followed by *Alternative C*. Impacts may reach moderate intensities at AT&T, because it supports one of the largest remaining Sonoma alopecurus populations, as well as a red-legged frog population, unless impacts are reduced through possible additional mitigation measures to minor. Access and staging and implementation-related impacts would range from very negligible to minor adverse, with implementation-related minor adverse impacts potentially occurring for a number of species under *Alternatives C* and *D*. Under *Alternative A*, there would be no implementation-related impacts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, because restoration would not be conducted in the near-term at these areas, except for previously permitted projects. Over the long-term, the lack of near-term restoration would either have no effect or possibly up to moderate adverse impacts on species of special concern.

Wildlife

The Point Reyes region supports 28 species of reptiles and amphibians, 58 species of mammals, and breeding habitat for 123 species of birds (NPS IRMA 2013). Dunes provide habitat for both resident and non-resident wildlife species, although it has one of the lowest mammal densities of any habitat in the park (Fellers and Pratt 2002). Certain types of wildlife species actually use European beachgrass and possibly iceplant as habitat, including deer mice (*Peromyscus maniculatus*), rabbits, Trowbridge's shrews (*Sorex trowbridgii*), western harvest mice (*Reithrodontomys megalotis*), and vagrant shrews (*Sorex vagrans*), western terrestrial garter snake (*Thamnophis elegans*), northern alligator lizards (*Elgaria coerulea*), and Pacific tree frog (*Pseudacris regilla*): some of these species may actually occur in higher abundances in invaded dunes than native ones.

Removal of non-native invasive plants through manual, mechanical, or chemical control approaches could negatively affect wildlife species. These impacts could either be direct ones – destruction of habitat, mortality or harm to wildlife, or destruction of nests, burrows, or breeding areas – or indirect impacts. Indirect impacts include disturbance of wildlife by equipment or crews, including possible nest abandonment; drift of herbicide onto non-target vegetation that act as food sources for wildlife; direct ingestion of plants sprayed with herbicides by wildlife; and other impacts. Impacts such as these are generally avoided or minimized through implementation of a number of mitigation measures, including thorough pre-restoration surveys, buffers to breeding areas, use of backpack sprayers and spot spraying to limit drift, and strict weather and wind restrictions on spraying and prescribed burns.

Removal of invasive plant species can also benefit wildlife species. Complete conversion to monotypic stands of European beachgrass and iceplant may eliminate habitat for certain types of mammals and birds and also eliminate native dune plant species and open sand that provides foraging sources or areas for certain wildlife species.

Based on these factors, *Alternatives B-D* could have from moderate beneficial to possibly moderate adverse long-term effects on wildlife species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with mechanical removal projects having possibly moderate adverse impacts on small mammals such as deer mice, which have been documented to occur in higher numbers in beachgrass stands (Pitts and Barbour 1979). Because all of these species occur in multiple habitats, park-wide adverse impacts would be no more than negligible. For some species such as certain bird species and even certain amphibian and reptile species, dune restoration could potentially have negligible to possibly moderate beneficial effects, with *Alternative C* offering the highest benefits. Access and staging and implementation-related impacts would range from very negligible to moderate adverse, with implementation-related moderate adverse impacts potentially occurring from injury or death to mammals and amphibians and reptiles during mechanical removal activities. There would be no effect under *Alternative A*, as no restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour in the near-term, except for previously permitted projects. Over the long-term, *Alternative A* would largely have no effect on wildlife species, except potentially for small mammals such as deer mice and certain birds that use invasive species as habitat (negligible beneficial) or other wildlife species that would be adversely affected (negligible).

Natural Physical Processes and Soils

Coastal dunes are dynamic ecosystems formed by the combined action of wind and wave. Sediment enters the ocean from river mouth and is then pushed along the coast by longshore sediment transport until the sediment accumulates and is washed up along beaches. From the beaches, winds move sands steadily inland over time through a series of evolving dune features, including foredunes, transverse dunes, parabolic dunes, and backdunes. European beachgrass and iceplant were originally planted to stabilize the dunes, but have eliminated natural forces such as sand transport or movement of sand through the system and wind erosion, which creates open space and blow-out areas needed by plovers for foraging. In addition, these invasives species change the topography of the dunes, steepening both foredune and backdune slopes and re-orienting the alignment of the dunes.

Coastal environments are considered among the most vulnerable to changes from climate change. With rising sea levels, there will be more frequent and more serious flooding of low-lying coastal areas by extreme tides, storm surges, and wave effects. Coastal dunes offer a buffer against storm extreme tides and storm surges. This buffering capacity, however, is minimized and potentially eliminated when dunes are over-stabilized by invasive plant species or other alterations.

Removing beachgrass and iceplant could increase the instability of dunes slopes and basins and change system topography, with the intensity of changes dependent on the restoration approach employed. Both mechanical and large-scale manual removal could result in burying of adjacent native dune communities, dune swale features, as well as adjacent grassland and coastal scrub areas inland of the dunes: impacts to adjacent ranchlands from sand movement and measures to potentially avoid or minimize impacts are discussed under *Adjacent Land Use*. Impacts such as these are generally avoided or minimized through implementation of a number of mitigation measures, including tapering slopes in backdune areas and conducting active revegetation of back dune areas.

However, restoration could also encourage more natural dune processes that would result in more natural dune topography and ensure that these vital ecosystems are resilient to climate change impacts such as sea level rise, increased wave scour and storm surge, and, potentially, stronger coastal winds, all of which might necessitate migration of dunes systems inland if they are to persist in the future.

Based on these factors, *Alternatives B-D* could have from very negligible to moderate beneficial effects on natural dune processes and response to climate change at AT&T/North Beach, B Ranch/A Ranch/Davis Property, with *Alternative D* having the highest benefits, because there would be more restoration of natural processes with complete removal of European beachgrass and iceplant. Soils would primarily be affected by staging, access, and restoration implementation. Over the long-term, implementation would have effects on dune soils ranging from very negligible to moderate beneficial, with *Alternative D* having the highest benefits. Staging and access would have at most minor adverse impacts, with the highest intensity impacts associated with heavy equipment used during mechanical removal projects. There may also be some short-term moderate adverse impacts on soils associated with implementation under *Alternative D*. There could be very negligible to possibly minor adverse long-term impacts under *Alternative A*, as the lack of near-term restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would continue to adversely impact natural dune processes and soils in these areas.

Water Resources

Coastal dunes are not necessarily considered "aquatic" systems, but, without proximity to water, coastal dunes could not exist, as they are formed from river sediment carried by longshore currents that are eventually washed up onto the beach and then blown inland. Not only do the Seashore's dunes directly border the Pacific Ocean, but a few systems also lie adjacent to other water bodies such as Abbotts Lagoon, Drake's Estero, and Estero de Limantour. Also, within dunes are often depressional features or "dune swales" that support wetland vegetation. Wetlands also occur along the inland edges of dune systems in coastal grassland.

Manual, mechanical, and chemical removal of European beachgrass and iceplant can impact these wetlands either directly or indirectly. Mechanical removal adjacent to wetlands has the potential to cause fill or fallback of soils from upland areas into wetlands due to movement of biomass and rhizome materials. In addition, fueling of equipment or use of herbicides could directly impact wetlands if proper prevention measures such tarps and drift shields are not employed, or wetland and fueling buffers – or restricted work zones – are ignored. Temporary fills or placement of soils or other materials in wetlands may be required to construct access routes either to or within the dune site. Indirect impacts include mobilization of high volumes of sand that bury dune slack wetlands, although these features may reappear in other areas as they are, by nature, ephemeral habitats. There are a number of impact avoidance and measures that would protect wetland ecosystems, including use of silt fencing during mechanical removal, buffers for herbicide spraying and equipment fueling, use of drift shields, and restrictions on spraying due to inclement weather and high wind conditions. At AT&T, special mitigation measures may be implemented under *Alternatives C* and *D* to reduce potential long-term impacts on dune swales – and Sonoma alopecurus and California red-legged frog – from moderate to minor, including selective retention of some European beachgrass-dominated wetland buffers, regrading of steep slopes, and active revegetation of adjacent slopes.

While wetlands may not benefit as dramatically from dune restoration as other habitats, European beachgrass and iceplant can, to a lesser degree, invade wetland areas and degrade wetland quality and function.

Based on these factors, *Alternatives B-D* could have no effect or long-term effects ranging from negligible beneficial (Alternative B) to moderate adverse, with *Alternative D* having the highest potential impacts, because, under this alternative, projects would primarily be conducted using mechanical removal. Potential moderate adverse impacts that could occur at AT&T would be mitigated to minor using several measures discussed above. Impacts from staging and access and implementation would be no more than minor, with the highest intensity impacts associated with heavy equipment primary and secondary access. Under *Alternative A*, there would be no implementation-related effects, because dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour in the near-term, except for previously permitted projects. Over the long-term, the lack of near-term restoration could have either no effect or negligible adverse effects on water resources such as wetlands.

Wilderness

As discussed earlier, the Seashore contains both designated and potential wilderness areas that must be managed differently from other lands within the park. Coastal wilderness is often valued for its "natural" and "untrammeled" conditions, as well as its "primeval character." Along beaches and dunes of the Seashore, wilderness is restricted to beach areas adjacent to the ocean and certain portions of the coastal dune system, including near the mouth of Abbotts Lagoon, portions of North Beach, A and B Ranches, and Davis Property, and Limantour Beach. Of the roughly 2,200 acres of coastal dune, bluff, and scrub within the Seashore, approximately 30% or 660 acres fall within designated wilderness.

Potential impacts to wilderness from manual, mechanical, and chemical removal of invasive plants could result from both the direct, as well as indirect, effects of restoration and would include many of the impacts discussed in other impact topics such as *Vegetation Resources*, *Species of Special Concern*, and *Wildlife*. Direct impacts of particular concern in wilderness include use of mechanized equipment in wilderness, such as heavy equipment, cars, trucks, and UTVs; installation of temporary construction facilities; and soil excavation and disturbance from burning or herbicide use. These impacts, along with noise associated with all of these activities, could temporarily disrupt the wilderness character of these coastal wilderness areas and preclude opportunities for solitude for visitors. Impacts such as these are generally avoided or minimized through implementation of a number of mitigation measures, including avoiding or limiting the use of mechanical equipment in wilderness areas and limiting the number of secondary access routes.

Over the long-term, coastal dune restoration could benefit wilderness character by returning these heavily impacted coastal ecosystems to a "natural" and "untrammeled" condition that could increase attractiveness of these areas for visitation.

Based on these factors, *Alternatives B-D* could either have no effect (no wilderness present) or beneficial long-term impacts ranging from very negligible to moderate on wilderness, with *Alternative C* having the highest potential benefits, followed by *Alternative D*. Staging and access and implementation would either have no effect (no wilderness present) or adverse impacts ranging from very negligible to moderate, with the highest intensity impacts associated with use of heavy equipment for dune restoration. Under *Alternative A*, there would be no implementation-related effects, because dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour in the near-term, except for previously permitted projects. Over the long-term, the lack of near-term restoration could have negligible to possibly minor adverse impacts due to continued expansion of invasive non-native plants in wilderness areas.

Soundscapes

While noise often has a negative connotation, one of the intrinsic values of national parks remains the potential for hearing "natural" noises such as crashing waves, running streams, thunder, or singing birds. A combination of noises that is intrinsic to a natural landscape is often characterized as a soundscape. Unlike more urban parks, the Seashore and north district of Golden Gate National Recreation Area (GGNRA) are located in a rural portion of western Marin County and must contend less with the intrusive influences of urbanization than the southern portions of GGNRA. Regardless of location, however, the Park Service is directed to preserve, to the greatest extent possible, the natural soundscapes of parks and to restore soundscapes that have become degraded due to "unnatural sounds" (noise; NPS 2006, Section 4.9).

Manual, mechanical, and chemical removal of European beachgrass and iceplant can both directly and indirectly soundscapes. Direct impacts would relate mostly use of heavy equipment in mechanical removal or motorized equipment such as UTVs and presence of crews in other types of restoration efforts. Measures that could avoid or minimize these impacts include including requiring vehicles to have received recent maintenance and be in good operating condition, restricting equipment idling time, and reducing the number of concurrently operating pieces of equipment.

Based on these factors, *Alternatives B-D* would have no long-term effects on soundscapes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. During implementation, adverse impacts from staging and access and dune restoration could range from very negligible to moderate, with the highest intensity impacts under *Alternatives C* and *D* linked to use of heavy equipment in dune areas. Moderate impacts could be reduced to minor by use of Best Management Practices designed to reduce noise-related impacts from heavy equipment, including ensuring that equipment has properly functioning and up-to-date sound control devices. Under *Alternative A*, there would be no long-term or implementation-related effects, because dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour in the near-term, except for previously permitted projects.

Cultural Resources

Coastal areas, including dunes, often end up being areas of cultural or archaeological significance. Native American tribes often congregated in these areas for collection of food and created centralized disposal areas or "middens." Ships that wrecked off the coast prior to the 21st century may have deposited timbers and other materials on the beach that eventually get buried by sand. Other items, discarded in the ocean, often washed up on the beach, as well, some of which may have some historical significance. Artifacts may have also ended up in the dunes that originated from more terrestrial sources such as from operational activities of the historic radio transmission facilities.

Most of the potential for impact to cultural resources from dune restoration comes from disturbance of soils during manual or mechanical removal. The use of heavy equipment to dig up beachgrass and iceplant, traveling by excavators along double track paths and roads, or even manual removal could unearth or partially uncover subsurface or surface archaeological or historic resources. Prescribed burning or mowing could impact any previously identified surface or shallow subsurface artifacts. Impacts such as these are generally avoided or minimized through implementation of a number of mitigation measures, including cultural resources surveys being conducted at any site in the Seashore that would be subject to ground disturbance, strict requirement for contractors to cease work if any potential resources are encountered, and, for areas with high potential for resources, presence of a cultural monitor. There may also be indirect impacts associated with sand remobilization that could threaten resources in adjacent dune areas.

Based on these factors, *Alternatives B-D* would have adverse impacts ranging from very negligible to moderate on cultural resources at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Moderate impacts associated with implementation may occur where recorded and unrecorded resources exist within established European beachgrass stands or iceplant stands and where removal of these plants could destabilize soils of the site. These impacts could be reduced to either negligible or minor either by avoidance or potentially by phasing removal efforts and taking steps to stabilize the area with erosion control procedures and revegetation. Under *Alternative A*, there would be no effect, because dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour in the near-term, except for previously permitted projects.

Visitor Experience

National parks are valued for the recreational and aesthetic resources they provide to the public, both visitors and nearby residents. Park visitors expect national parks to provide beauty, a sense of quiet, and opportunities for hiking, bird-watching, and other recreational pursuits. Perhaps, some of the most valued natural resources within parks in terms of sheer visitor numbers are beach and water-related ones such as beaches, covers, rivers, lakes, oceans, and waterfalls, and even geysers. Beaches, wetlands, and water bodies offer opportunities for hiking, birdwatching, fishing, kayaking and canoeing, boating, and swimming.

Visitors used to quiet or solitude could be disturbed by humans removing or treating non-native plants and by the use of heavy and noisy equipment or vehicle transport. If mechanical removal was performed or mechanical equipment was used for transport, the equipment would release pollutants and stir up sand and dust. The use of prescribed burning as a pre-treatment measure could generate smoke that is irritating to visitors. Staging areas, where temporary office space, fuel storage and personnel parking takes place, may also be in areas where visitors now experience a low level of human presence. While herbicides that would be used would not require a formal Re-entry Interval (REI), the Seashore still requires that those areas being sprayed with herbicide are closed during and 24 hours after spraying. Impacts such as these are generally avoided or minimized through implementation of a number of mitigation measures, including requiring vehicles to have received recent maintenance and be in good operating condition, restricting equipment idling time, ensuring that burns are not conducted during adverse weather conditions and that they comply with air quality regulations and restrictions, and providing adequate prior notification for closures of work areas and for activities that would be performed.

In the long-term, with restoration, views would become more natural and open. Species diversity of plant life is likely to increase, and native animal life would be more abundant, all of which could increase visitor enjoyment.

Based on these factors, *Alternatives B-D* would have negligible to possibly moderate long-term benefits on visitor experience at AT&T/North Beach, B Ranch/A Ranch/Davis Property, with *Alternative C* having the highest potential benefits due to the fact that more invaded dune areas could be restored under this alternative. Implementation-related impacts would range from very negligible to moderate adverse due to presence of construction equipment and possible temporary closures of some areas during construction. Under *Alternatives C* and *D*, staging and access could have a very negligible adverse impact on visitor experience at B Ranch/A Ranch/Davis Property and AT&T, with moderate adverse impacts at Limantour and North Beach. Project areas in the southern portion of the Great Beach are very rarely visited by the public due to the lack of easy access, however, AT&T is visited by a number of park visitors interested in the historic radio facility, and Limantour and North Beach are widely visited by beachgoers. Under *Alternative A*, there would be no implementation-related effects, because dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour in the near-term, except for previously permitted projects. Over the long-term, there could be negligible adverse effects from continued expansion of invasive non-native species into coastal dunes, particularly as both European beachgrass and iceplant tend to form monocultures with very low species diversity.

Adjacent Land Use

Inland of active dunes are remnants of coastal marine terrace that are strongly influenced by past deposition events, evident in the sandy characteristics of the soils that now underlie vast managed grassland, coastal prairie, or coastal scrub lands along the coast. Centuries of grassland establishment and subsequent organic matter deposition have transformed these once granular, relatively nutrient-poor, well-drained soils into fertile grasslands. Many of these grasslands support active beef and dairy cattle ranching within the park. Consistent with current trends within the agricultural industry, a number of lessees have begun managing their pastures and/or herds as organic.

Manual, mechanical, and chemical removal of European beachgrass and iceplant can both directly and indirectly affect these adjacent lands. Direct impacts would relate mostly to the fact that most dune systems need to be accessed through ranches. Transportation of construction crews, the use of heavy equipment, staging areas, and access roads could have temporary and adverse effect on neighboring ranchers, cattle, or on the lands and land use itself. Indirectly, mechanical and large-scale manual removal could cause large-scale mobilization of sands that have been stabilized prior to this by European beachgrass and iceplant. These sands could move into adjacent lands and affect land use, including forage quality and quantity. Loss of available forage could require additional forage or water supplementation. Most ranchers already supplement forage, however, based on discussions with ranchers, cost of forage supplementation for cattle has increased in recent years, particularly for those running organic operations.

In addition, sand could bury fences that ranchers are required by the park to maintain to keep cattle out of sensitive dune habitat or natural or artificial water sources for cattle. Ranchers may be concerned about the potential for drift of herbicide onto adjacent pastures managed as organic, if standard best management practices required by the park to be employed for all spray operations are not employed.

Measures that could avoid or minimize these impacts include good communication and close cooperation with ranchers, careful oversight of and good communication with contractors, establishment of buffers or no spray zones adjacent to organic pastures, and careful adherence to best management practices regarding restrictions of spraying during certain climatic conditions. As it has done in the past, the Seashore would also work with ranchers when installing new fencing to ensure that only materials that meet organic certification needs are used.

Based on these factors, *Alternatives B-D* would either have no long term effect or potential adverse effects ranging from negligible to moderate at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. These adverse impacts would result from loss of forage from remobilization of sands and may result in changes in the amount of forage or water supplementation required, with *Alternative D* potentially having the high intensity impacts due to the potential for mechanical removal activities. Due to standardized best management practices regarding chemical treatment, including use of buffers between organic operations and chemical treatment and restrictions on spraying during certain weather conditions, none of the alternatives would have the potential for more than a negligible adverse effect on organic or non-organic operations. There would no long-term effects associated with this project under Alternative A, because near-term restoration would not be conducted, except for previously permitted projects. However, as discussed in this document, based on analysis of historic aerial imagery, sand movement into the pastures has occurred even with adjacent dune areas being dominated by invasive plants, and this would be expected to continue in future years.

During implementation, staging and access and dune restoration would either have no effect on adjacent land use or potential adverse impacts ranging from very negligible to minor adverse, with minor or possibly minor impacts under *Alternatives C* and *D* linked to staging and access of heavy equipment within pastures adjacent to dunes. Under *Alternative A*, in which there would be no implementation-related effects.

Public Health and Safety

Enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks (NPS 2006, Section 8.2). Some of this enjoyment may ultimately depend on health and safety of park visitors. While recognizing that there are limitations on its capability to totally eliminate all hazards, the Park Service – and its concessioners, contractors, and cooperators – are directed to provide a safe and healthful environment for visitors and employees (NPS 2006, Section 8.2). Based on Park Service Management Policies (2006, Section 8.2), unacceptable impacts are impacts that, individually or cumulatively, would … create an unsafe or unhealthy environment for visitors or employees.

Potential impacts to health and safety of visitors could result from manual, mechanical, and chemical removal of invasive plant species and from pre- and post-treatment measures such as prescribed burning and mowing. Park staff and contractors are responsible for public safety and must provide adequate area closures, trail monitoring, and signage to ensure that visitors understand safety precautions. The use of herbicides, mechanical equipment, and prescribed burning must conform to Occupational Health and Safety Act regulations (OSHA), USEPA standards, California Department of Pesticide Regulation (CDPR), and local air quality management district regulations. Impact avoidance and minimization measures include closures of work areas; noticing of closures; strict weather restrictions on spraying and prescribed burning. Potential long-term impacts include remobilization of sand that, in some situations, can blow onto immediately adjacent public roadways, possibly increasing public safety hazards relative to current conditions.

Dune restoration can also lessen threats to public heath and safety by improving ease and visibility of access in restored dune areas.

Based on these factors, *Alternatives B-D* would have very negligible to negligible long-term beneficial effects on potential risks to public health and safety at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Potential minor threats to public safety could occur where dune restoration efforts would occur closer to public roads and parking lots: these threats could be minimized to some degree by leaving a buffer of iceplant near the road or installing sand fence, which could reduce potential impacts to negligible. Potential impacts would be offset by improvements to hiking safety associated with removal of European beachgrass. Indeed, under *Alternative A*, the lack of near-term restoration at these dune system areas could result in negligible adverse impacts to public health and safety.

Implementation-related impacts would range from very negligible to minor adverse, with higher intensity impacts related to the potential presence of construction equipment in dunes near beaches and in parking lots. Based on results from application of project-specific information in U.S. Forest Service (USFS) risk assessment models, none of the potential avenues for impacts to public safety from chemical treatment such as spray drift or inadvertent contact with treated vegetation would even come closer to approaching the Hazard Quotient threshold level of concern (HQ=1.0) for sensitive individuals such as young women and children. Under *Alternative A*, there would be no implementation-related effects, because dune restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Park Operations and Management

As with most federal agencies, the Park Service relies on Federal appropriations to fund its core activities through base funding, although there is increasing use of alternative revenue sources, such as private monies and grants, to fund specific projects. Coastal dune restoration projects typically involve efforts of a number of park personnel, including those from Resource Management, as well as from Budget, Contracting, Cultural Resources, Interpretation, Law Enforcement, and Facilities.

Potential impacts to park operations involve both logistical and maintenance considerations. Park biologists would be heavily involved in running restoration efforts, including volunteer programs. Fire Division employees would be the most likely ones to implement any use of prescribed burning as a pre-treatment measure. Other park staff may be needed to assist with restoration efforts, including Budget, Contracting, Cultural Resources, Interpretation, Law Enforcement, and Facilities. These staff would help prepare contracts, process invoices, manage accounts, survey for cultural resources and prepare SHPO documentation, post web-sites and produce press releases, assist with inquiries from the public, and help with public safety concerns.

Other potential impacts to park operations include changes in the amount of maintenance required to keep park facilities and roadways operational and safe for staff and visitors. Mechanical or large-scale manual removal of invasive plants could mobilize sands that blow over immediately adjacent roadways and parking lot surfaces, increasing the amount of maintenance required.

Based on these factors, over the long-term, *Alternatives B-D* would have either no effect or adverse impacts ranging from negligible to possibly minor adverse, with *Alternative D* having the highest potential impact due to the potential for more impacts on park roads and facilities from sand remobilization and associated impacts in maintenance demands. Higher intensity impacts could potentially occur from restoration at A Ranch, Limantour, North Beach, and, to a lesser extent, Davis Property, where restored areas would adjoin paved park roads and parking lots. Implementation-related or short-term impacts would range from very negligible to negligible adverse, with higher intensity impacts related to the degree of contracting and other administrative support required to implement dune restoration projects. There would be no effects under *Alternative A*.

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PURPOSE AND NEED FOR ACTION

INTRODUCTION

Point Reyes National Seashore ("park" or "Seashore"), a unit of the National Park Service (Park Service) is preparing a programmatic compliance document for restoration of three coastal dune systems at the Seashore to benefit native coastal dune ecosystems, natural dune processes, and federally and non-federally listed species that live in or use these ecosystems. These three general areas – AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour -- are considered a high priority for restoration, because of the value of these areas to threatened and endangered species and the opportunity to expand unfragmented coastal dune habitat. Habitat would be restored by removing highly invasive, non-native plant species that have greatly altered dune structure, natural processes such as sand movement, vegetation communities, and habitat function for native plants and animals uniquely adapted to this coastal environment. This document leverages previous compliance efforts conducted by the park for past dune restoration projects, including the Environmental Assessment (EA) prepared for the Abbotts Lagoon Coastal Dune Restoration Project in 2009.

Purpose and Need

The ***Purpose*** of this action is to improve and restore native coastal dune ecosystems in up to 600 acres of the Seashore through removal of non-native or invasive plant species and to, thereby, assist with recovery efforts for the highly imperiled endangered and rare species associated with these ecosystems.

Restoration is ***Needed*** for the following reasons:

Invasive Species Threaten Habitat

The Seashore preserves some of the last remaining high quality coastal dune habitat in the United States. However, this habitat is seriously threatened by the rapid encroachment of at last two invasive, non-native plant species, European beachgrass (*Ammophila arenaria*) and iceplant (*Carpobrotus edulis*). By 2009, more than 60% (1,400 acres) of the park's roughly 2,200 acres of coastal dune, bluff, and scrub habitat was estimated to be dominated by European beachgrass and iceplant (NPS 2009).

European beachgrass, a member of the grass or Poaceae family, is a native perennial grass of Europe and North Africa introduced to California in the late 1800s to help stabilize blowing sand dunes. Along the Pacific Coast, European beachgrass has spread to inhabit areas from Santa Barbara County, California in the south to Canada in the north. European beachgrass predominantly spreads vegetatively through rhizomes or belowground root structures. Up to approximately 758 acres of European beachgrass occur along the Great Beach on the outer coast of the Seashore, and another approximately 124 acres occur along the Liman-

European beachgrass forming a dense monotypic stand

Coastal Dune Restoration Environmental Assessment
Point Reyes National Seashore

National Park Service
Point Reyes National Seashore
Marin County, California

0 0.75 1.5 Miles

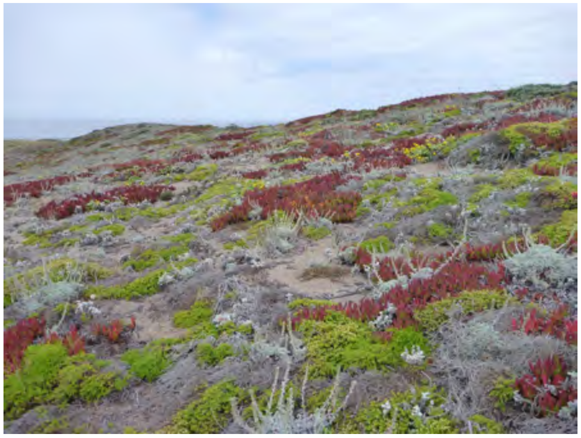
N

Figure 1. Beachgrass and Iceplant Extent as of 1994 Vegetation Mapping Effort in Seashore

European Beachgrass

Iceplant

S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\1_Beachgrass and Iceplant.mxd tour Spit, with the northern portion of the Great Beach and Limantour more heavily dominated by beachgrass than iceplant (Figure 1).



Iceplant forming large red patches intermixed with native dune vegetation

Iceplant, a succulent, prostrate member of the Aizoaceae family, was introduced to California in the early 20th century to stabilize dunes adjacent to railroad tracks and was later planted along highways and on coastal sand dunes (Albert 1995a). Its popularity as a planting along California's highways and freeways has led to iceplant to be also called, "freeway iceplant." This succulent spreads both vegetatively and by seed (NPS 2003). Approximately 388 acres of iceplant are present along the Great Beach, with iceplant being more dominant than beachgrass toward the central and southern portions. On the Limantour side, iceplant accounts for approximately 33 acres of converted dune habitat (Figure 1).

Other non-native invasive or potentially habitat-altering species can also occur in the dunes. These include European sea rocket (*Cakile* spp.) and bush lupine (*Lupinus arboreus*). Within the Seashore, European sea rocket's distribution is much more limited relative to European beachgrass and iceplant. Bush lupine is native to California, but its historic range apparently incorporated only central and southern California. As with other coastal areas, bush lupine establishes in both grasslands and dunes (Pickart and Sawyer 1998).

Yellow bush lupine

Park Service Management Policies (2006) state that, "all exotic plant and animal species that are not maintained to meet an identified park purpose will be managed—up to and including eradication—if (1) control is prudent and feasible, and (2) the exotic species interferes with natural processes and the perpetuation of natural features, native species or natural habitats, or disrupts the genetic integrity of native species……" (NPS 2006, Section 4.4.2).

Rare Species Impacted by Invasive Species

The Seashore's dunes provide habitat for up to 11 federally listed species, however, the primary species using the dunes are the threatened Western snowy plover, the endangered Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*), and the endangered plants, beach layia and Tidestrom's lupine. Other federally listed species that occur in or near dunes or occasionally frequent dune areas include California red-legged frog (*Rana draytonii*; dune swale wetlands; FT), Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*; wetlands in or near dunes; FE), California least tern (*Sternula antillarum*; FE), and Willow flycatcher (*Empidonax trailii extimus*; FE). Additionally, the Seashore's dunes contain the largest remaining expanses of two uncommon native foredune habitat types–American dunegrass (*Elymus mollis* ssp. *mollis*) and beach pea (*Lathyrus littoralis*).

Western snowy plover (Photo: Bruce Farnsworth)

These rare species and habitat types are imminently threatened by both physical and ecological changes associated with the presence and spread of European beachgrass and iceplant.

Invasive plants have both direct and indirect effects on native flora and fauna. The large monotypic stands or mats of European beachgrass and iceplant directly displace native dune vegetation communities, decreasing cover and species richness and diversity of native species and simultaneously increasing overall vegetation cover relative to native dune communities (Barbour et al. 1976, Boyd 1992, Olsen 1994, Vilà et al. 2006, Carboni et al. 2010). Among the species displaced are rare ones (Pavlik 1983, Seabloom and Wiedemann 1994, USFWS 1998, Wiedemann and Pickart 2004, Thorpe 2008). Plant species at Point Reyes that may be impacted include rare ones such as Tidestrom's lupine, beach layia, curlyleaf monardella (*Monardella undulata*; California Native Plant Society (CNPS) List 4.2), and dune gilia (*Gilia capitata* ssp. *chamissonis*; CNPS List 1B.1). Many of these native dune species act as nectar sources for the federally endangered Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*). The invasive species can also expand into beach areas, eliminating potential nesting areas for Western snowy plover.

In addition to direct effects, these species have indirect effects by creating dense stands that provide cover to animal predators of Western snowy plover and seeds of Tidestrom's lupine. European beachgrass stands harbor a higher density of native deer mice (*Peromyscus maniculatus*) than native dune communities (Boyd 1988), and, at the Seashore, these mice can consume up to 82% of the seeds of endangered Tidestrom's lupine (Dangremond et al. 2010). In fact, recently completed population viability analyses by university researchers have shown that almost all of the Seashore's Tidestrom's lupine populations are headed towards extinction, because they are not successfully reproducing due to seed predation (Dangremond et al. 2010, Pardini and Knight, unpub. data). Plover numbers within the Seashore during the last decade have also dropped dramatically: a number of factors may be responsible, including regional trends, habitat disturbance by people and dogs, and direct and indirect impacts of invasive plants.

Federally endangered Tidestrom's lupine

Recognition of these impacts led the U.S. Fish and Wildlife Service (USFWS) in its 1998 Recovery Plan for Seven Coastal Species to call for restoration of dune habitats through an "aggressive program to control non-native invasive plant species" (USFWS 1998).

In Management Policies, Park Service units are required to "survey for, protect, and strive to recover all species native to national park system units that are listed under the Endangered Species Act. The (Park) Service will fully meet its obligations under the Park Service's

Organic Act and the Endangered Species Act to both proactively conserve listed species and prevent detrimental effects on these species. To meet these obligations, the (Park) Service will ….undertake active management programs to inventory, monitor, restore, and maintain listed species' habitats; control detrimental nonnative species; manage detrimental visitor access; and reestablish extirpated populations as necessary to maintain the species and the habitats upon which they depend….” (NPS 2006, Section 4.4.2.3).

Natural Dune Processes and Conditions Impacted by Invasive Species

European beachgrass mixed with native shrubs in backdunes

Both European beachgrass and iceplant form dense, monotypic mats or stands. These dense stands alter sand dune structure and function by slowing sand movement and changing sand deposition patterns. In natural communities, dunes continually change in response to sands transported into these systems by waves and wind, typically forming morphologically and floristically distinct foredune and backdune communities. Prior to establishment by invasive species, foredunes were less continuous in terms of structure, hummocky in nature, and generally low in height with gentle slopes (Barbour and Johnson 1988, Pickart and Sawyer 1998). Natural foredune complexes are often characterized by relatively flat corridors or "blow-outs" between dune ridges that allow for movement of wind and sediment, as well as animals, and "slacks" or depressional basins where groundwater and precipitation form dune swales or wetlands. Non-native species and their deep root and rhizome systems armor dune systems and prevent natural migration, which leads to overly large and steeply sloped foredunes and backdunes (Cooper 1936, 1967, Pickart and Sawyer 1998). They may also change the pattern of dune development, creating continuous ridges parallel to the beach rather than ones oriented perpendicular to the beach along the prevailing wind direction (Cooper 1958, Seabloom and Wiedemann 1994, Wiedemann and Pickart 2004).

In Management Policies (2006), Park Service units are required to "reestablish natural functions and processes in parks unless otherwise directed by Congress….. Impacts on natural systems resulting from human disturbances include the introduction of exotic species … and the disruption of natural processes. The (Park) Service will seek to return such disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated. The (Park) Service will use the best available technology, within available resources, to restore the biological and physical components of these systems, accelerating both their recovery and the recovery of landscape and biological community structure and function. Efforts may include, for example, removal of exotic species….” (NPS 2006, Section 4.1.5).

Wilderness Impacted by Invasive Plant Species

The National Wilderness Preservation System was established by Congress in 1964 to ensure that some lands of the United States would be preserved and protected in their natural condition for the permanent good of the people. Wilderness is defined as "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation which is protected and managed so as to preserve its natural conditions" (16 U.S.C. 1132).

Within the Seashore's coastal dunes, wilderness is primarily located along the beach areas, with many of the dunes themselves not incorporated into wilderness although there are a few exceptions near the mouth of Abbotts Lagoon, North Beach, A and B Ranches, Davis Property, and Limantour Beach. Acres of wilderness within project areas ranges from 0 acres at AT&T and Davis to 190 acres at Limantour, with 40- to 90 acres of wilderness at North Beach and A and B Ranches. Planting of European beachgrass and iceplant prior to establishment of the park has impinged on the "untrammeled" nature of wilderness, because the dunes are not unhindered and free from modern human control or manipulation." In addition, the rapid spread of these non-native plants has impacted the "Natural" nature of the wilderness, in that the ecological systems are not substantially free from the effects of modern civilization. The dense monocultures or stands of both species now present throughout the dunes reduces the attractiveness of these areas for visitation and, thereby, lessens the opportunities for solitude or a primitive and unconfined type of recreation.

Resiliency to Climate Change Impacted by Invasive Species

Coastal environments are considered among the most vulnerable to changes from climate change, including direct changes (e.g. changes of temperature and precipitation) and indirect changes (e.g. sea level rise, wind and water circulation, increasing storm events; U.S. Environmental Protection Agency (EPA) 2013). With rising sea levels, there will be more frequent and more serious flooding of low-lying coastal areas by extreme tides, storm surges, and wave effects (USEPA 2013). Coastal dunes offer a buffer against storm extreme tides and storm surges (Pries et al. 2008). This buffering capacity, however, is minimized and potentially eliminated when dunes are over-stabilized by invasive plant species or other alterations. Over-stabilization makes dunes more susceptible to loss from erosion by not enabling them to move or migrate naturally in response to sea level rise and changes in erosional patterns (Millington et al. 2009).

Abbotts Lagoon breached in 2011 from a storm surge

Objectives

Objectives are specific statements of purpose. Alternatives are not considered reasonable unless they are able to meet, to a large degree, primary objectives and resolve purpose and need for action. These objectives largely draw from the extensive scoping of project purpose and objectives conducted during the earlier Abbotts Lagoon planning process, as well as recent scoping efforts related to future dune restoration efforts.

The ***primary objectives*** related to dune restoration at the Seashore include:

- Remove non-native, invasive plant species from dune habitat where they interfere with natural physical processes such as sand movement and hydrology.

- Remove non-native, invasive plant species from dunes to create conditions under which native plant and wildlife species can flourish.

- Minimize potential for non-native species reinvasion of restored habitat.

– Increase potential coastal dune habitat for target threatened and endangered species affected by non-native, invasive plant species. The USFWS Recovery Plan for endangered dune plant species calls for expanding population numbers and ranges through restoration and protection of dune habitats, with restoration to be focused on an "aggressive program to control non-native invasive plant species."

– Work with park ranchers to minimize impacts to beef and dairy cattle ranching operations on adjacent lands.

Secondary objectives are goals that the park would like to achieve in taking action, but that do not define whether an alternative is reasonable. In other words, fulfilling these goals is desirable, but not required.

The **secondary objectives** related to dune restoration at the Seashore include:

– Increase visitor understanding of natural dune processes.

– Use adaptive management to inform and improve subsequent dune restoration efforts.

– Increase opportunities for research into understanding the restoration of coastal California dunes.

Planning Process

This environmental planning process follows certain prescribed rules and regulations that the Park Service has developed to implement the National Environmental Policy Act (NEPA). These regulations are contained in the Park Service's Director's Order 12 (DO-12; NPS 2001), as well as the NEPA regulations governing all federal agencies (40 CFR 1500 et seq.). Options for complying with NEPA on a federal level involve preparation of a Categorical Exclusion (CatEx), an Environmental Assessment (EA), or an Environmental Impact Statement (EIS). For documents such as EAs and EISs, DO-12 advises agencies to include a full range of alternatives and requires that the No Action, or continuation with existing conditions or management programs, be analyzed as a baseline for comparison. DO-12 also requires that the EA be available for public review for 30 days and recommends holding a public meeting if "large-scale interest" in the proposal exists.

Excavator removing European beachgrass

Prior Related EA Efforts

Starting in 2005, the Seashore initiated internal scoping for the largest dune restoration conducted at the Seashore – the Abbotts Lagoon Coastal Dune Restoration Project. A decision was made at that time to prepare an EA to complete the environmental planning process required by NEPA for this project, which would remove invasive species from approximately 300 gross acres of dunes just south of Abbotts Lagoon. A scoping letter was sent to approximately 300 parties on the park's mailing list, and three (3) letters were received. Two were supportive of dune restoration, but had concerns about potential direct and indirect impacts to rare plant species. There was also concern expressed about noise and adverse impacts of heavy equipment in the dune area to wildlife. These concerns were addressed in the EA.

The EA for Abbotts Lagoon project was released to the public in February 2009 for 45 days. A letter was sent to approximately 300 people noticing them of the availability of the document for review and the time and date of the public meeting, which was held on March 11, 2009, and attended by one member of the public and two reporters. The EA was also noticed by the State Clearinghouse and through direct mailings to agencies. Seven (7) comment letters were received by the end of the comment period.

Issues raised in these letters included: concerns about and requests for more information on the use of herbicide; concerns about the impacts of mechanical removal on wildlife and visitation by birders; concerns about the impacts of dune restoration on rare plants and dune swale wetlands; requests for more detailed information on iceplant removal, restoration timelines, and cost estimates; requests for better protection of dune and wetland habitats on ranchlands from grazing impacts; and requests for improvement of fencing to allow better public access.

These concerns and others raised after release of the EA were addressed in the Finding of No Significant Impact and the errata sections for the EA, which were approved by the Regional Director on June 25, 2009. The selected alternative was the alternative identified as the preferred one in the EA – Alternative C – which primarily relied on mechanical methods for removal of European beachgrass. A copy of the signed FONSI, which includes the errata sections, was mailed to permitting agencies and commenters on July 9, 2009. A copy of the FONSI and errata sections was also posted on the Seashore's website.

Current EA Efforts

The success of the Abbotts Lagoon Coastal Dune Restoration Project has encouraged the Seashore to pursue additional dune restoration efforts where resource needs are highest. Following some initial internal scoping discussions and discussions with regulatory agencies, the park elected to prepare an environmental compliance document for removal of European beachgrass and iceplant from dune ecosystems in the park considered to be of the highest priority for restoration.

This compliance effort has very similar purpose, need, objectives, and, to some extent, proposed alternatives to conducting dune restoration as the original compliance 2009 EA effort. One of the primary differences will be in the geographic scope of potential restoration efforts covered under this document. The scope of this document is larger than the previous EA. In addition, while alternatives will still analyze different approaches to restoring the dunes, the type of techniques or combination of techniques proposed have been altered to reflect current information on the best methods for performing large-scale removal of these invasive species with the least impact to existing natural, cultural, and adjacent land use resources.

This document will focus on restoration at three general areas within the Seashore. These areas include AT&T and North Beach dunes south of the Abbotts Lagoon project area; B Ranch, A Ranch, and Davis Property dunes at the southern end of the Great Beach; and Limantour Spit. These are areas where restoration holds the highest potential for benefitting Tidestrom's lupine, beach layia, Myrtle's silverspot butterfly, and/or Western snowy plover (Figure 2).

A scoping letter was sent to the public on December 6, 2012, to solicit comments on dune restoration within the Seashore, the proposed compliance route, range of alternatives, and topics to be analyzed as part of the EA. At the time of this letter, the proposed compliance route was preparation of a programmatic compliance document that would have covered dune restoration throughout the Seashore, but the broader scope of this type of document was judged to be better handled by future compliance efforts. Several of the high priority dune restoration areas were proposed for evaluation at project- or site-specific detail in that proposed programmatic document (AT&T; B Ranch). These projects, along with North Beach, A Ranch, Davis Property, and Limantour, are now the focus of this EA.

The scoping period closed on January 15, 2013. The Seashore received 12 letters. Concerns or comments expressed in these letters included:

- *support for dune restoration;*
- *general concerns about herbicide use;*
- *concern about impacts to park agriculture from sand movement;*
- *concern about herbicide use adjacent to organic pastures;*
- *concerns about long-term management of invasives;*
- *concerns about use of a programmatic approach rather than a project-by-project approach; and*
- *request to evaluate use of hydromechanical obliteration as a possible removal technique*.

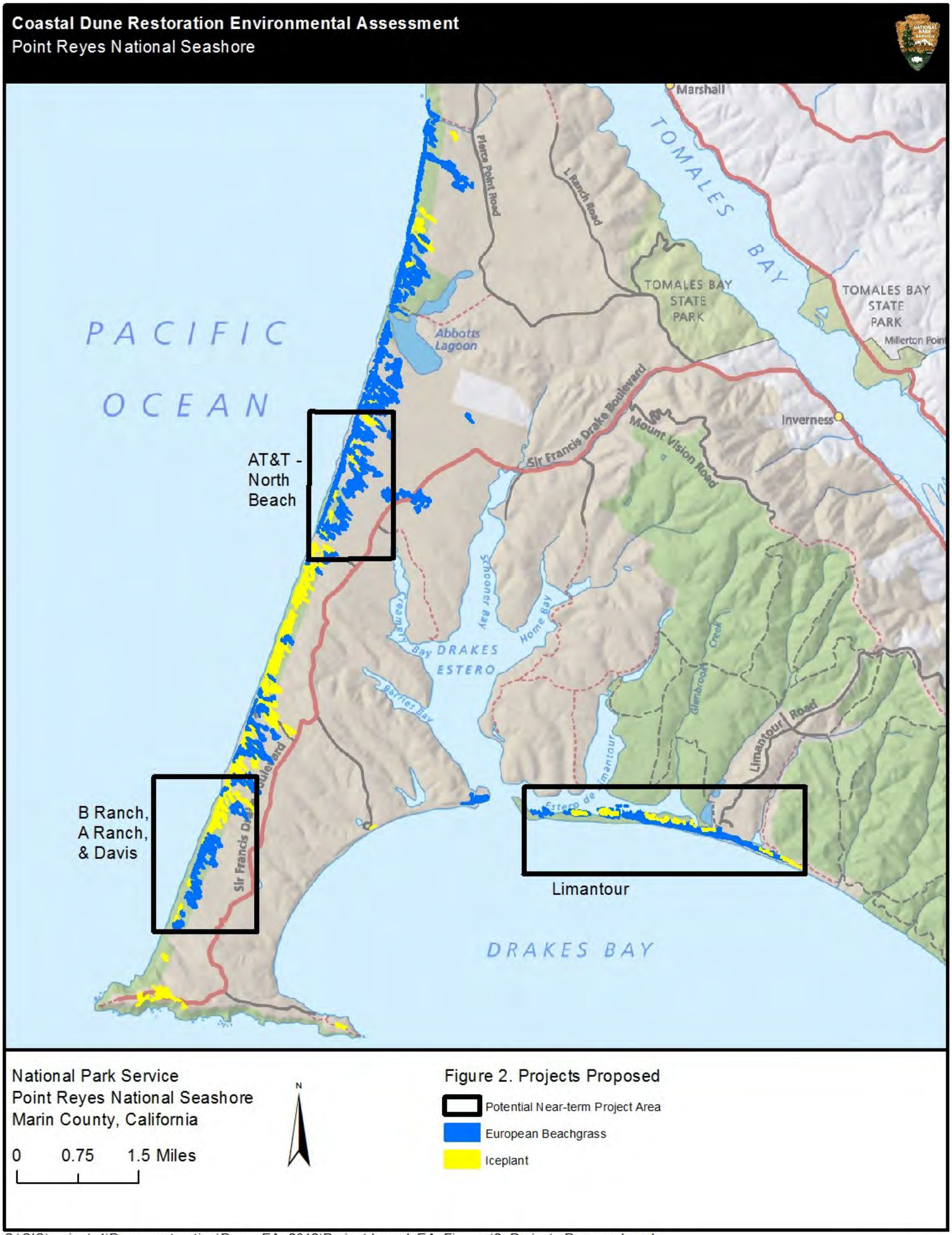
Concerns or comments expressed in these letters – in addition to issues identified during internal scoping with Park Service staff – were used to develop alternatives and impact topics for this EA.

The review deadline for this EA is available by accessing the park's website (*www.nps.gov/pore*) or the Park Service planning and environmental compliance website, PEPC (*parkplanning.nps.gov*). The commenting procedure is described on these two websites. The EA will be posted for public review and comment on the Park Service's PEPC website. The Park Service will consider all comments received in making a decision on alternatives selection. The Park Service may modify its EA following public comment if new information or concerns are raised, and the combination of the EA, public comments, and other information (such as cost, logistics, etc.) will be used to make a final decision on how to proceed.

The decision will be documented in a Finding of No Significant Impact (FONSI), and a notice will be distributed when the FONSI published on the PEPC website. However, if the impact assessment determines that the implementation of the selected alternative would have potential for significant environmental impacts, the Park Service would either modify the alternative, develop mitigate sufficient to minimize impacts to a less than significant level, or prepare an EIS. The EIS would be circulated for additional public review and input.

Planning Criteria (Constraints)

Planning criteria or constraints can be laws, policies, or logistical or other factors that prevent or limit the Seashore in taking certain actions or implementing certain alternatives. In the case of dune restoration, some of these include:



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Legislative and Planning Documents

Proposed actions such as these are often driven by key pieces of legislation, policies, and/or regulatory laws. These are described in more detail below. Other legislation, policies, and regulatory laws may affect how the proposed action is structured or implemented, but do not necessarily represent the basis for action. These are described in more detail later in this document.

Organic Act and Park Service Management Policies

In the Organic Act of 1916 (Organic Act), Congress created the Park Service and directed it to manage units of the national park system, "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 U.S.C. 1). The 1978 Redwood Amendment reiterates this mandate by stating that the Park Service must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 U.S.C. 1a-1). The legislative history of the Redwood Amendment further clarified that all units of the national park system, whether designated as parks, recreation areas, seashores, or lakeshores, were to be managed to the same high standard unless Congress specifically provided otherwise.

Although the Organic Act and the Redwood Amendment use different wording ("unimpaired" and "derogation") to describe what the Park Service must avoid, both acts define a single standard for the management of the national park system – not two different standards. For simplicity, Park Service Management Policies (2006) uses "impairment," not both statutory phrases, to refer to that single standard.

Based on its authority under the Organic Act, the Park Service has promulgated a series of regulations contained in title 36 of the Code of Federal Regulations (CFR). The provisions in title 36 provide a comprehensive suite of regulations that govern activities within units of the national park system.

Point Reyes National Seashore Enabling Legislation

The Seashore was established September 13, 1962, "to save preserve, for purposes of public recreation, benefit and inspiration, a portion of the diminishing seashore of the United States that remains undeveloped (Public Law 87-657)." The Seashore is comprised of 70,046 acres of beaches, coastal headlands, extensive freshwater and estuarine wetlands, marine terraces and forests. Amendments in 1976 (PL 94-544 and 94-567) state that the Seashore is to be administered without impairment of its natural values.

Other Federal Laws, Policies, Regulations and Plans

The Park Service is governed by laws, regulations, and management plans before, during, and following any management action related to this environmental assessment.

National Environmental Policy Act, 1969, as Amended

NEPA requires all federal agencies to consider the potential environmental impacts of their decisions or proposals before they implement them. NEPA is the law guiding preparation of this EA.

National Park Service Management Policies

The Park Service's Management Policies (NPS 2006) set the framework and provide the direction for actions of the Park Service. Adherence to policies is mandatory unless allowed by enabling legislation, or waived or modified by the Secretary, Assistant Secretary, or the Director, or if a law directly and specifically directs an action contrary to Park Service policy. The Management Policies also contain guidance applicable to the alternatives contained in this document. This EA assesses the effects of the alternatives on park resources and values and provides information used in determining if these effects would cause unacceptable impacts.

To assess the impacts of the proposed action, policies relating to resource protection were considered during EA preparation. Many of these policies were already referenced under Project Purpose and Need. One other relevant policy includes:

- The Service will protect geologic features, including sand dunes, from the unacceptable impacts of human activity, while allowing natural processes to continue (Section 4.8.2).

Endangered Species Act of 1973, as Amended

The purpose of the Endangered Species Act (7 USC 136; 16 USC 460 et seq. (1973)) is to conserve the "ecosystem upon which endangered and threatened species depend" and to conserve and recover listed species. Under Section 7 of the Endangered Species Act of 1973, as amended, the Park Service is required to coordinate with the USFWS and National Marine Fisheries Service (NMFS) to ensure that its actions affecting federally listed species do not jeopardize their continued existence or result in the destruction or adverse modification of their critical habitat. Consultation is required whenever such species or habitat may be affected by a proposed project. Through the consultation process, the agencies develop a Biological Opinion setting forth their assessment of the impact of the project on listed species and on any Critical Habitat that may exist within the area of effect. The Biological Opinion may contain conservation recommendations and reasonable and prudent measures for the agency or applicant to follow.


Federally endangered Myrtle's silverspot butterfly

Several federally listed threatened and endangered species and/or their Critical Habitat exist in the Seashore. The Park Service has determined that some of the actions proposed in this EA have the potential to impact listed species. In order to fully understand the possible effects of the actions proposed in this EA on listed species and their Critical Habitat, the Park Service has initiated consultation with the USFWS.

USFWS Recovery Plans

In 1998, the USFWS completed a recovery plan titled, *Recovery Plan for Seven Coastal Plants and the Myrtle's Silverspot Butterfly*. This plan outlined steps required to recover eight federally threatened and endangered species. Four of the species in this plan occur at the Seashore: Tidestrom's lupine, beach layia, Sonoma spineflower (*Chorizanthe valida*; FE), and the Myrtle's silverspot butterfly. The USFWS identified seven actions to accomplish species recovery and prioritized these tasks as 1, 2, or 3. Priority 1 is an action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future. Priority 2 is an action that must be taken to prevent a significant decline in the species population/habitat quality or some other significant negative impact short of extinction. Priority 3 includes all other actions necessary to meet the recovery objective (USFWS 1998). Of the seven actions outlined in the plan, those which are Priority 1 are: (1) Protect existing populations and habitats; and (2) Establish active management for the reduction of non-native invasive plant species. These two Priority 1 tasks are addressed by the proposed dune restoration efforts and represent a large step towards recovery of these species.

A recovery plan has also been prepared for the Western snowy plover, whose habitat is now constrained by non-native invasive plants (USFWS 2007). In addition to helping with recovery of endangered plants and butterflies, one of the primary reasons this restoration effort is being proposed is to restore plover breeding and rearing habitat in the park.

Wilderness Act of 1964, Point Reyes Wilderness Act of 1976, and Directors Order 41: Wilderness Preservation and Management

The National Wilderness Preservation System was established by Congress in 1964 to ensure that some lands of the United States would be preserved and protected in their natural condition for the permanent good of the people. Such federally owned areas are designated by Congress as "wilderness areas." Wilderness is defined as "an area where earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." An area of wilderness is further defined as "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation which is protected and managed so as to preserve its natural conditions" (16 U.S.C. 1132). According to Section 4(c) of the Wilderness Act, permanent improvements or human habitation can include permanent or temporary roads, use of motorized equipment, aircraft, structures, or commercial enterprises.

During the 1970s, the Park Service studied the Seashore, as directed by the Wilderness Act of 1964, to determine the suitability of designating areas of the Seashore as wilderness. Recognizing the uniqueness of the resources on the Point Reyes Peninsula and the threats that ensuing commercial and land development posed to other surrounding lands, the Park Service recommended that 10,600 acres be designated as wilderness (NPS 1972b, 1974). Congress ultimately decided in 1976 to designate more than 33,000 acres as wilderness or potential wilderness, including 25,370 acres as wilderness and another 8,003 acres of land and water as potential wilderness (PL 94-544, October 18, 1976, 90 Stat. 2515 and PL 94-567, October 20, 1976, 90 Stat. 2695). While the legislative language clearly articulates acreage in section 1, the map filed with the committee as required under section 2 of the legislation calculated that the actual acreage of those lands and waters are 24,200 acres of wilderness and 8,530 acres of potential wilderness.

Within the Seashore's coastal dunes, wilderness is primarily located along the beach areas, with many of the dunes themselves not incorporated into wilderness. There are a few exceptions. The mouth of Abbotts Lagoon and the dunes directly on either side are within designated wilderness. Limantour Beach and its more low-lying dune system also fall within designated wilderness, as well as sections of A, B Ranch, Davis Property, and North Beach dunes. Of the roughly 2,200 acres of coastal dune, bluff, and scrub within the Seashore, approximately 30% or 660 acres fall within designated wilderness.

Executive Order 13112 – Invasive Species

This Executive Order requires the Park Service to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species can cause.

Impact Topics

Impact topics are the resources or values that could be affected, either beneficially or adversely, by implementing one of the proposed alternatives. The relative impact of each of these problems or opportunities is examined in the *Environmental Consequences* section of this EA. The following issues were developed initially by Park Service staff and consultants, although they have been refined through public scoping comments from both the prior Abbotts Lagoon EA and the current EA development process.

Other issues raised during scoping were determined to not have the potential for significant adverse effect: the discussion of the potential effect of these impact topics is addressed under *Impact Topics Considered, but Dismissed, from Further Analysis*.

Certain impact topics such as climate change have the potential to affect multiple resources such as air quality, hydrology, vegetation, wildlife, and others: in this instance, it will be addressed principally under *Natural Physical Processes and Soils*. (See next section for more detailed discussion on rationale for this decision). Because wetlands include unique vegetation and hydrology, these aspects are discussed both under *Vegetation Resources* and *Water Resources*.

Vegetation Resources

Invasion of non-native species has dramatically altered native dune vegetation communities, which support a number of critical threatened and endangered plants and wildlife species. These clonally-spreading invasives have not only directly impacted native dunes through establishment of expansive, monotypic stands that oust native species, but indirectly through changes in water availability, nutrients, soil biota, and even numbers of herbivores. Additionally, the Seashore's dunes contain the largest remaining expanses of two uncommon native foredune habitat types–American dunegrass and beach pea. Coastal dune restoration can both impact and benefit native vegetation resources.

Native dune community with Menzies' wallflower and Tidestrom's lupine

Species of Special Concern

The Seashore's dunes provide habitat for up to 11 federally listed species, however, the primary species using the dunes are the threatened Western snowy plover, the endangered Myrtle's silverspot butterfly, and the endangered plants, beach layia and Tidestrom's lupine. Other federally listed species that occur in or near dunes or occasionally frequent dune areas include California red-legged frog (FT), Sonoma alopecurus (FE), California least tern (FE), and Willow flycatcher (FE). At least four of these species depend on coastal dunes or adjacent beaches for some portion of their life cycle, including snowy plover, Myrtle's silverspot butterfly, Tidestrom's lupine, and beach layia. Coastal dune restoration can both impact and benefit species of special concern.

Wildlife

Pacific tree frog

The Point Reyes region supports 28 species of reptiles and amphibians, 58 species of mammals, and breeding habitat for 123 species of birds (NPS IRMA 2013). Dunes provide habitat for both resident and non-resident wildlife species, although it has one of the lowest mammal densities of any habitat in the park (Fellers and Pratt 2002). Certain types of wildlife species actually use European beachgrass and possibly iceplant as habitat, including deer mice, rabbits, Trowbridge's shrews (*Sorex trowbridgii*), western harvest mice (*Reithrodontomys megalotis*), and vagrant shrews (*Sorex vagrans*), western terrestrial garter snake (*Thamnophis elegans*), northern alligator lizards (*Elgaria coerulea*), and Pacific tree frog (*Pseudacris regilla*): some of these species may actually occur in higher abundances in invaded dunes than native ones. Coastal dune restoration can both impact and benefit wildlife species.

Natural Physical Processes and Soils

Coastal dunes are dynamic ecosystems formed by the combined action of wind and wave. After sands are deposited on beaches, winds move them steadily inland over time through a series of evolving dune features, including foredunes, transverse dunes, parabolic dunes, and backdunes. European beachgrass and iceplant were originally planted to stabilize the dunes, but have eliminated natural forces such as sand transport or movement of sand through the system and wind erosion, which creates open space and blow-out areas needed by plovers for foraging. In addition, these invasives species change the topography of the dunes, steepening both foredune and backdune slopes and re-orienting the alignment of the dunes.

Coastal environments are considered among the most vulnerable to changes from climate change. With rising sea levels, there will be more frequent and more serious flooding of low-lying coastal areas by extreme tides, storm surges, and wave effects. Coastal dunes offer a buffer against storm extreme tides and storm surges. This buffering capacity, however, is minimized and potentially eliminated when dunes are over-stabilized by invasive plant species or other alterations.

Coastal dune restoration can benefit natural physical processes of dunes, although there is potential for at least short-term impacts, as well.

Water Resources

Coastal dunes are not necessarily considered "aquatic" systems, but, without proximity to water, coastal dunes could not exist, as they are formed from river sediment carried by long-shore currents that are eventually washed up onto the beach and then blown inland. Not only do the Seashore's dunes directly border the Pacific Ocean, but a few systems also lie adjacent to other water bodies such as Abbotts Lagoon, Drake's Estero, and Estero de Limantour. Also, within dunes are often depressional features or "dune swales" that support wetlands. Wetlands also occur along the inland edges of dune systems in coastal grassland. Coastal dune restoration can both impact and benefit water resources.

Wetlands located among native dune and shrub communities

Wilderness

As discussed earlier, the Seashore contains both designated and proposed wilderness areas that must be managed differently from other lands within the park. Coastal wilderness is valued for its solitude and natural wilderness character. Along beaches and dunes of the Seashore, wilderness is restricted to beach areas adjacent to the ocean and certain portions of the coastal dune system, including near the mouth of Abbotts Lagoon, portions of A and B Ranches, and Limantour Beach. Of the roughly 2,200 acres of coastal dune, bluff, and scrub within the Seashore, approximately 30% or 660 acres fall within designated wilderness. Coastal dune restoration can both benefit and impact wilderness areas.

Soundscapes

While noise often has a negative connotation, one of the intrinsic values of national parks remains the potential for hearing "natural" noises such as crashing waves, running streams, or singing birds. A combination of noises that is intrinsic to a natural landscape is often characterized as a soundscape. Unlike more urban parks, the Seashore and north district of GGNRA are located in a rural portion of western Marin County and must contend less with the intrusive influences of urbanization than the southern portions of GGNRA. Regardless of location, however, the Park Service is directed to preserve, to the greatest extent possible, the natural soundscapes of parks and to restore soundscapes that have become degraded due to "unnatural sounds" (noise; NPS 2006, Section 4.9). Coastal dune restoration can both benefit and impact soundscapes within parks.

Cultural Resources

Coastal areas, including dunes, often end up being areas of cultural or archaeological significance. Native American tribes often congregated in these areas for collection of food and created centralized disposal areas or "middens." Ships that wrecked off the coast prior to the 21st century may have deposited timbers and other materials on the beach that eventually get buried by sand. Other items, discarded in the ocean, often washed up on the beach, as well, some of which may have some historical significance. Artifacts may have also ended up in the dunes that originated from more terrestrial sources such as from operational activities of the historic radio transmission facilities. Coastal dune restoration can impact cultural resources.

Visitor Experience

National parks are valued for the recreational and aesthetic resources they provide to the public, both visitors and nearby residents. Park visitors expect national parks to provide beauty, a sense of quiet, and opportunities for hiking, bird-watching, and other recreational pursuits. Perhaps, some of the most valued natural resources within parks in terms of sheer visitor numbers are beach and water-related ones such as beaches, streams, lakes, and waterfalls. Beaches, wetlands, and water bodies offer opportunities for hiking, birdwatching, fishing, kayaking and canoeing, boating, and swimming. Coastal dune restoration can both benefit and impact the visitor experience.

Adjacent Land Use

Inland of active dunes are remnants of coastal marine terrace that are strongly influenced by past deposition events, evident in the sandy characteristics of the soils that now underlie vast managed grassland, coastal prairie, or coastal scrub lands along the coast. Centuries of grassland establishment and subsequent organic matter deposition have transformed these once granular, relatively nutrient-poor, well-drained soils into fertile grasslands. Many of these grasslands support active beef and dairy cattle ranching within the park, authorized under agricultural lease/special use permits (lease/permits). Consistent with current trends within the agricultural industry, a number of lessees have begun managing their pastures and/or herds as organic. Coastal dune restoration can both impact and benefit adjacent land use.

Public Health and Safety

Enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks (NPS 2006, Section 8.2). Some of this enjoyment may ultimately depend on health and safety of park visitors. While recognizing that there are limitations on its capability to totally eliminate all hazards, the Park Service – and its concessionaires, contractors, and cooperators – are directed to provide a safe and healthful environment for visitors and employees (NPS 2006, Section 8.2). Based on Park Service Management Policies (2006, Section 8.2), unacceptable impacts are impacts that, individually or cumulatively, would … create an unsafe or unhealthy environment for visitors or employees. Coastal dune restoration can both impact and benefit public health and safety.

Park Operations and Management

As with most federal agencies, the Park Service relies on Federal appropriations to fund its core activities through base funding, although there is increasing use of alternative revenue sources, such as private monies and grants, to fund specific projects. Coastal dune restoration projects typically involve efforts of a number of park personnel, including those from Resource Management, as well as from Budget, Contracting, Cultural Resources, Interpretation, Law Enforcement, and Facilities. Coastal dune restoration can impact park operations and management.

Impact Topics Considered, but Dismissed, from Further Analysis

The following impact topics were considered but dismissed from further analysis because either (a) the resources do not exist in the Seashore's dunes or would not be impacted by the projects or (b) impacts could occur, but would have minor or less than minor impacts. A brief rationale for dismissal of these impact topics is provided below.

Socioeconomic Resources

Marin County generates considerable revenue from the tourist industry. In 2002, it was estimated that the Seashore contributes over $150 million to the regional economy visitor expenditures on dining, fuel, gifts, groceries, and lodging (NPS 2002). The proposed coastal dune restoration program could contribute to the local economy through small increases in visitation and hiring of contractors for project implementation, but these benefits would be expected to be negligible, and, otherwise, the program would have no impacts on socioeconomic resources, including gateway communities or employment.

Environmental Justice

Executive Order 12898 requires that all federal agencies evaluate the impact of proposed actions on minority or low-income communities. According to the USEPA Office of Environmental Justice, environmental justice is the "fair treatment of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws. Fair treatment means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies." For environmental justice impacts to occur, significant environmental impacts attributable to a project must fall disproportionately upon environmental justice populations within the affected area. The proposed action would not have disproportionate health or environmental effects on minorities or low-income populations or communities as defined in the USEPA's Environmental Justice Guidance (1998). Any temporary closures of dune or beach areas during implementation would be equally applied to all visitors, regardless of race or socioeconomic standing. Any socioeconomic impacts would not disproportionately affect members of environmental justice populations.

Night Sky

Management Policies (2006) direct the Park Service to "preserve, to the greatest extent possible, the natural lightscapes of parks, which are natural resources and values that exist in the absence of human-caused light" (Section 4.10). Recognizing the roles that light and dark periods and darkness play in natural resource processes and the evolution of species, the Park Service will protect natural darkness and other components of the natural lightscape in parks (Section 4.10). Natural darkness or "night skies" can be impacted by artificial lighting (Section 4.10). The proposed action would have no impacts to night skies, particularly as construction would occur only during daylight hours.

Relationship between Short-Term Uses of the Environment and Maintenance and Enhancement of Long-Term Productivity

The proposed action would have short-term, negligible adverse effects on energy resources during project implementation. Long-term, negligible beneficial impacts on sustainability and energy resources should accrue once dune restoration is underway, and maintenance requirements decrease over time.

Air Quality

Use of cars and trucks to transport contractor and park crews, as well as potentially heavy equipment for mechanical removal, would result in emission of criteria pollutants. However, the degree of impact for all air quality emissions would be negligible and short-term. Negligible impacts are defined by the Park Service as fewer than 50 tons per year of any pollutant emitted. For complete mechanical removal of 132 acres of European beachgrass in 255 acres at Abbotts Lagoon, the Park Service previously estimated that emissions from heavy equipment would be 0.2 tons hydrocarbons, 5.6 tons CO, 0.7 tons particulates, and 3.84 tons NOx over the life of the project. The emissions from refueling were estimated to be 0.15 tons HC, 0.7 tons CO, 0.5 tons NOx, and 0.09 tons particulates over the life of the project. None of these amounts exceeds the 50 tons per year of each pollutant specified by the Park Service as negligible impacts (NPS 2009). The proposed actions that would be implemented under this EA are likely to be the same size or smaller and less intensive than the Abbotts Lagoon Coastal Dune Restoration Phase I mechanical removal project.

Another measure of potential air quality impacts is used by the Bay Area Air Quality Management District (BAAQMD). The BAAQMD has established thresholds of significance under California's environmental compliance policy, California Environmental Quality Act (CEQA) for construction impacts. According to BAAQMD, fine particulate matter (PM10) is the pollutant of greatest concern with respect to construction activities (BAAQMD 1999). (BAAQMD noted that construction equipment do emit CO and other ozone precursors such as reactive organic gasses (ROG), however, these emissions are included in the emission inventory that is the basis for regional air quality plans and would not generally be expected to impede attainment or maintenance of ozone and carbon monoxide standards in the Bay Area.)

BAAQMD has identified a set of feasible control measures for minimizing production of PM10 through construction activities, including Basic Measures for all construction sites and Enhanced Measures for larger construction sites (> 4 acres; BAAQMD 1999). If all of the control measures are implemented as appropriate for the size of the construction site, then BAAQMD has deemed that emissions from construction activities would be considered less than significant under CEQA. Mitigation measures include watering active construction areas twice daily and unpaved access routes and staging areas three times daily; daily sweeping of paved areas, including roads; covering all hauling trucks, leaving two feet of freeboard on haul trucks; applying soil stabilizers to inactive construction areas; limiting traffic speeds to 15 mph on unpaved roads; and replanting vegetation in disturbed areas.

Should control measures be not or only partially implemented, potential emissions of PM10 and other air pollutants emitted in the exhaust of construction equipment are either estimated using area or gallon-based factors developed by BAAQMD (BAAQMD 1999) or quantified based on the type and horsepower of equipment, number of days of operation or truck trips, number of control measures to be implemented, and average trip length, etc. For this document, we used the same analysis approach that was employed for the Giacomini Wetland Restoration Project Environmental Impact/Environmental Impact Report (2007), which bases PM10 estimates on cubic yard-based estimation factors developed by BAAQMD (1999). Based on thresholds established for Giacomini EIS/EIR (1999), Alternatives A and B would have no to very negligible effects, as heavy equipment would not be used. Potential impacts for Alternatives C and D would range from negligible (Alternative C) to minor (Alternative D): reliance on heavy equipment to remove European beachgrass was estimated to generate 42- to 43 lbs of PM10/day, which falls below the 53 lbs/day established as the upper limit for minor effects under the Giacomini EIS/EIR (2007). It is likely that impacts would be considerably less, because some of the mitigation measures discussed above would be employed.

Smoke from use of prescribed burning as a pre-treatment measure prior to chemical control efforts would have an additional impact from particulates and other volatilized substances. The Air Basin Plan includes prescribed burning into annual calculations when impacts are analyzed for basin-wide impacts. Projects are approved until the annual allotment of emissions from prescribed burning is reached. Smoke Management Plans are reviewed and approved by Bay Area Air Quality Management District (BAAQMD) before prescribed burns are scheduled, and the BAAQMD must also approve the prescribed burn on the day of the burn in light of air basin conditions at that time. Although emissions from burning were not modeled for this project, using those for the park's Fire Management Plan (NPS 2004) indicate the following emissions would occur for a large-scale dune restoration project that involves 90 acres of prescribed burning pre-treatment: 7 tons of particulates, 8.2 tons of carbon monoxide, 1.0 ton of hydrocarbons, and 0.23 tons of NOx. These numbers assume that the documented rates of burning of grasslands and coastal scrub vegetation are similar to those that would be experienced on site with less woody dune and dune scrub vegetation. The rates referenced above are well below the definition of negligible impacts for air emissions.

As both use of mechanical equipment and prescribed burning would have no more than negligible effects on air quality, air quality is not discussed further in this EA.

Climate Change – Carbon Sequestration

Carbon sequestration potential – the ability to act of natural areas to act as a sink for carbon dioxide – is strongly tied to habitat type, with salt marshes, mangrove forests, and eelgrass meadows being considered the "highest sink" coastal ecosystems, because carbon is uptaken by plants and stored long-term in soils (Murray et al. 2011). The coarse sand substrate of coastal dunes does not have the same storage capacity as these other habitats. Therefore, the proposed action would be unlikely to have more than negligible benefits on carbon sequestration.

Alternatives

Alternatives Development Process

The Park Service NEPA regulations (Director's Order 12) indicate that a range of alternatives must be developed with environmental resources as the primary determinant (Section 2.7a). In other words, alternatives are to propose different means of accomplishing objectives while at the same time minimizing adverse impacts or maximizing beneficial impacts to some or all resources. Alternatives are also to be environmentally distinct, with issues "sharply defined" to provide a clear basis for choice among options (40 CFR 1502.14).

Techniques or approaches for restoring coastal dunes within the Seashore invaded by European beachgrass and iceplant have been developed since 2001 by park staff using past experience, information from managers of other coastal dune systems that have been restored, and published information in reports and journals. Since 2001, the park has restored approximately 225 acres of coastal dunes within the Seashore using a combination of hand, herbicide treatment, and mechanical removal, with an emphasis on mechanical and hand removal.

Development of alternatives for this EA relies considerably on the value analysis process conducted for the earlier Abbotts Lagoon Coastal Dune Restoration Project. Value analysis is an organized team effort directed at analyzing the functions of facilities, processes, systems, equipment, services, and supplies for the purpose of achieving essential functions at the lowest life-cycle cost consistent with required performance, reliability, quality, safety, and achievement of Park Service mission priorities such as resource protection, sustainability, and quality visitor experience.

In addition, during development of the Abbotts Phase I and later projects, park staff also investigated what other agencies and organizations have been doing to effectively remove these invasive plant species with successful ecological outcomes. Published and electronically available information on other European beachgrass removal efforts along the Pacific Coast were reviewed, and, in some cases, project managers from other management agencies were contacted for additional information. In some instances, the methods used by these other agencies have continued to evolve over time in response to changes in technology and results from monitoring of their own restored dunes.

Background on Removal of European Beachgrass in Dune Systems

Manual Removal

One technique that has been successfully used, at least for some invasive plant species, is manual removal. Manual removal involves use of a shovel to dig up rhizomes to a specified depth, which varies depending on the project. Early results from Humboldt Dune suggested this method showed considerable promise. A 1988-1989 project conducted removal every week to every two (2) to four (4) weeks for approximately nine (9) months: This project successfully eliminated beachgrass, had relatively low re-treatment needs in the second year, and increased native plant cover from 2.7% to 38% (Pickart and Sawyer 1998). The success of this project prompted larger projects to be conducted at Humboldt in 1992 and 1997, which also proved successful in terms of eliminating beachgrass and encouraging native species to colonize (Pickart and Sawyer 1998). Based on 1997 costs, successful hand removal projects were estimated to cost at least $34,674/acre, primarily for labor costs: Retreatment by hand required at least eight (8) visits during the first year and seven (7) visits the second year, followed by additional treatment during a third year (Pickart and Sawyer 1998). Labor was estimated at 2,951 person hours per acre for all three (3) years (Pickart and Sawyer 2008).

Between 2001 and 2003, more than 30 acres were restored near the mouth of Abbotts Lagoon using primarily hand removal methods (Figures 3 - 4: Previous restoration projects at Abbotts/Fig 4: blow up of Abbotts Triangle/North). Early hand removal projects experimented with differing depths of excavation (1.5- to 3 feet) and disposal approaches, but, in general, they were not considered very practical for larger scale projects due to the amount of manual sand excavation nor very effective in terms of the amount of re-treatment required, which was considerable. Retreatment in subsequent years totaled 42 acres, showing that regrowth was significant (Peterson et al. 2003). In 2007, one park staff member estimated that 20% of the treated area re-grew within as little as six months, and some areas required as many 15- 20 repeat treatments before control appeared to be achieved (J Rodgers, NPS, *in* Point Reyes Light 2007, Peterson 2004).
Since these removal efforts were completed in 2004, European beachgrass in the 2001-2004 project area slowly reestablished, and by the beginning of Phase I, had reclaimed most of the treated area south of the lagoon mouth, which totaled approximately 11.0 net acres (NPS, unpub. data). In 2004, the park estimated hand removal costs at between $14,818/acre (1.6 feet deep removal) to $27,936/acre (3.3 feet deep removal) for initial treatment and some retreatment during a two-year period (Peterson 2004).


Volunteers manually removing European beachgrass.

Manual re-treatment has continued annually since 2004 on original European beachgrass treatment areas north of Abbotts Lagoon near the mouth (Figures 3 - 4). At least 10,000 person-hours have been dedicated from 2007 to 2012 to maintaining previously treated areas: Most of this has been accomplished through sporadic volunteer events (E. Hamingson, NPS, *pers. comm*.). Beachgrass has not been successfully eradicated in this area.

Manual removal by contractors was also conducted as part of the Point Reyes Headlands/ Paleodunes restoration effort, which was initiated in 2008 (Figure 3). By the project end, initial manual removal of 0.96 acre of European beachgrass by a multi-person crew took approximately 303.3 hours/acre at a cost of $12,133/acre (E. Hamingson, *pers. comm*.). Again, this does not include follow-up re-treatment of European beachgrass.

Mechanical Removal

A few agencies have used mechanical removal for treatment of European beachgrass. The U.S. Forest Service (USFS) first used mechanical removal at the Oregon Dunes National Recreation Area (Pickart and Sawyer 1998). Several projects conducted at this area between 1995 and 1996 excavated European beachgrass and its rhizomes to a depth of 3.3 feet and then "capped" these sands with another 3.3 feet of sand (U.S. Forest Service 1995 a,b *in* Pickart and Sawyer 1998). However, apparently, the depth of excavation and burial was inconsistent, and moderate to substantial resprouting occurred the next spring (Pickart and Sawyer 1998). Another technique used by the Bureau of Land Management (BLM) at

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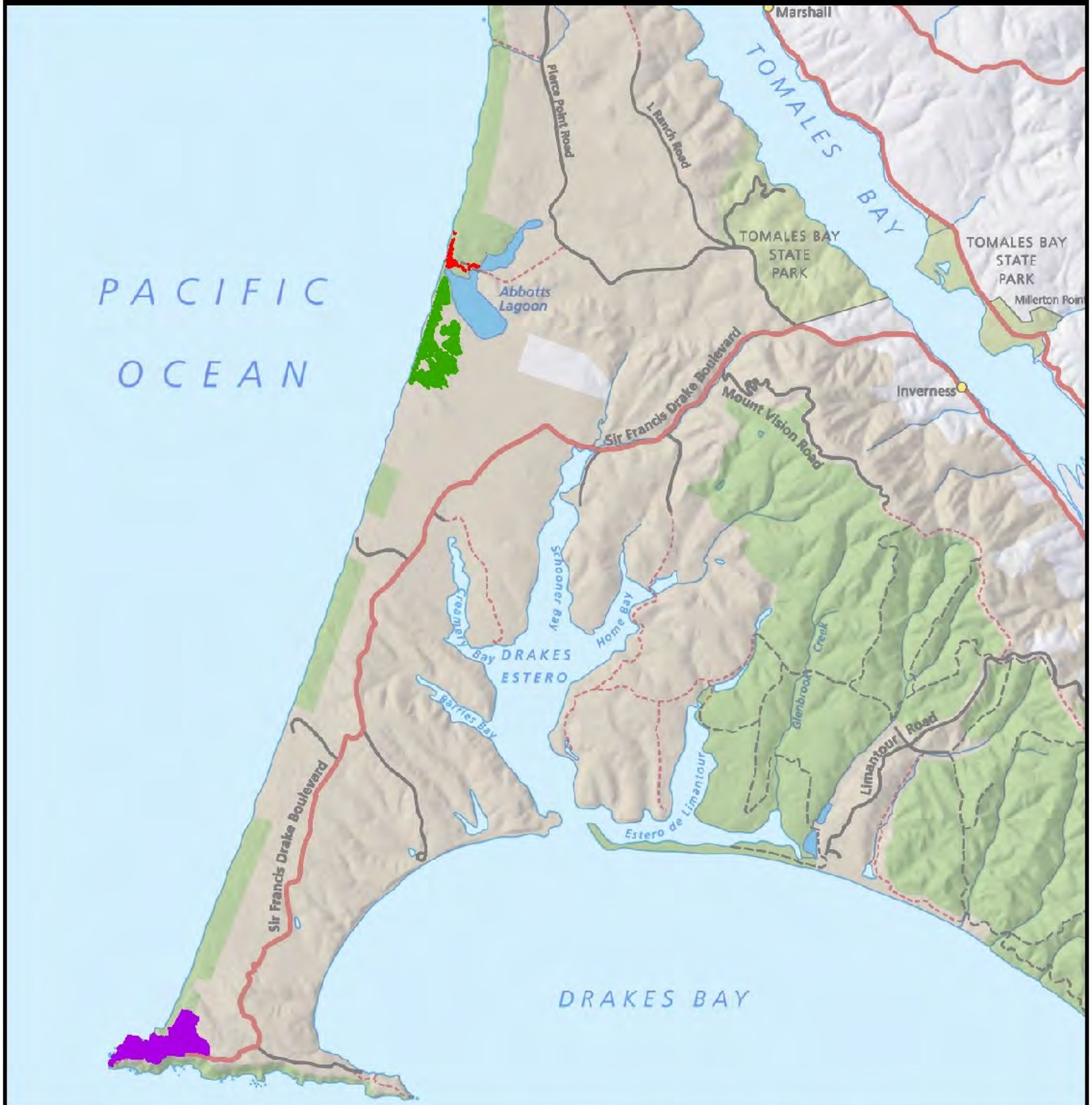

National Park Service
Point Reyes National Seashore
Marin County, California

0 0.75 1.5 Miles

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Figure 3. Extent of Previous Restoration Efforts at the Seashore

- Headlands/Paleodunes
- North of Abbotts
- Abbott's Lagoon

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Figure 4. Initial Coastal Dune Restoration Efforts Near Abbott's Lagoon

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Coos Bay Shorelands involved use of a ripper to sever rhizomes and break up soil compaction, followed by hand removal of respouts: While this appeared successful, the program managers had previously applied saltwater to the beachgrass plants, which, while not successful, may have weakened them and affected treatment results (Pickart and Sawyer 1998).

In recent years, the USFS has at Oregon Dunes used a combination of mechanical techniques, including "scalp and bury," which removes 2.5 feet of the upper European beachgrass sand layer and buries it in pits approximately 6 to 8 feet in depth, or a scalp-and-push technique, which scalps vegetation to a 6- to 8 feet depth and then pushes materials onto beach for redistribution by wind and tidal action (USFS 2010). Many of these areas have been re-treated several times apparently (USFS 2010), suggesting that European beachgrass does recolonize following this type of mechanical treatment.

In 2004-2005, California Department of Parks and Recreation (CDPR) conducted a pilot project experiment on mechanical removal at Little River State Beach in California. The project compared three different approaches to mechanical removal, including one that primarily involved excavators (Excavator), one that involved excavation by D8 or D850 bulldozers to a depth of 3 feet and burial of beachgrass with a 2-foot cap similar to the "scalp and bury" technique at Oregon Dunes (Dozer-Grade), and one that involved bulldozers with a rake attachment capable of pulling up rhizomes from 2 feet deep (Dozer-Rake; Transou et al. 2007). Costs ranged from $2,967/acre for Dozer-Rake treatments to $3,920/acre for Excavator Treatments (Transou et al. 2007), however, it should be noted that CDPR uses its own equipment and operators (Jay Harris, CDPR, *pers. comm.*), which thereby lowers cost relative to other mechanical removal projects. Re-treatment effort was 30 percent lower in the Dozer-Grade areas than in the other two treatments (Transou et al. 2007). Treatment results, combined with cost, led CDPR to conclude that mechanical removal was the most effective beachgrass removal method (Transou et al. 2007). The success of this pilot project encouraged development of a 80-acre dune restoration project at Little River that used mechanical grading to remove beachgrass.


Excavator moves sand to bury European beachgrass.

The Seashore initially used mechanical removal in a 20-acre area just south of the mouth of Abbotts Lagoon, where some hand removal had been conducted previously (Figure 4). This project used an approach very similar to what was used in 2011 called "horizon flipping," which essentially involved digging out at least 3.5- 7 feet of "dirty" sand or sand contaminated by European beachgrass rhizomes and then digging out an additional 3 feet of "clean" sand from below the "dirty" sand and placing in a separate pile (Peterson 2004). The dirty material was then pushed into the pit, and the pit was capped with the clean sand (Peterson 2004). Two excavators were operated by Seashore employees who were funded by project monies. Actual burial depths at the project site initially varied from 1.5 – 5 feet due to poor communication with the equipment operator. Mechanical removal costs for this project ranged from $5,363 to $15,696/acre (including equipment rental, operator salary, and fuel; Peterson 2004; Hyland and Holloran 2005).

A similar approach was used on a much larger scale for the Seashore's Abbotts Lagoon Coastal Dune Restoration Phase I Project (Figures 3 - 5; Detail of Abbotts Phase I-III). This project removed up to 80 acres of European beachgrass within a 190-acre Project Area over a period of 5 to 5.5 months. However, due to the fact that contractors were used rather than park staff for equipment operations, costs were much higher: $25,000 to $30,000/ acre.

Chemical Control

A number of restoration efforts along the Pacific Coast have used chemical control to treat European beachgrass. Chemical control originally involved almost exclusively use of glyphosate (Pickart and Sawyer 1998). Indeed, some early studies suggested that glyphosate might not have been very effective for removal unless applied at higher concentration rates (10%; Aptekar, *in prep. in* Pickart and Sawyer 1998). In Monterey, a 7% solution of glyphosate was successfully used to treat 10.4 acres at Sunset State Beach (Hyland and Holloran 2005). Initial experiments with a grass-specific product, Fusillade®, did not adequately control the invasive, so, later, the project area was first burned to eliminate thatch and stimulate regrowth before herbicide was applied (Hyland and Holloran 2005). Subsequent herbicide treatments occurred at 6 and 12 weeks later, with a total of five (5) follow-up treatments required to achieve 100% control (Hyland and Holloran 2005). By the sixth treatment, total herbicide used had dropped from 100 gallons to 2.5 gallons (Hyland and Holloran 2005). At that time, this method was estimated to cost approximately $1,619/acre, with retreatment included (Hyland and Holloran 2005).

Over time, many agencies have switched to using imazapyr with glyphosate for treatment, which appears to be more effective than just glyphosate and to require less retreatment. Importantly, lower concentrations of these chemicals can be used apparently without sacrificing efficacy: Glyphosate concentrations have dropped from 10% in those early projects to 1% in more recent restoration efforts (Pickart and Sawyer 1998), whereas imazapyr concentrations have remained fairly constant (1-1.5%). In addition, as noted earlier, some agencies have experimented with use of pre-treatment measures such as prescribed burning or mowing to remove beachgrass thatch and stimulate re-growth and improve uptake of herbicide (Hyland and Holloran 2005). Some agencies have reported that this herbicide combination has controlled almost 80- to 90% of the European beachgrass present with as little as one (1) to three (3) treatments.

Within the Seashore, small projects using herbicide started to be implemented once it became clear that hand removal was not very effective and required considerable re-treatment effort. The Park Service conducts an integrated pest management (IPM) program to reduce risks to the public, park resources, and the environment from pests and pest-related management strategies (NPS 2006, Section 4.4.5.2). Integrated pest management is a decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage by cost-effective means while posing the least possible risk to people, resources, and the environment. All prospective users of pesticides must have prior approval from the park's regional IPM coordinator before using any products (NPS 2006, Section 4.4.5.3). The decision to incorporate a pesticide into a management strategy will be based on a determination by a designated IPM specialist that use of the chemical is necessary, because non-chemical options have been used, but found to be not feasible or ineffective. If chemicals are used, the IPM program encourages use of products with the lowest toxicity.

In 2008, approximately 3.5 acres of European beachgrass were treated in the southern portion of the dunes near the Lighthouse using herbicide, and, one to two years later, treat-

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Figure 5. Aerial Photograph of Dune Restoration Projects South of Abbott's Lagoon

S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\5_Aerial photograph of dune restoration projects south of Abbott's Lagoon.mxd ment has significantly reduced cover of these plants, although re-treatment has been necessary (E. Hamingson, *pers. comm.*). Initial treatment costs of these European beachgrass stands were estimated at $1,500/acre, although it did not include any follow-up treatment.

Following completion of Phase I at Abbotts Lagoon, the Seashore recognized that mechanical restoration, while ecologically successful, was prohibitively expensive at $25,000 to $30,000/acre. In fact, the Abbotts Lagoon was scaled back from 132 acres of removal in a 300-acre project area to 80 acres in a 190-acre project area, because there were not sufficient monies to fully fund the project.

To enable completion of additional restoration at Abbotts Lagoon and develop the best methods for cost-effectively treating European beachgrass in the park, in fall 2011, the Seashore treated approximately 31 acres in the Abbotts Lagoon project area using an experimental approach (Figures 4 - 5). Two different concentrations of glyphosate (2% and 7% as either AquaMaster® or AquaNeat®) were applied along with a uniform imazapyr concentration (1% as Habitat®), with treatments assigned randomly to plots in backdune and foredune stands to determine whether effectiveness varied based on physical location or age of stand. This pilot project was implemented in fall 2011: More than 99.5% of the beachgrass appeared dead as of summer 2012 (NPS, unpub. data). Follow-up of the few missed patches or plants or undersprayed plants was conducted in fall 2012, with only 16 hours of re-treatment required in fall 2012. Minimal re-treatment is expected to be needed in the future to treat germinants and re-sprouts. As part of this project, the dead biomass was also mowed in fall 2012 to speed up decomposition of European beachgrass and, hopefully, colonization by native dune plant species: Dead European beachgrass decomposes very slowly. Cost for this phase totaled approximately $2,500/acre, which included re-treatment in fall 2012.

Based on results of this project, a third phase of restoration was initiated at Abbotts Lagoon in fall 2012 that treated European beachgrass in another 30 acres using 2% glyphosate (AquaMaster®) and 1.5% imazapyr (Habitat®; Figures 4-5). Mechanical removal was performed within more than 1.2 acres of wetland and organic pasture buffer areas. Cost for the chemical treatment portion of this phase totaled slightly less than $3,000/acre and included re-treatment in 2013 of areas where more than 2% of the treated area appeared to have not been treated effectively.

Saltwater Irrigation and Other Techniques

Beachgrass's lower tolerance for higher salinity soils prompted experimentation with a technique using irrigation with saltwater. Early projects demonstrated some slowing of vegetative growth and reduction in flowering, but not mortality (Van Hook 1983 *in* Pickart and Sawyer 1998). Seedlings and actively growing clones appear to be most susceptible, whereas dormant rhizomes are actually resistant to saltwater inundation and, in some cases, are actually stimulated to regenerate when exposed to prolonged saltwater inundation (Pickart and Sawyer 1998). Unsprayed clones of European beachgrass can actually temper the negative effects of saltwater irrigation unless all clonal plants are treated (Pickart and Sawyer 1998). In 1996, BLM and other agencies spent $220,000 to pump saline baywater onto a 26-acre dredged material to treat invading beachgrass for a total of four months in the summer, resulting in 36 inches of saltwater being applied (Pickart and Sawyer 1998). Plants browned, but, after tilling was conducted, the beachgrass recovered to a large extent (Rittenhouse, *pers. comm. in* Pickart and Sawyer 1998). Saline waters did not appear to penetrate below the top 4 to 5 inches of the soil (Pickart and Sawyer 1998). While use of multiple techniques confounded interpretation of results, this project was not considered successful, and the site was later treated mechanically (Pickart and Sawyer 1998).

Background on Removal of Iceplant in Dune Systems

In California, control of iceplant has been successful using either hand removal (Ferriera and Gray 1988, D'Antonio 1988, Howald 1988 *in* Pickart and Sawyer 1998, Andreu et al. 2010, NPS, unpub. data) or chemical control (Connors 1986, Guinon and Allen 1990, Langner 1992, Moss 1994, Cowan 1995 *in* Pickart and Sawyer 1998). Mechanical treatment is not typically conducted, perhaps because the amount and associated cost of excavation to remove this shallowly rooted species does not seem warranted.

The Nature Conservancy and other agencies have successfully conducted hand removal of iceplant at Manila Beach and Dunes, Lanphere-Christensen Dunes Preserve, and Humboldt Bay Dunes (Miller 1994, Pickart 1995, Theiss 1994 *in* Pickart and Sawyer 1998). At Humboldt Bay, shovels were used to "roll up" iceplant as roots were severed below (Theiss 1994 *in* Pickart and Sawyer 1998). These areas were further raked to clean up debris. These projects resulted in near eradication of iceplant after one year, although missed or buried portions of plants resprouted, requiring some retreatment (TNC, unpub. data *in* Pickart and Sawyer 1998).

Before and after removal of iceplant.

Removal of iceplant by hand from dunes in Spain, where iceplant is also considered an invasive, resulted in approximately 52% of the plots having no reestablishment following treatment (Andreu et al. 2010). Most of the resprouts came from smaller iceplant individuals, which likely established from seed in the seedbank (Andreu et al. 2010).

The Seashore has also conducted extensive iceplant removal projects using manual techniques, including a 100-acre removal project on steep coastal bluffs near the Point Reyes Lighthouse. The Paleodunes project involved removal of 27 acres of iceplant using both manual and chemical techniques (Figure 3). Approximately 2% glyphosate as either AquaMaster® or AquaNeat® was used to treat dense patches of iceplant at a cost of approximately $1,000/acre, compared to $11,723/acre for manual removal of iceplant.

As with initial beachgrass herbicide treatment projects, most of the efforts to treat iceplant with herbicide have relied on glyphosate (Pickart and Sawyer 1998). In some cases, dead plants have been left to provide a stabilized environment for native plant seedling recruitment, but retention of iceplant mats may elevate nutrient levels and, thereby, increase the potential for invasion of non-native species (Pickart and Sawyer 1998). In the Paleodunes project, large mats of duff were raked to minimize allelopathic effects and nutrient addition, and, within two to three years, most of the remaining duff had blown away, allowing primary successional native plant species to establish within the dead vegetation.

ALTERNATIVES INCLUDED FOR ANALYSIS

The alternatives incorporated for analysis are strongly related to those that were analyzed as part of the Abbotts Lagoon Coastal Dune Restoration Project EA. However, there have been some changes in the treatment approach. Since that document was prepared, the Seashore has learned more about the various traditional treatment approaches from its own and others' restoration experiences: Alternatives have been altered to reflect this increase in the knowledge base. Secondly, the earlier Abbotts Lagoon project area did not support extensive stands of iceplant, so only one alternative action was contemplated for treatment of iceplant – manual removal. Other areas within the park, including B Ranch, A Ranch, Davis, and, to a lesser extent, North Beach, have much more extensive stands of iceplant that may necessitate other approaches. Lastly, other invasive or potentially habitat-altering species other than European beachgrass or iceplant also need to be addressed.

This document will evaluate a range of alternatives. The first alternative, the No Action Alternative, would involve no near-term dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour (Alternative A). The three action alternatives would enable near-term restoration at these three general dune system areas using slightly different techniques or combinations of techniques.

- Under Alternative A, no near-term dune restoration at these three general dune system areas would be conducted other than those previously permitted. This would not preclude implementation of dune restoration in these areas at some later point in time under a different compliance effort, nor would it preclude dune restoration from being conducted in other areas of the park either in the near-term or long-term under separate compliance efforts.

- The three action alternatives differ in terms of which methods would be used for initial treatment: Alternative B (Manual Removal), Alternative C (Chemical Control), and Alternative D (Mechanical Removal; Table 1).

- However, Alternatives C and D would actually rely on a combination of techniques, such as manual removal of beachgrass in wetlands and mechanical removal of beachgrass in wetland and organic pasture buffers in Alternative C, or hand removal of sparse patches of iceplant in Alternatives C and D (Table 1).

- In addition, re-treatment may not be the same as the initial control methods. For example, hand removal or spot spraying of re-sprouts may take place after mechanical removal (Alternative D), and hand removal may also occur after initial chemical control (Alternatives C and D; Table 1).

- Alternative C may also involve some pre-treatment measures to reduce thatch and stimulate re-growth such as prescribed burning or mowing. Mowing may also be conducted after herbicide treatment or for constructability reasons such as to decrease potential for use of beachgrass by wildlife while construction is being implemented.

- Costs are addressed under each alternative where costs could be different depending on the removal approach employed.

The areas selected for restoration are ones that have been identified as high priority for near-term restoration based on park objectives of increasing unfragmented restored coastal dune habitat and preventing listed plant and animal species from becoming locally extinct. As noted above, these sites include AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour Dunes (Figures 6 - 8). These areas support one or more of the following federally listed species -- Tidestrom's lupine (*Lupinus tidestromii*; FE), beach layia (*Layia carnosa*; FE), and Western snowy plover (*Charadrius alexadrinus nivosus*; FT).

Alternative A – No Near Term Action

According to Director's Order 12 (sec. 5.2), EAs must fully describe and analyze the No Action alternative. The analysis of the No Action alternative "sets a baseline of existing impacts continued into the future against which to compare impacts of action alternatives" (Director's Order 12, Section 2.7). For project-level documents, No Action typically means that the proposed action doesn't take place.

Under this alternative, these projects may not be necessarily conducted in the near-term or immediate future, but it is possible that dune restoration could be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour at some later point under a new compliance effort. This alternative would also not preclude dune restoration from being conducted elsewhere in the Seashore under separate compliance efforts. Under this alternative, projects that have been previously permitted under separate compliance – including removal of up to 12 gross acres of iceplant and 21 gross acres of European beachgrass in the foredunes at B Ranch – would proceed.

Actions Common to All Action Alternatives

In addition to some common restoration activities, staging and access, monitoring and environmental protection measures, the following actions would be common to Alternatives B, C, and D:

- Restoration actions and associated activities (e.g., staging, access) would be designed to be the most ecologically effective, cost-efficient, and ecologically sensitive methods for achieving the purpose and objectives while also taking into strong consideration adjacent land uses, visitor enjoyment and safety, and other park resources.

- Coastal dune restoration adjacent to actively managed or grazed pastures within the Seashore would be designed to minimize movement of sand from the dunes onto adjacent pastures through activities such as actively revegetating once European beachgrass and iceplant is removed, tapering slopes of backdune areas in mechanical removal areas, carefully phasing restoration in backdune areas, and other avoidance and minimization measures. Restoration efforts would be coordinated closely with adjacent ranchers or other property owners.

- All work would avoid, minimize, or mitigate impacts to federally, state, or locally listed species, with every effort made to avoid "take" where possible.

- All work would avoid, minimize, or mitigate loss of jurisdictional wetlands from implementation of restoration, with every effort made to avoid loss where possible.

- All restoration efforts would require long-term follow up to reduce invasive plant cover at less than 1%.

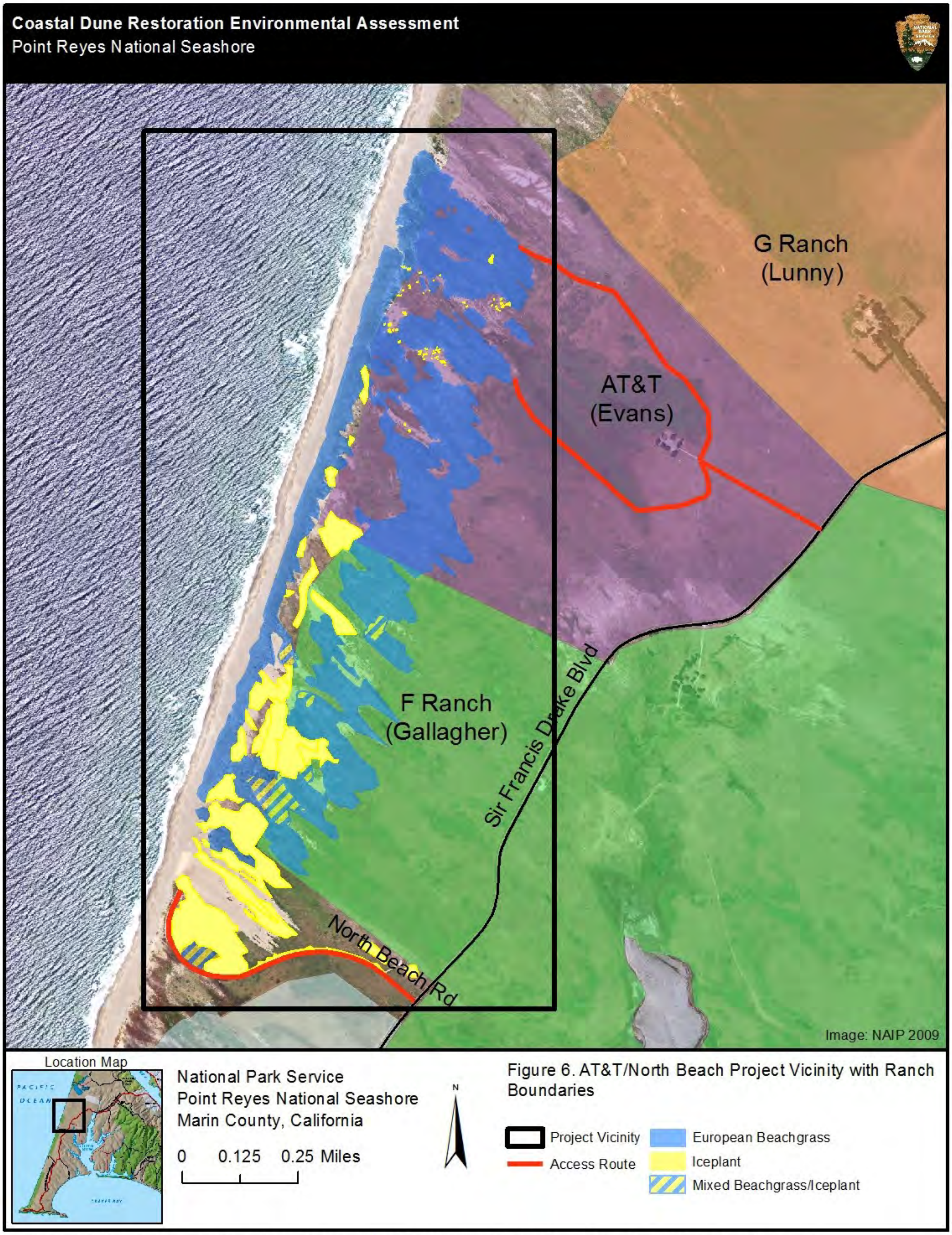

Figure 6. AT&T/North Beach Project Vicinity with Ranch Boundaries

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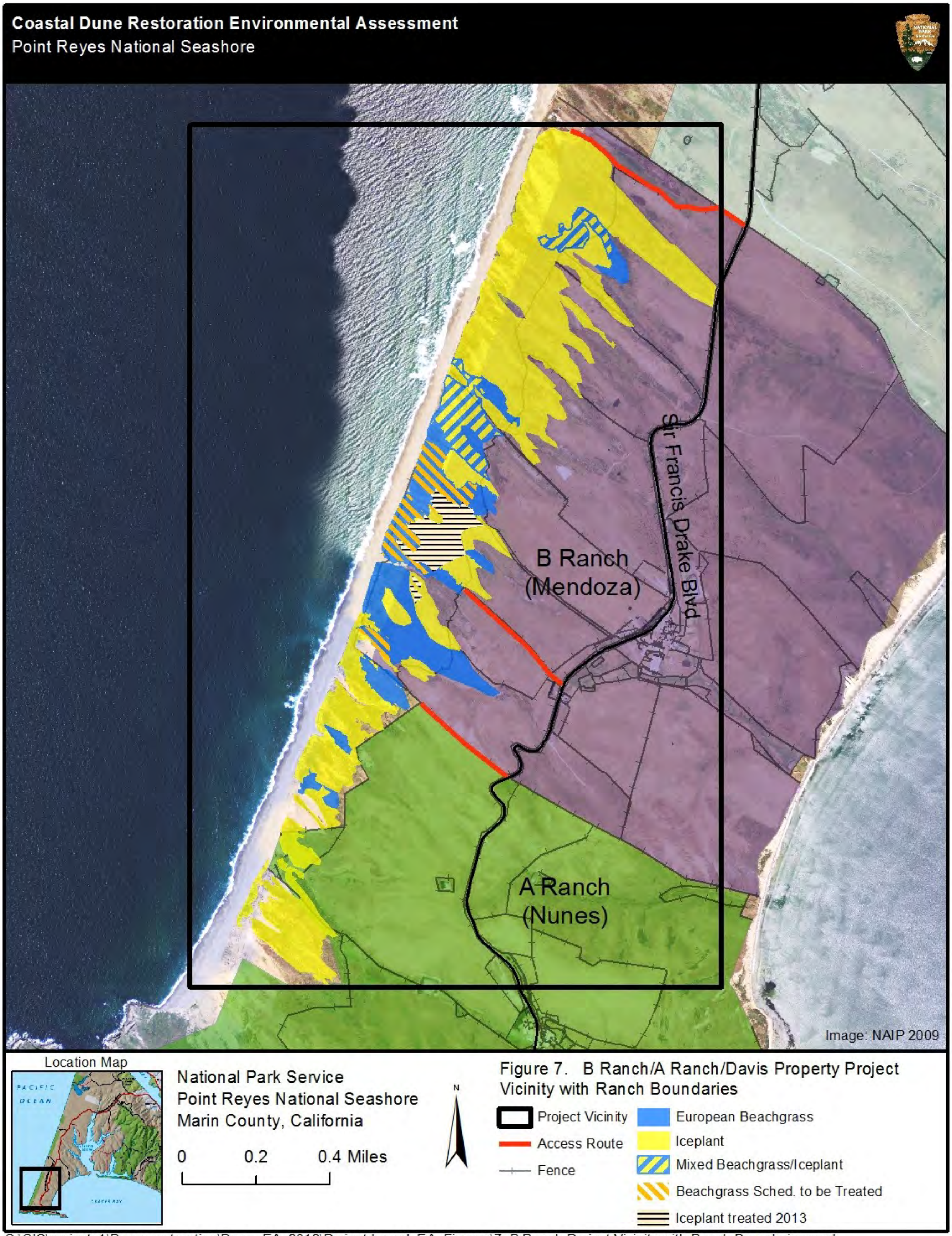

Figure 7. B Ranch/A Ranch/Davis Property Project Vicinity with Ranch Boundaries

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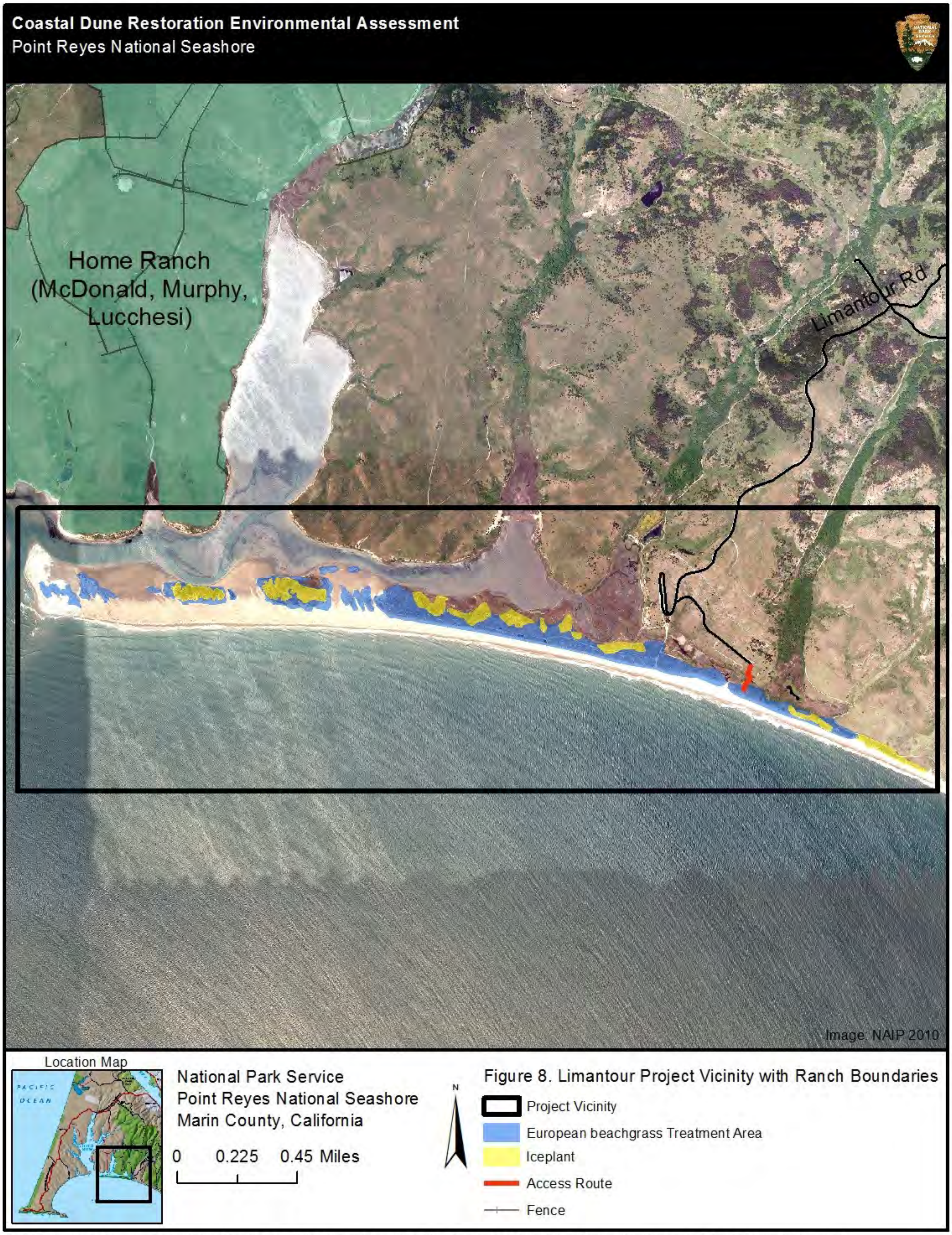

Figure 8. Limantour Project Vicinity with Ranch Boundaries

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Restoration Activities

Ultimately, the size of projects undertaken at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour could vary to some degree under the different action alternatives in extent and size of treatment depending upon the funding available and treatment approach selected, as some methods are more expensive than others.

Project planning efforts for all of these projects would be similar and include mapping of current invasive plant boundaries and verifying boundaries of wetlands and special status plant species populations within proposed project areas. The park would coordinate planning efforts with ranchers to ensure the least amount of impact to ranch operations from implementation activities such as access, staging, and removal.

As noted earlier, most of the alternatives involve a combination of removal techniques for European beachgrass and iceplant. However, only the manual removal approach for these species is common to all action alternatives. This is described here.

Manual Removal

Hand removal of European beachgrass would be performed using hand-held tools that will minimize disturbance to surrounding native plants. For example, when working in areas dominated by shrubs, a narrow-bladed hand tool would minimize impacts on the roots of adjacent shrubs and make it easier to insert the blade deeply into the soil to sever just the beachgrass roots. In hand removal areas where beachgrass is found in low densities (less than 50 percent areal coverage), individual clumps shall be removed by inserting the bladed hand tool to a depth of 1.5 feet to sever the roots, while simultaneously pulling the grass clump free. All efforts would be made to remove as much of the root mass as possible while minimizing disturbance to native vegetation.

Piles of iceplant left to decompose.

Where beachgrass is found in higher densities (greater than 50 percent areal coverage), a hand tool would be used to excavate the rootmass by digging either a trench or a pit around the beachgrass clump. The trench or pit would be dug to typically 1 to 2 feet below the surface.

Recently excavated (by hand) beachgrass biomass shall be piled in small manageable piles on top of tarps or in contractor bags on the perimeters or edges of sensitive resource areas. Excavated material would not be placed in dune mat, rare plant, or wetland areas. Material would be picked each day or every other day for disposal. If the time between stockpiling and removal is more than one day, the piles would be covered overnight with a tarpaulin anchored with sand bags at the toe and on the top or in sealed contractor bags. This will prevent blown sand from accumulating in the pile and will stop the biomass from being blown away. Hand removal material would not be stockpiled for more than two days. These same tools and techniques would be used to remove any resprouting beachgrass.

Iceplant is typically shallow-rooted, requiring excavation to no more than 6 inches deep. For this reason, iceplant can be removed by hand in many instances. The removal of iceplant mats will result in bare soils that are left in a "roughened" condition due to the shallow excavation and removal of roots. Every reasonable effort would be made to avoid damage to native vegetation in and adjacent to the designated work area.

Small iceplant individuals shall be pulled by hand from the sand. A trenching shovel or similar tool shall be used to help sever the roots and excavate any remaining shoots or runners. Larger clonal mats of iceplant shall be removed by excavating the roots beneath one edge and rolling the mat up onto itself. As the mat is rolled up, the roots would be severed just below the soil surface, freeing the mat and allowing it to be rolled further. In situations where the mats of iceplant cannot be rolled, the plants shall be pulled from the ground and any remaining roots shall be excavated with shovels.

The removed iceplant would either be left to decompose in centralized stockpiles or buried. At the completion of the removal, the restoration area may potentially be raked to gather any remaining plant material such as roots, shoots, and leaves, which shall be added to existing biomass stockpiles. These same tools and techniques would be used to remove any resprouting iceplant.

Bush lupine (*Lupinus arboreus*) would only be removed in instances where densities grow high enough that they could potentially alter restored dune systems and create conditions favorable for non-native and native plant species that not considered characteristic of dune ecosystems. Bush lupine also routinely occurs in adjacent grasslands and coastal scrub, so selective removal from certain dune areas would not eradicate this species from the Seashore. For bush lupine, plants would be manually removed by using a narrow-bladed shovel. In general, the use of a weed wrench is not possible as sand provides too unstable a surface for leverage purposes. Some plants have roots greater than 8 feet in depth, requiring extensive digging. Sometimes plant roots must be abandoned in soil as their taproots run too deep or into too dense a soil type to be completely removed; under these circumstances, aboveground biomass is cut with a blade and removed.

Restoration of Backdune Areas Adjacent to Ranchlands

Restoration efforts would be coordinated closely with adjacent ranchers. When adjacent ranchlands border proposed dune restoration areas, restoration plans would emphasize minimizing movement of sands following restoration into adjacent pastures. Methods for achieving this plan would include one or more of the following: 1) focusing on oceanward portions of the dune system initially; 2) active revegetation of backdune areas; 3) tapering backslopes if mechanical removal is used; 4) phasing restoration in the backdunes to allow time for native vegetation to recruit into the backdunes and assist with soil stabilization; 5) use of some type of sand stabilization technique such as straw bunches (straw planting), mechanical straw crimping, or other proven technique; and/or 6) other avoidance and minimization measures.

Cows in B Ranch pasture adjacent to dunes

In active revegetation restoration approaches, small portions of the backdune areas (~3- to

10 acres depending on dune system conditions and proximity to ranchlands) would be treated to eradicate European beachgrass or iceplant and then actively revegetated once it appeared that initial treatment was successful. Revegetation before invasives have been successfully removed increases the potential for re-treatment to adversely affect any seedlings establishing from broadcast seed or any container plants installed. Within these plots, revegetation would be conducted using both seed and container plant installations. A combination of native dune scrub species would be selected for planting based on characteristics such as 1) having a large root system that extends both laterally and vertically; 2) recruiting from seed and vegetatively; 3) being a fast establisher in terms of both belowground and aboveground biomass; 4) recruiting quickly once established; 5) being unlikely to create an environment favorable to non-native species; and 6) not creating management issues for adjacent ranchers. Some of the species proposed for planting include:

– the prostrate form of coyotebrush (*Baccharis pilularis*), which is a faster establisher with roots up to approximately 10.5 feet long (U.S. Forest Service/USFS 2013);

– mock heather (*Ericameria ericoides*), which has a dense lateral and vertical root system that extends down to approximately 3 feet in finer soils (Antonio and Mahall 1991) and down to approximately 6 feet in dune soils (Purer 1936 *in* Antonio and Mahall 1991).

– California blackberry (*Rubus ursinus*), which is thought of often as a riparian species also grows in the dunes within the Seashore. It spreads both from seed and vegetatively.

– Lizardtail (*Eriophyllum staechadifolium*) is a subshrub that commonly grows in coastal dune and scrub areas.

Plants would be installed both using container plantings and seed, as well. Shrubs would be preferentially planted on 3- to 5- foot centers, although the spacing may be larger if the area is extensively seeded. Seeding rates of 20 lbs/acre have been recommended for diverse seed mixes including both large and small seeds, although rates may need to be adjusted depending on the combination of species included (Pickart and Sawyer 1998). Plants would be installed in the early winter, and seed would be broadcast in late fall or early winter. In more exposed areas, straw planting may be used to help protect newly installed plants and seeds. Depending upon rates of natural recruitment or recruitment by seed broadcast, replanting may not be necessary even if container plantings show considerable mortality. The goal for revegetation would be to establish at least 40% to 50% vegetation cover over a five-year period to ensure that sands in the backdunes do not migrate into adjacent ranchlands.

Straw planting has been used in small areas of bare sand in exposed areas or in areas surrounded by only minimal native vegetation (Dorrell-Canapa 2005, Pickart and Sawyer 1998). Hand-sized bunches of sterile straw would be "planted" on 18- 24-inch centers to a depth of 3 inches, leaving 6- to 10 inches protruding from the sand (Dorrell-Canapa 2005). Plantings can occur on the leeward side of straw bundles, which increases protection against the scouring and dehydrating effects of direct wind exposure. These straw bundles typically persist for several years until they decompose or are buried by sand (Dorrell-Canapa 2005). Approximately 2,000 pounds of straw and 320 person-hours are needed per acre of bare sand to implement this technique (Ferreira and Gray 1987 *in* Dorrell-Canapa 2005). Native seed may also be broadcasted and possibly worked into the sand to increase vegetation establishment in bare sand areas.

Fast-moving sand could need a combination of techniques to provide barriers to wind movement, such as straw planting together, along with possibly other techniques such as mechanical straw crimping. Mechanical straw crimping involves blowing of sterile sand by a machine onto the surface of the sand after broadcasting native seed at approximately 15 pounds/acre, and then the sand surface is rolled with a tractor-drawn straw crimper, which punches the straw into the sand over top of the broadcasted native seed (Dorrell-Canapa 2005). Approximately 4,000 pounds of straw may be required per acre (Dorrell-Canapa 2005). While the straw blows around more than with straw planting, this technique does roughen the soil surface, which provides protective "crevices" for seed germination (Dorrell-Canapa 2005).

Staging and Access

Implementation of the proposed projects would require development of staging areas and access routes. Larger projects may require construction trailers, power and telephone drops to provide services to the trailers, and water. Access routes would either need to be created or would use existing access roads, including park and ranch roads. Access routes would be needed to travel to the site, as well as travel within the site. Minor improvements may be needed to make ranch roads suitable for transport or travel of heavy equipment and trucks. These secondary routes would be delineated with posts or with lathe and flagging. In certain instances, vehicles may travel along the beach to access certain foredune areas. Surveys would be conducted prior to route selection either in pastures or along the beach to ensure that new roads did not impact rare plants, critical wildlife habitat, sensitive cultural resource areas, or ranching operations.

Staging areas would need to be created near the project areas to store equipment, supplies, and facilities for employees such as restrooms and parking. Staging areas may need to be temporarily fenced to provide security for refueling equipment, storage containers, and parked vehicles, as well as to keep people and livestock out of staging area. Upon completion of this project, all staging areas and access routes would be reclaimed to their former condition; temporary fences would be removed, and all materials that were not previously present at the site would be removed.

At several of the areas prioritized for potential future dune restoration (AT&T, B Ranch, A Ranch, and possibly Davis), staging would involve either use of existing ranch dirt access roads with possible minor, temporary improvements (e.g., rocked culverted swale crossing; AT&T; Figure 9) or crossing through pastures along existing two-track routes (B Ranch, A Ranch, Davis Property; Figure 10). Primary staging areas in both locations would be located in on the inland edge of the dune system where staging would not impact any sensitive resources or ranching operations. At AT&T, contractors might use the paved area at the radio station facility to locate a construction trailer: All use of this area would need review by park Cultural Resources staff to ensure historic resources or uses are not impacted. At Davis property, access may also occur via a controlled access park road on the north of the Davis Property (Figure 10).

Staging area with water and a container for UTV and equipment

At North Beach and Limantour, access and staging could occur primarily via park roads and parking lots. At Limantour, access would involve use of an existing trail between the small/east parking lot and the beach (Figure 11). It is the only established beach access from the parking area. The trail is approximately 700 feet long and 4- to 6-feet wide. Minor, temporary improvements could include clearing of vegetation to widen the trail for vehicle access. The primary staging location would be in the small/east parking lot (Figure 11). A construction trailer might be placed on the pavement, along with portable restrooms, as necessary. At North Beach, access and staging may occur in the North Beach visitor parking lot (Figure 9).

Prior to the start of these projects, work and access areas would be marked in the field to clearly identify them for both park staff and contractors. Marking may be done in a variety of ways, including installation of spray-painted lathe, lathe with flagging, or t-posts: GPS may be used to more accurately locate work area perimeters. All staking methods would be reviewed by park wildlife biologists to ensure that there was no potential for stakes to act as "perches" for raptors: if so, other marking methods would be used. Staking would not only identify work areas, but avoidance or buffer areas, as well. Depending on the contract, staking would be conducted by either park staff or the contractors, but, either way, park staff would review and approve any staking conducted by contractors.

Treatment Effectiveness and Revegetation Monitoring

Treatment effectiveness focuses specifically on evaluating whether the quality of performed work meets specifications. In the case of herbicide treatments, sprayed areas are surveyed during and immediately after work is performed to ensure that more than 99% of plants appear to have been treated based on the visible evidence of blue dye on the leaves. Within 90 days, the sprayed areas are surveyed again: Should more than 2% of the plants appear to show no signs of die-back, the contractor would be asked to re-spray. Missed or under-treated plants are either marked by a point or, for larger patches, a polygon using high-accuracy GPS instruments, and then this information is brought into GIS for mapping and area characterization purposes. This procedure is repeated again in six (6) months when signs of either being missed or under-treated are more evident due to the fact that plants are actively growing again: Plants are sprayed in the fall, so the third inspection would occur in the spring of the following year.

European beachgrass resprouts in a mechanical removal area

Hand removal and mechanical removal areas are also visually inspected to ensure that more than 99% of aboveground biomass of European beachgrass and iceplant has been removed. Park Service personnel inspect hand removal work while being performed to ensure that the proper amount of belowground roots and rhizomes are being removed. For mechanical removal, QA/QC measures also incorporate documentation of the depth of "dirty" or aboveground biomass- and rhizome-contaminated sand that is excavated through measurement and recording of excavation depths by the contractor on a daily basis. The mechanical QA/QC procedure also includes documentation of the depth of the "clean" (biomass and rhizome-free sand) sand cap placed in excavated areas through placement of specially marked lathe that is more than 3-feet in length. Failure to meet any of the contract requirements will require remediation by the contractor.

Plants installed in the backdune plots adjacent to ranchlands would be monitored to assess mortality of plantings and overall species establishment. This would involve counting of container plants remaining by the summer following initial installation, as well as a visual assessment of overall cover within the backdune plot to determine whether additional plantings or seed broadcasting is necessary.

Monitoring

Monitoring of existing restoration projects would continue as funding allows to determine the success in determining level of re-treatment necessary, as well as success in restoring native vegetation communities and progress toward recovering listed and rare species. Efforts to track the number of rare plants, Western snowy plover nesting sites, nesting success and health of each plover, as well as the presence of the Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) population would continue as funding allows.

Resource Protection

Coastal dune restoration typically takes place in areas of high ecological and other resource importance, where the avoidance or minimization of adverse impacts to species of special concern, rare vegetation communities, wetlands, cultural, and adjacent land use resources is very important. Current actions taken to protect these and other resources from impacts of removal are described in detail below and summarized in Table 1.

General Environmental Resources

– To the maximum extent practicable, projects would be conducted in late summer and fall to ensure that implementation does not overlap or only slightly overlaps with the end of breeding seasons for many special status and protected species, including Western snowy plover (ends Sept. 15), California red-legged frog (*Rana draytonii*; FT; ends July 31), Myrtle's silverspot butterfly (FE; ends Aug. 31), and breeding birds protected by Migratory Bird Treaty Act (ends July 31).

– Buffers would be maintained between mechanical treatment and active nests for snowy plovers (500 feet); nesting birds (100 feet); California red-legged frog habitat (100 feet during breeding season); and rare plants (10 feet). The same buffers could apply for manual removal.

– Because animals are highly mobile, multiple pre-construction surveys, clearance surveys, or daily monitoring during the work period may be required. Sometimes, pre-construction clearance surveys may find some of these species in new areas. Surveys would be conducted in all construction areas by qualified biologists with the last survey no more than 1 week prior to start of construction in that area, except for California red-legged frog, where the last survey must occur within 48 hours of construction start. Should special status species or nesting birds be located, no treatment would be undertaken within the above listed buffers during the specified time period, if any. Treatment activities would be delayed in this area until the end of construction avoidance period. These areas would be marked similar to the established wildlife restriction areas. Should species be found outside the construction avoidance period, the contractor will consult with the Park Service or its designated representative to determine the best course of action, which may include relocation of individuals to appropriate habitat by a qualified biologist or other actions permitted under the Biological Opinion.

– An education program will be conducted for associated park staff and interns, contractors, and their employees before the project begins and as needed throughout the duration of the project as staff changes occur or as conditions warrant. Emphasis of the education program will be on identification of the various species, their legal status and Endangered Species Act protection, the measures being taken during the project to reduce adverse impacts to them, and conditions that will require stoppage of work.

Western snowy plover

Western snowy plover adult and chicks. (Photo: Callie Bowdish)

Snowy plovers over-winter in Point Reyes along Point Reyes Beach, Limantour Beach, and at Drakes Beach and Estero, and breed at some of these sites. The seasonal presence of the breeding Western snowy plovers imposes the longest lasting time constraint on when and where removal can take place. The plover nesting and foraging zone is almost exclusively in the foredunes, although chicks are precocious, and both they and adults can sometimes forage through blowouts inland from the foredune. Western snowy plovers may begin the breeding season between March-April, and can lay more than one clutch to extend breeding, nesting and rearing into mid-September.

– Avian surveys would be conducted in project areas during breeding season to locate nests and plover broods.

– A minimum 500-foot buffer would be established between an active nest and any restoration activities, and no work would be conducted within the buffer until the nest is no longer active unless approved by USFWS or a USFWS-approved biologist.

Myrtle's silverspot butterfly

Myrtle's silverspot butterflies may be observed between mid-June and early October. During this period, adults take flight in search of nectar sources in grasslands and dunes. Several native dune mat plant species are known to provide nectar for the butterflies, and the Western dog violet (*Viola adunca*), a grassland species, is used by larvae as the butterflies' sole source of food prior to pupating. The known habitat range within the park for Myrtle's silverspot includes the areas surrounding Drake's Estero and the Estero de Limantour; the Great Beach from north of South Beach to just north of Abbotts Lagoon: and Tomales Point from Marshall and Kehoe Beaches to White Gulch and just north of McClure's Beach.

– Between June 15 and August 31, all vehicles will be driven at speeds of < 10 mph when traveling off-road within the Project Area to protect adult flying Myrtle's silverspot.

Western dog violet is the only larval host plant for the Myrtle's silverspot butterfly.

– If new access routes need to be constructed in grasslands, surveys would be conducted to ensure that routes pose the least amount of impact possible to western dog violet, the larval plant for this species.

California red-legged frog

California red-legged frog (CRLF) occur in perennial and seasonally inundated wetlands and moist habitats such as riparian forests and scrub and grasslands, including wetlands in and adjacent to dunes. Frogs breed in ponded wetlands during the winter, with egg masses and tadpoles present in these areas through mid-summer. Following breeding, frogs migrate some distance from ponds through non-wetland habitat (even dunes) to reach moist areas such as moist grasslands and riparian forest and scrub.

California red-legged frog.

– At least three night surveys for CRLF would be conducted by a qualified biologist in work areas either in or adjacent to known CRLF habitat or potential CRLF habitat prior to mechanical, chemical and possibly manual removal treatments, with the last survey being within 48 hours of the start of work.

Rare Plants and Native Dune Communities

The dunes contain some highly sensitive and rare plant communities that are sometimes interspersed within stands of European beachgrass and iceplant. Some of these habitats contain federally listed endangered species or species designated by the California Native Plant Society (CNPS) as rare. In fact, more than 10 rare plant species are known to occur within the Seashore's coastal dunes or adjacent habitats (see *Affected Environment* for *Species of Special Concern*). These species include both perennials (Tidestrom's lupine) and annuals (beach layia and curlyleaf monardella/*Monardella sinuata* ssp. *nigrescens,* CNPS List 1B.2-Proposed). In addition, as noted earlier, even the species not considered rare can serve as nectar sources for the federally endangered butterfly (western dog violet).

A drift shield around a native cudweed.

– Existing rare plant distribution information would be reviewed prior to developing restoration plans, and surveys may be conducted prior to restoration to better define the current extent of native vegetation communities and rare plants within project areas.

– Every effort would be made to schedule restoration activities outside of the typical bloom periods. In addition, where annual species are present, preference would be given to scheduling during the fall or early winter, when plants may not be present.

– To minimize introduction or spread of invasive or non-native plant species, staff and contractors would be required to thoroughly clean equipment and vehicles prior to start of use. Any new piece of equipment brought in, or any piece of equipment taken off site and then returned to the site, would also be washed.

– Contractors would be required to remove sand, mud, vegetation and seeds from vehicle wheels and under carriage before entering and exiting the construction site onto park or county roadways through installation of tire cleaning stations near main project entrance.

Cultural Resources

Because of the proximity of the dunes to the coast, these areas often contain archaeological resources or even historical resources that could be impacted by restoration activities, particularly mechanical removal ones.

– The Park Service would provide contractors education on cultural resource restrictions prior to project start. Certain areas within project areas may be designated as Archaeologically Significant Resource Areas. Particular care would be taken during work in these areas, particularly when implementing mechanical removal or post-treatment measures.

– If human remains are discovered, the contractor would be required to cease activity in the area of discovery, protect the remains, and notify the park immediately. On notification that human remains have been discovered on federal land, the Park Service would certify receipt of the notification, take steps to secure and protect the remains, notify the Native American tribe or tribes likely to be culturally affiliated with the discovered human remains within one (1) working day, and initiate consultation with the Native American tribe or tribes in accordance with regulations described in 43(CFR) Part 10 Subpart B Section 10.5.

Water Resources

While dunes themselves are a relatively "dry" habitat, wetlands often occur within lower elevation basins or "swales" within the dunes, particularly where groundwater tables intercept the soil surface. Wetlands and water bodies can also occur on the perimeter of the dunes, with oceans often present on one side of the project area and freshwater marshes or moist meadows and grasslands on the other.


Wetland adjacent to dunes

– Depending on the activity, work in areas that are regulated as wetlands by either the U.S. Army Corps of Engineers (USACE) or the California Coastal Commission (CCC) would require permits.

– Wetlands near staging areas and access routes would be clearly marked to ensure that there is no vehicle and minimal crew traffic in these areas.

– Manual removal of European beachgrass and iceplant would be the primary method of removal in regulated wetlands.

– A Spill Prevention and Response Plan (SPRP) would be required from contractors. This plan would be required to incorporate specific measures to avoid impacts to wetlands and water bodies. These include:

– At a minimum, all staging, storage, chemical mixing and loading, and refueling areas and any equipment repair or similar activity must take place at least 100-feet from any Sensitive Resource Area, wetland, creek, pond, ocean, lagoon, or other waterbody or area subject to restriction due to special status wildlife.

- Refueling and chemical mixing and storage shall only occur in areas approved by the park.
- Protective tarps shall be used during chemical mixing, storage, equipment refueling, or equipment repair or comparable method with prior approval of the park.
- The contractor shall check construction equipment daily for any fluid leaks and promptly fixing any leaks.

– In the event of a spill or leak, each piece of equipment would have the proper containment equipment readily at hand, and the operator would be trained in the proper protocol and use. Park Service staff and/or construction managers would be notified, and the disposal procedures outlined in the prevention plan would be initiated. Spill response kits would be kept with the heavy equipment and stored in the on-site staging areas. Kits would likely contain spill berms, hazardous materials drums, drip pans, and absorbent materials.

Wilderness

Designated wilderness in the Seashore occurs along beaches and in certain portions of the adjacent coastal dunes, including areas in and along the Great Beach and Limantour. All projects proposed to be conducted in wilderness within the park are required to undergo a Minimum Requirements Analysis. Several of the previous dune restoration projects underwent this process prior to implementation. The measures discussed in Chapter 2 represent the mitigation measures implemented as part of these past projects.

– Any restoration efforts in wilderness would be subject to restrictions on installation of permanent or temporary facilities (i.e., staging areas, access routes) and use of mechanized equipment in wilderness areas.

– No staging would be allowed in wilderness areas.

– Access routes would be the minimal necessary to achieve project objectives and would be clearly marked. All-terrain vehicles used within wilderness would be parked outside wilderness boundaries when not in use.

– Any changes proposed to these measures would potentially require that the park undergo a new Minimum Requirements Analysis process to evaluate any new potential impacts associated with the proposed activity to wilderness.

Visitor Experience and Soundscapes

Beaches and adjacent dunes are highly frequented by visitors. Visitor enjoyment may be impacted by dune restoration projects. The park would attempt to minimize these impacts through the following:

Notification about an herbicide project posted at the Abbotts Lagoon Trailhead.

— Construction dates/times, planned closures of portions of project areas and adjacent areas, and suggestions for alternative recreational opportunities would be provided to visitors via docents, rangers, park website, Visitor Center, parking lots/trailheads, etc., and posted at the project site in advance.

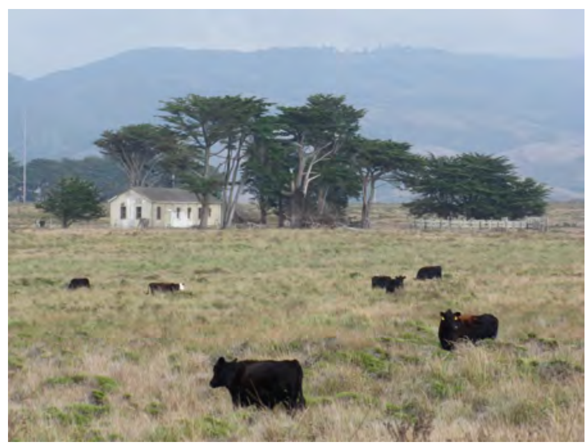
Adjacent Land Use

Most of the coastal dunes within the Seashore directly abut lands leased for ranching or park lands. Dune restoration activities have the potential to impact these adjacent lands through access and staging, as well as through restoration. Some of the ranch lands are managed as organic pastures, such that no herbicide application is allowed on these lands, and any fence construction must use materials that comply with organic standards.

- The park would coordinate with adjacent ranchers to ensure that project implementation, access, or staging activities would not impact ranching operations.

- All efforts would be made to avoid creation of new access routes through pastures, where it can be avoided. Staging areas would be sited to the maximum extent practicable out of the primary pasture areas. Contractors would be educated about the need to maintain gates and fencing. Any impacts to ranch facilities such as degradation to existing roads would need to be repaired by the contractor prior to project completion.

- For projects directly bordering actively used ranchlands, measures would be taken to avoid or minimize sand movement into inland pastures (Table 1). Depending on site conditions, restoration may emphasize restoration in the oceanward portion of the dunes; conduct active revegetation in backdune areas; phase restoration in the backdunes in a series of small plots over time to allow for native plant establishment; implement sand stabilization techniques; and taper slopes in the backdunes if mechanical removal is performed. See more detailed explanation earlier in this section.


Cows in a leased pasture adjacent to the dunes.

Public Health and Safety

While unlikely, dune restoration does have the potential to impact health and safety of park visitors. All tasks associated with project implementation would be conducted with the highest priority being the health and safety of the public, as well as staff and contractors.

- Contractors would be required to prepare an Accident Prevention Plan for submission to the park that must include daily tailgate meetings to discuss potential safety issues.

– The park would post notices regarding work activities and associated closures at all entry points to the project areas, including any major trailheads prior to start of the restoration activity.

Sign at the entrance to the staging area

Alternative B - Dune Restoration Using Manual Control Methods

Restoration in this alternative would primarily use manual control methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket (*Cakile maritima*) and bush lupine. The techniques employed for this restoration approach are discussed – along with the common staging and access, monitoring, and environmental protection measures – above under *Actions Common to All Action Alternatives*.

This method would use manual techniques for both initial treatment and follow-up treatments. Initial treatment would remove roots from a depth of 1.5 feet down regardless of rooting depth in dune habitats. (Beachgrass is more deeply rooted in foredunes than backdunes.) Based on projects where manual removal of beachgrass appears to have had some success (e.g. Lanphere-Christensen Dunes; Pickart and Sawyer 1998), follow-up treatments would need to be conducted at least eight (8) times during the first year every two to four weeks, with re-treatment moving decreasing in frequency over time. Iceplant would also be removed to a consistent depth of 6 inches and re-treated every six months for two years. The specifics of manual removal techniques – and how they might vary for at least European beachgrass depending on surrounding vegetation and density – are described in *Actions Common to All Action Alternatives*.

Project logistics greatly depend on the size of the treatment area, location, and number of sensitive resources that must be avoided. However, it is likely that all projects would involve working across the landscape in a sequential fashion to minimize potential for reinvasion of restored areas. Also, to minimize the potential for reinvasion, European beachgrass biomass would need to be disposed of off-site either through hauling biomass and rhizomes off-site and disposing in a landfill or some other destructive method or through moderately deep burial and capping in an approved disposal location. Iceplant could be disposed on-site in stockpile areas. For bush lupine, flowering materials would need to be disposed of off-site, or flowers would need to cut off bushes, so that bushes could be left on-site.

Restoration Activities

Dune Restoration Approach

– Alternative B would include all pertinent measures discussed under Alternative A-Continue Current Restoration Program and Actions Common to All Action Alternatives.

- Under this alternative, the park would initially treat European beachgrass and iceplant and potentially other invasive species within project areas using manual removal methods (Table 1).

- The park would also re-treat European beachgrass, iceplant, and potentially other invasive species using manual removal methods (Table 1). Manual re-treatment of European beachgrass would be expected to take at least five (5) to eight (8) return visits during the first year. Full re-treatment of iceplant would be expected to take two years, with at least two (2) re-treatment events each year. Full re-treatment for other species would be expected to take two years, with at least two (2) re-treatment events each year.

- Under Alternative B, the primary tools that would be used would be non-mechanized hand tools. Within wilderness, there would be no staging of equipment and tools; UTVs would be used when necessary to haul and dispose of biomass, as disposal of material on-site can sometimes pose a risk to reestablishment of removed species, as well as result in unsightly "piles" within wilderness areas. Therefore, under Alternative B, the minimum tool necessary to accomplish restoration objectives would include UTVs, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable.

- For comparative evaluation purposes, based on estimated costs of eradication using this method and current funding availability, selection of this alternative could result in treatment of approximately 5- to 7 acres at AT&T, along with 2 acres of iceplant (Table 1). There are no current funding proposals approved for the other proposed restoration areas.

Techniques used in Alternative B are discussed in Actions Common to All Action Alternatives.

Time and Cost

Manual removal costs are difficult to estimate, particularly as more re-treatment is required for this technique. However, based on 1997 numbers provided by Pickart and Sawyer (1998) for dune restoration in Humboldt and escalated by 3.5 percent annually to 2012, manual removal could cost $52,879/acre. This number includes at least eight (8) re-treatments spread over several years. Unfortunately, none of the other numbers available reflect treatment to eradication, so it is difficult to compare the Humboldt numbers with those from past park projects.

For iceplant, initial removal by hand at the Paleodunes project cost $11,723/acre. At least four (4) successively smaller follow-up treatments would be necessary to bring iceplant to control levels over two years, with re-treatment every six months. No numbers are available for treatment to control, but an estimate based on projected re-treatment efforts required would be $20,000/acre.

Staging and Access

Staging and access operations would be as described above for *Actions Common to All Action Alternatives*.

Monitoring

Staging and access operations would be as described above for *Actions Common to All Action Alternatives*.

Environmental Protection

Environmental Protection measures would be as described above for *Actions Common to All Action Alternatives* (Table 1).

Alternative C - Diverse Mix of Restoration Methods, with Emphasis on Chemical Control for Initial Treatment (Preferred Alternative)

Restoration in this alternative would primarily use herbicide control methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, although it would incorporate manual and mechanical removal potentially, as well. Herbicide may also be used for iceplant, but smaller infestations would probably be removed by hand. Manual removal would be primarily used for European beachgrass plants that occur in regulated wetlands, with the potential exception of mechanical being used for heavier infestations, and also for non-native invasive or potentially habitat-altering species such as European searocket and bush lupine. Mechanical or manual removal may be used in buffers adjacent to wetlands or organic pastures. Herbicide treatment areas may be pre-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and to reduce the amount of herbicide needing to be applied: Mowing may also be used after treatment to speed up decomposition of European beachgrass and establishment by native species.

Restoration Activities

In addition to common staging and access, monitoring, and resource protection objectives and measures described above under *Actions Common to All Action Alternatives*, *Alternative C* includes the following actions:

Dune Restoration Approach

- Alternative C would include all measures discussed under *Actions Common to All Action Alternatives*.

- Initial treatment of European beachgrass in coastal dunes would be conducted using herbicide and backpack sprayers with calibrated wands or wicking techniques (Table 1). The aquatic-label herbicides proposed for use are glyphosate (AquaMaster®; currently marketed as Roundup Custom®) and imazapyr (Habitat®). These would be used in combination at concentrations of 2% and 1%, respectively, which either meets or is lower than label recommendations for "a robust, perennial grass at the heavily-established" infestation qualifier-level.

- Pre-treatment of European beachgrass herbicide treatment areas would be potentially conducted through use of prescribed burning or mowing (Table 1). These treatments reduce thatch and encouraging re-growth of new shoots, thereby increasing efficacy of herbicide application and reducing the volume of herbicide needing to be applied.

– Re-treatment of European beachgrass would be conducted either through either manual removal or spot-spraying herbicide on missed or undertreated plants (Table 1). Full re-treatment with herbicide would be expected to take two to three additional spray events, with the number of plants to be treated dramatically reduced even after initial treatment. Manual re-treatment of European beachgrass would be expected to take at least five (5) to eight (8) return visits during the first year.

– Manual removal of European beachgrass would be primarily conducted in wetlands and in some upland buffer areas buffers to wetlands and organic pastures (Table 1), with five (5) to eight (8) re-treatment events during the first year.

– Mechanical removal would be potentially used to remove European beachgrass in buffer areas to wetlands, heavily infested wetland areas, and organic pastures (Table 1).

– Initial treatment of iceplant in coastal dunes would be conducted using either manual removal or herbicide backpack sprayers with calibrated wands (Table 1). The aquatic-label herbicide proposed for use is glyphosate (AquaMaster®; currently marketed as Roundup Custom®). This would be at a concentration of 1.5%, which meets label recommendations for this species.

– Re-treatment of iceplant would be conducted through manual removal (Table 1). Full re-treatment would be expected to take two years, with at least two (2) re-treatment events each year.

– Initial and re-treatment of other species such as bush lupine and European searocket would be conducted using manual removal methods (Table 1). Full re-treatment would be expected to take two years, with at least two (2) re-treatment events each year.

– Following treatment, mowing may be used in European beachgrass areas to speed decomposition of European beachgrass and establishment by native species.

– Under Alternative C, the primary tools that would be used would be herbicide treatment using backpack sprayers. Within wilderness, there would be no staging of equipment and tools; UTVs may be used when necessary for hauling of equipment and hauling and disposal of biomass, as in Alternative B, and, in addition, excavators may be used to mechanically remove invasives within wetland and organic pasture buffers, although the amount of equipment and the duration of mechanical removal activities would be reduced relative to Alternative D. Therefore, under Alternative C, the minimum tool necessary to accomplish restoration objectives would include UTVs and excavators, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable. Mowing and prescribed burning proposed as potential pre-treatment measures may not be conducted within wilderness, as they are not actions that are essential for successful implementation of dune restoration.

– For comparative evaluation purposes, based on estimated costs of eradication using this method and current funding availability, selection of this alternative could result in treatment of approximately up to 77 acres of beachgrass and 1.5 acres of iceplant at AT&T using chemical control, along with manual or mechanical removal of another 3 acres of beachgrass and manual removal of 0.5 acre of iceplant (Table 1). There are no current funding proposals approved for the other proposed restoration areas.

Techniques used in *Alternative C* are discussed below, except for manual removal technique, which is discussed in *Actions Common to All Action Alternatives* and *Alternative B*, and me-

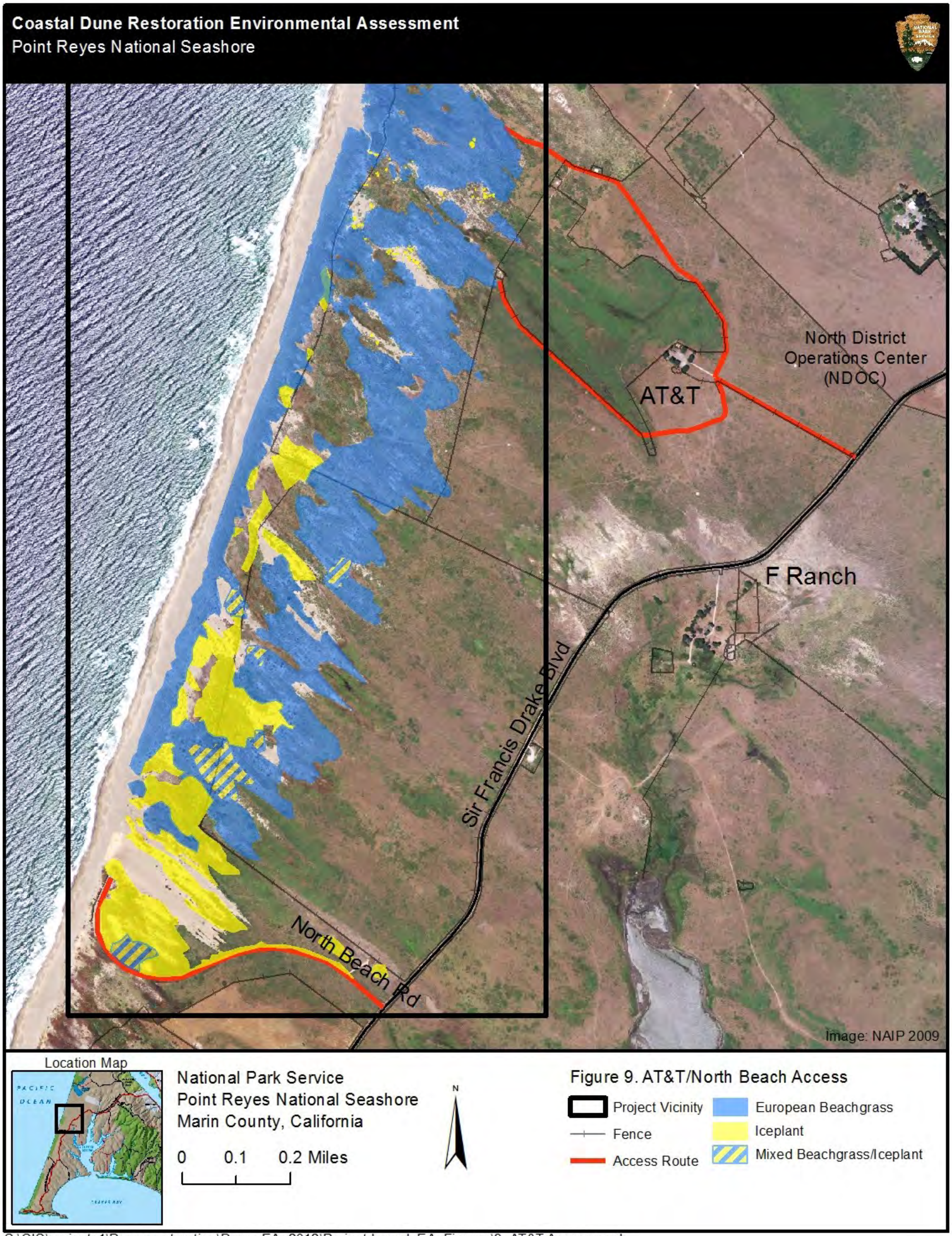


Figure 9. AT&T/North Beach Access

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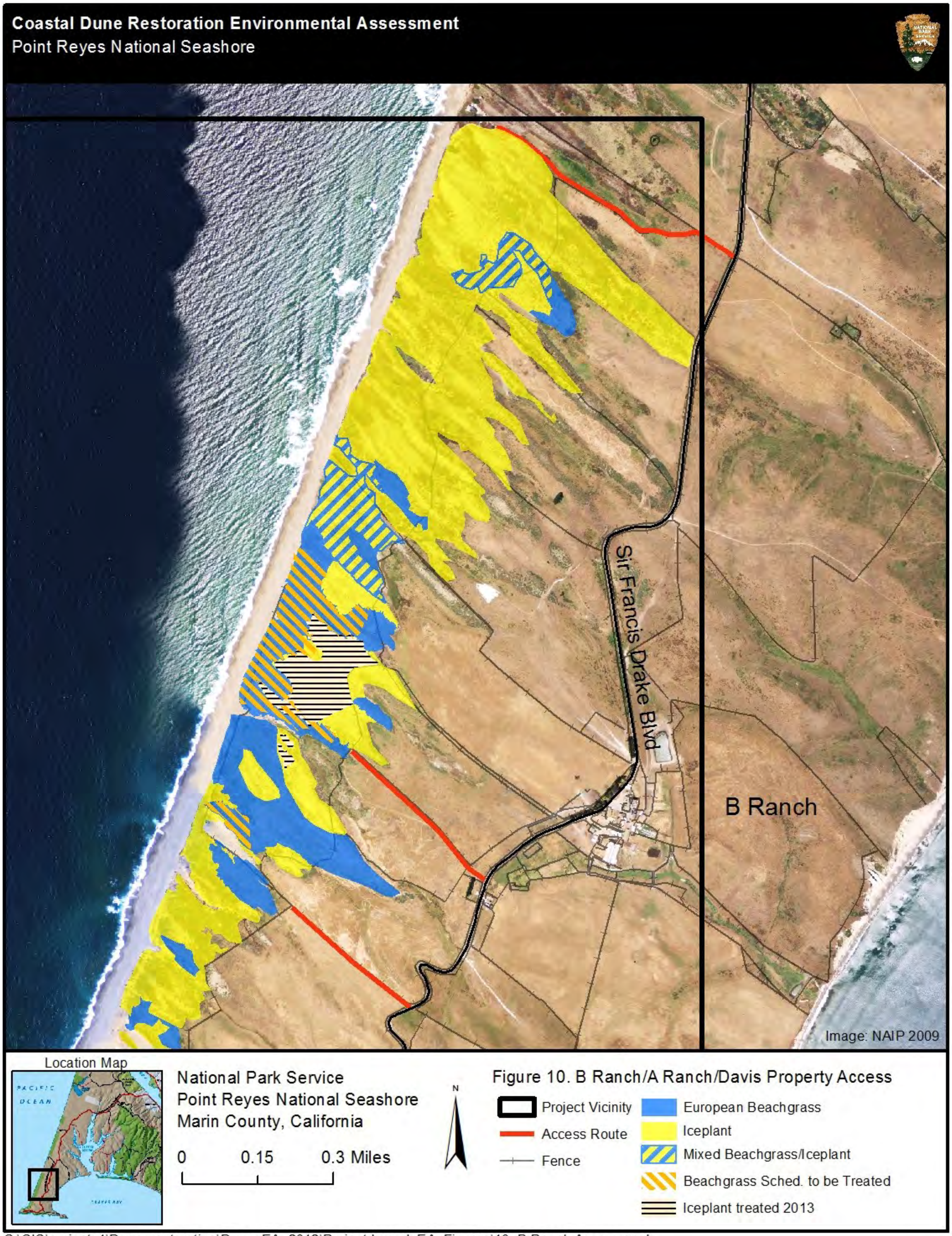

Figure 10. B Ranch/A Ranch/Davis Property Access

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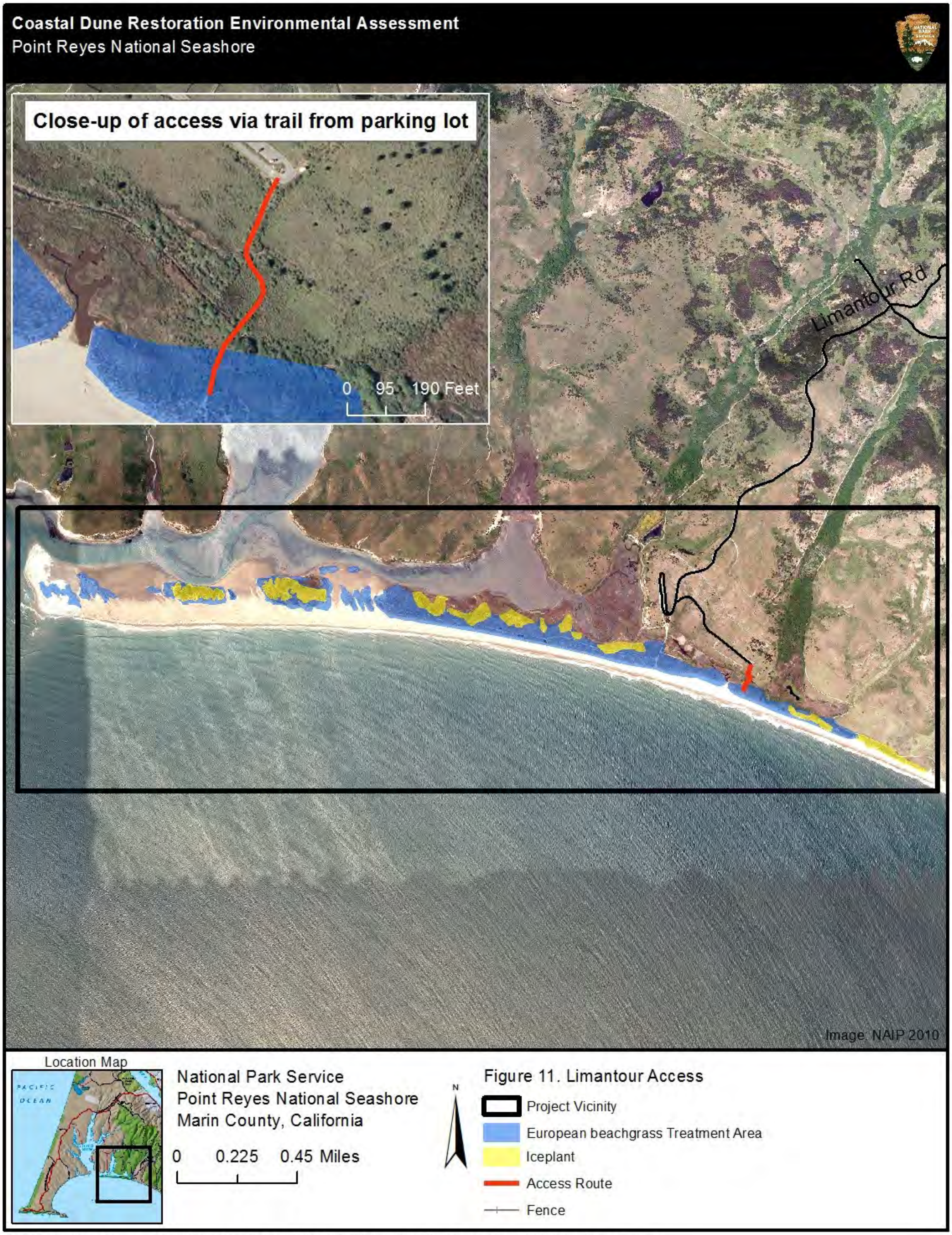


S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\11_Limantour Access.mxd chanical removal, which is discussed under *Alternative D*. Staging and access, monitoring, and environmental protection measures are also discussed above under *Actions Common to All Action Alternatives*.

As described earlier in this chapter, herbicide use on lands managed by the Park Service requires initiation and approval of a Pesticide Use Proposal or PUP. PUP requests are reviewed and approved by the Pacific West Regional Integrated Pest Management (IPM) Coordinator or by officials at the Washington D.C. office (WASO). Approvals require tracking of quantities and areas where pesticides are used. All herbicide application would be in compliance with manufacturers' labels and would occur only under appropriate weather conditions.

Project logistics greatly depend on the size of the treatment area, location, and number of sensitive resources that must be avoided. However, it is likely that all projects would involve working across the landscape in a sequential fashion to minimize potential for reinvasion of restored areas.

European Beachgrass Removal Using Herbicide

Chemical treatment would consist of foliar application with 2% concentration of glyphosate (formulated as AquaMaster®; currently marketed as Roundup Custom®; or other formulation without an incorporated surfactant), 1% concentration of imazapyr (formulated as Habitat® or another formulation), 1% concentration of a non-ionic vegetable oil surfactant (Competitor® or another formulation), and 1.5% concentration of a blue dye, using label specifications for combined total treatment (initial and any follow-up) of no more than 8 quarts or 8 lbs acid equivalent (a.e.)/acre/year of glyphosate concentrate and no more than 6 pints or 1.5 lbs a.e./acre/year of imazapyr. The concentration of dye will be increased or decreased where necessary, based on visual assessments made after the first and second herbicide application. These concentrations were determined by following species-specific label recommendations, evaluating past experience with herbicide application on European beachgrass, and by considering recommendations from land managers coping with similar invasive species' issues.

Glyphosate is a broad-spectrum, non-selective, post-emergence systemic herbicide developed by Monsanto (Franz 1985; Franz et al. 1997 *in* SERA 2011a). Glyphosate inhibits the shikimic acid pathway in plants, which is involved in the production of essential aromatic amino acids (SERA 2011a). This inhibition leads to an inhibition or cessation of growth, cellular disruption, and, at sufficiently high levels of exposure, plant death (SERA 2011a). The time course for these effects can be relatively slow, depending on the plant species, growth rate, climate, and application rate (SERA 2011a). By 2003, when glyphosate was no longer protected by patent, the number of commercial formulations had increased substantially and continues to grow (SERA 2011a). Some of these formulations incorporate a surfactant, and some do not: Some Round-Up® products, for example, contain a surfactant (SERA 2011a). Because there are concerns that surfactants in glyphosate formulations such as Round-Up® may be even more toxic than glyphosate or enhance the toxicity of glyphosate (SERA 2011a), the park typically does not use formulations of glyphosate that incorporate a surfactant, but uses so-called technical grade glyphosate formulations such as AquaMaster® (currently marketed as Roundup Custom®). AquaMaster® or Roundup Custom® is an aquatic label formulation classified as a Caution-level or Toxicity Class III chemical, one level higher than chemicals considered non-toxic (Toxicity Class IV).

For Roundup Custom®, the recommended label application rate for European beachgrass varies from a 3.5% to 8% solution, with a 0.5-1.5% non-ionic surfactant added and applied on a low-volume basis. However, to decrease the amount of herbicide being used and based on past experience with the park's and other agencies' projects, the proposed concentration for glyphosate would be approximately 2% concentration. In accordance with label instructions, the application would occur before 50% of green leaf color is lost during fall senescence.

Imazapyr is a non-selective herbicide used to control a variety of grasses, broadleaf weeds, vines, and brush or woody species (SERA 2011b). Imazapyr is an imidazolinone compound that enters the plant through its foliage and, to a lesser extent, its roots and then translocates through the xylem and phloem portions of plants to the roots, where it disrupts enzymes or amino acids specific to plant growth (ImazapyrFactSheet.pdf n.d.). The original formulation of imazapyr was Arsenal® (ImazapyrFactSheet.pdf n.d.), but imazapyr is now off patent, and numerous formulations are available both from BASF and other companies, including Habitat®, which is most commonly used for many wildland weed issues. Habitat® is classified as an aquatic-label formulation that is classified as a Caution-level or Toxicity Class III chemical, one level higher than chemicals considered non-toxic (Toxicity Class IV). While imazapyr formulations can be used in pre-emergence applications, the most common applications are post-emergent where the vegetation to be controlled is growing vigorously (SERA 2011b).

Based on classifications on the Habitat® label, the distribution and size of European beachgrass in most areas of the park constitutes a robust, perennial grass at the heavily-established-infestation qualifier-level. Habitat® can be applied at 4-6 pints/acre for species with this designation. Habitat® cannot be applied at more than the equivalent of 6 pints or 1.5 lbs a.e./acre/year, which represents a 1.5% hand-held-concentration, however, for beachgrass treatment, a lower concentration solution (1%) would typically be used.

Both imazapyr and glyphosate must be combined with a suitable surfactant to facilitate uptake and translocation of the herbicide down into the rhizomes. One of the types of adjuvants recommended for use with these types of herbicide is methylated seed oil, which is a type of "spreader" that disperses the droplet of herbicide mixture on the leaf surface to improve herbicide uptake and overall effectiveness. Surfactants are also used to control spray drift by altering the surface tension of the solution so small droplets cannot form (PRI 2010). The park currently uses Competitor®, which is a modified vegetable oil containing a non-ionic emulsifier system.

An inert marker dye or colorant will also be added. Colorants (dyes) are added to the herbicide mixture to the dye is to mark areas that have been treated with herbicides to ensure full coverage and avoid duplicative treatments (PRI 2010). The dye also serves to notify workers and the general public of the location of treated areas (PRI 2010).

Treatment would be conducted using either a backpack sprayer with a calibrated nozzle, where spray volume is adjusted specifically to minimize drift, or through direct contact with wicking from a wand. Use of the latter is not subject to drift. No broadcast application methods would be allowed. When work is conducted near rare plants or native dune mat, either a 10-foot buffer must be implemented, OR a drift shield can be employed instead. Crews would be directed to avoid native vegetation intermixed within European beachgrass or iceplant to the maximum extent practicable. Also, as mentioned under environmental protection measures, there would be no spraying under adverse weather conditions, including wind speeds exceeding 10 mph at the level of the target plant; rainfall, including no treatment 24 hours after a rainfall event or 24 hours before a predicted rainfall event when there is a 20% chance of rainfall; or moderate to heavy fog conditions.

Before each application, backpacks, which carry approximately 3.5 gallons each, would be tested and calibrated by flushing with water. At the conclusion of each application, backpacks would be triple-rinsed twice with water – the rinse would be applied on areas yet to be sprayed or areas sprayed previously that day, as it is considered a negligible amount of herbicide and part of the pre-calculated application amount. All mixing and loading of chemicals, and any fueling and/or servicing of equipment, would be done only on impermeable surfaces, as well as at least 100 feet from wetlands.

After applications, equipment would be properly rinsed and stored. Used Personal Protective Equipment (PPE) would be disposed of accordingly, and contaminated equipment would be clearly labeled and secured in a locked location. Post-application reports (such as solution mixed and applied, area covered, work hours, etc.) would be prepared on a daily basis to ensure efficiency and accuracy in herbicide reporting and treatment efforts. At the conclusion of application operations, all herbicide amounts would be properly reported to the proper authorities, specifically Park Service IPM.

Treatment would typically occur in the fall or spring, although treatment in the winter is possible if weather conditions are dry. Fall is a time when most plants are undergoing some type of senescence or becoming more dormant, and this is the preferred time for application due to special status species and herbicide effectiveness considerations. The herbicide mixture used in this approach relies on both translocation of imazapyr and glyphosate into the root system or storage organs –- which typically happens during the fall.

Information on time to effect for both of these chemicals on European beachgrass is limited. However, glyphosate is considered faster acting than imazapyr: For other perennial grass species, such as non-native cordgrass species (*Spartina* sp.), complete browning occurred with glyphosate in 7 to 21 days (K. Patten, *pers. comm*., *in* CCC 2005). In another project, glyphosate treatment resulted in noticeable yellowing or browning within one week, with full control taking another taking another three weeks (Barker and Prostak 2008). Because it is so fast-acting, glyphosate is sometimes used with the slower-acting imazapyr as a "brown-down indicator" to allow for more rapid detection of missed or skipped areas (CCC 2011). With non-native cordgrass, imazapyr often takes 2-4 weeks after treatment to see yellowing of the leaves, and complete plant death can take several months (CCC 2011). Since imazapyr is such a slow-acting herbicide, if it is applied in the fall, managers may not know if the entire stand at a site has been effectively treated until the following spring, because treated plants may not show much of response before senescence: However, non-native cordgrass, which is a clonal species that dies back considerably each winter, will simply not reemerge in the spring (CCC 2011).

Similar experiences have been noted by people working with European beachgrass. At northern California coastal dunes, treatment in the fall with 2% glyphosate and 1-1.5% imazapyr allowed for the glyphosate to act quickly on the plant, probably within weeks, but that low a concentration of glyphosate showed no noticeable affect on plant vigor. At this site, the imazapyr effect was not noticeable for at least four months. In terms of differences in treatment response, this agency found that foredune stands may be slightly more difficult to eradicate due possibly to higher soil moisture levels.

It is critical that coverage of plants with an initial treatment is both thorough and extensive, as new shoots can emerge quickly from surviving plants and from adjacent un-treated stands. During applications, staff and/or crew would ensure that at least 50% of the leaves are contacted by the spray solution. Where beachgrass is thick, or covered by a high degree of leaf detritus, herbicide would be applied from several angles to ensure adequate spray coverage. In general, leaves would be swiped by directing spray to at least two sides of the plant in smooth, slow vertical motions. Applicators would work methodically through areas to ensure that no plants are missed – an evenly-advancing work line, with approximately 15 feet between individuals would allow adequate spacing for safety and application continuity. Treated areas would be mapped with a GPS where possible to ensure that progress is sufficiently documented.

European Beachgrass Pre-Treatment Using Prescribed Burning and/or Mowing

Prescribed burning could be used as a pre-treatment measure to enhance herbicide uptake of target species and reduce biomass in selected portions of project areas, with backdune areas preferred due to the higher abundance of shrubs that could help to carry a fire. Sparse beachgrass stands and areas with seep or wetland vegetation are least conducive to prescribed burning (R. Wong, NPS, *pers. comm*.). Conducting a prescribed burn prior to herbicide has been successfully implemented in some California parks and may reduce the volume of herbicide that is needed for initial and follow-up treatments (Hyland & Holloran 2005).

Tractor mowing an area of beachgrass.

Implementation of a prescribed burn must comply with the Seashore's Fire Management Plan and Park Service policy. Additionally, a burn plan must be prepared, and required permits must be obtained. The burn would be conducted by the Seashore's Fire Management staff in collaboration with cooperators from local fire departments and resource management agencies.

Prescribed burns would most likely occur in the fall between August 15 and December 15. The Seashore would notify Bay Air Quality Management District (BAAQMD) 24 hours prior to burning and on each burn day to obtain a meteorological forecast, determine whether it is an approved burn day, and request an acreage allocation before burning. Actual acreage burned would also be reported to BAAQMD. Burning would not occur 1) on holidays or weekends, 2) on "no burn days" as determined by BAAQMD unless a variance is requested and granted or 3) if the National or Regional Preparedness Levels preclude new prescribed fires.

One week prior to burning, burn notification flyers would be delivered to residents and businesses near the location of the burn. Flyers would be posted on bulletin boards and in post offices, and a press release would be sent to local media. On burn days, prescribed fire warning signs would be placed at trailheads, parking lots, and other public access locations. Wind flow and direction would be monitored by the crew prior to and during ignition, and smoke emission and behavior would be continually monitored and documented. If hazardous or unhealthful smoke conditions are observed in Smoke Sensitive Areas, the Fire Management Officer would advise the Chief Ranger and the Fire Information Officer, who would coordinate notification about smoke conditions and potential health impacts. Hazardous conditions can be defined as chronic smoke that reduces visibility to less than 3 miles in Smoke Sensitive Areas: Short-term reduced visibility in the immediate fire vicinity should not cause hazardous conditions. Unhealthful conditions can be defined as chronic smoke that exceeds federal ambient air standards in a Smoke Sensitive Area.

During prescribed burn operations, crews would probably access the project area by foot, although ATVs may be used to transport supplies. Ignition would most likely be carried out using a standard drip torch. Depending on the burn location, it may be necessary to install fire lines (2-10-foot strips of cleared vegetation along the perimeter of the burn). Fire breaks would be carefully located to ensure that no rare plants, wetlands, or other special status species are impacted.

Mowing could be used either as a pre-treatment measure to reduce European beachgrass biomass and stimulate new growth or a post-treatment measure to speed up decomposition of standing dead European beachgrass and re-establishment of native plant species. A skid-steer loader with a rotary mower attachment would be used in most of the project area, except in areas where slopes are too steep, where traction is slippery, or where there is a risk of the loader tipping. These areas would deliberately be left unmowed. In general, "mowable" areas are considered complete when more than 95% of vegetation is mechanically cut, tilled, or destroyed to at least within 4-5 inches of the sand surface.

Iceplant Treatment Using Herbicide

Use of low-volume, backpack foliar herbicide would be used primarily in areas where iceplant forms dense mats with 80-100% cover and/or where patch size of iceplant exceeds 0.5 acre. Iceplant piles may also be treated with herbicide. Herbicide treatment would consist of 1.5% glyphosate applied using backpack sprayers with a calibrated nozzle, where spray volume is adjusted specifically to minimize drift, or through direct contact with wicking from a wand. Use of the latter is not subject to drift. No broadcast application methods would be allowed. Herbicide would be applied to cover a majority of the foliage while avoiding drip.

For AquaMaster®, currently marketed as Roundup Custom®, the recommended label application rate for iceplant is 1.5% by volume, with a 0.5-1.5% non-ionic surfactant to aid penetration of herbicide through waxy cuticle of plant leaves and stems.

Impact avoidance and minimization measures would be similar as described for European beachgrass above. Also, the same measures would be used for calibrating equipment prior to use and cleaning and disposing of used equipment.

Time and Cost

Based on past park projects, approximately 0.65 to 2.0 acres of European beachgrass and iceplant can be sprayed per day depending on ruggedness of terrain and weather conditions. Based on rates of mechanical removal for the Abbotts Lagoon Phase I project, approximately 0.20 acre in the foredunes and 0.5 to 0.9 acre in the backdunes can be restored per day, with rates in the foredunes much lower than those in the backdunes, because rhizomes in the foredunes are much deeper and potentially require more excavation. Treatment of buffer areas may be slower than open areas due to the expanded amount of "edge" present relative to non-buffer areas. Rates for manual removal are discussed under *Alternative B*. Post-treatment mowing requires approximately 1-3 hours per acre, depending on terrain.

Estimations of cost for herbicide treatment depend on many factors, including site conditions, topography, distance from urban areas, and whether retreatment is included, etc. Based on past projects within the Seashore and elsewhere, contract costs for initial herbicide treatment costs during the past five (5) years have ranged between $1,500 and $3,000/acre, with higher costs per acre often including one re-treatment event. As at least

1- 3 re-treatment events may be required with chemical control, costs per acre could range up to approximately $4,500 per acre for initial and re-treatment costs. For iceplant, contract costs can be lower, closer to between $1,000 and $2,000 per acre, with re-treatment performed by volunteers or staff. Costs can be potentially reduced by using in-house licensed staff, but this can be logistically challenging for larger projects due to flexible nature of the work, which requires that scheduled spraying must be cancelled on some days due to adverse weather. If mowing were used as a pre- or post-treatment measure, cost per acre would be between $650 and $1,000 per acre if mowing were conducted by an outside contractor.

Mechanical removal costs using contractor crews and equipment ranged from $25,000 to $30,000 per acre for the Abbotts project depending on the location within the dunes (e.g., foredunes, backdunes). Costs for manual removal and mechanical removal are discussed in more detail under *Alternative B* and *Alternative D*, respectively. Some follow-up by hand or by spot-spraying would be required, which could bring total costs per acre to approximately $28,000 to $33,000 per acre.

Staging and Access

Staging and access operations would be as described above for *Actions Common to All Action Alternatives*.

Monitoring

Staging and access operations would be as described above for *Actions Common to All Action Alternatives*.

Environmental Protection

In addition to the resource protection measures identified above under the *Actions Common to All Action Alternatives*, the following resource protection measures would apply to Alternative C (Table 1):

General Environmental Resources

- Buffers would be maintained between mechanical treatment and active nests for snowy plovers (500 feet); nesting birds (100 feet); California red-legged frog habitat (100 feet during breeding season); and rare plants (10 feet). The same buffers could apply for manual removal.

- Buffers would be maintained between herbicide treatment and active nests for snowy plovers (500 feet); nesting birds (100 feet); occupied California red-legged frog habitat (60 feet); wetlands (25 feet); organic pastures (25 feet); and rare plants and native dune vegetation if spraying done without shield (10 feet).

Noise associated with mechanical work will be as short as possible in duration.

Western snowy plover

- Prescribed burning would take place in the fall, both when vegetation is the most desiccated and available for burning, and after the plovers have completed their nesting and rearing cycle.

Myrtle's silverspot butterfly

- Efforts would be made to preferentially schedule mechanical removal, herbicide treatment, or prescribed burning activities in known Myrtle's silverspot habitat between August 31 and June 15, if at all possible, which is outside the known flight period for Myrtle's silverspot.

- Herbicide application would involve spot spraying directly on foliage of individual plants to minimize impacts to butterflies, particularly during flight season (mid-June through August 31). All use of herbicide during this period will involve spot-spraying directly onto foliage of individual plants.

California red-legged frog

- Should California red-legged frog be present during the breeding season (December 1 – July 31), a minimum 100-foot buffer would be established between wetlands currently supporting red-legged frog and mechanical treatment during the breeding season, and no work would occur within the buffer unless 1) a trenched silt fence is installed in between the work area and the wetland to prevent frogs from entering the work area, and the work area is subsequently declared clear of red-legged frog by a qualified biologist or 2) a construction monitor would be present during vegetation clearing phases. All vegetation within the 100-foot buffer may be scraped prior to excavation under the supervision of a qualified biologist to minimize impacts to frogs.

- If frogs are found, frogs shall be trapped and relocated to non-work areas approved in advance by Park Service staff in consultation with appropriate technical experts and/or agencies (e.g. U.S. Geological Survey).

- A minimum 60-foot buffer would be established between wetlands currently supporting California red-legged frog and herbicide treatment.

Rare Plants and Native Dune Communities

- A biological monitor will be on site during mechanical treatment and chemical treatment in areas where rare plants have been documented, unless those areas have been flagged off to minimize potential for accidental removal, or the crew has received sufficient training and previous oversight to determine that there would be minimal potential for impacts.

- Herbicide cannot be applied within a 10-foot buffer around rare plants, unless a drift shield is being used adequately to ensure that adjacent rare plants are not affected.

- Calibrated backpack sprayers with adjustable single-wand nozzles would be used to avoid over-spraying onto non-target vegetation and open sand areas.

- Prescribed burning would be conducted in the fall would allow sensitive plants and dune vegetation communities to complete their life cycle or complete seed set. If vegetation in a patch of dune mat or other important native vegetative communities (including dune slacks or hollows) is dense enough to carry a fire, an unvegetated ring around the feature would be created in the European beachgrass stand by manual removal or mowing to keep fire from burning the native vegetation.

- A 20-foot buffer would be established between Native Dune communities and burn activities.

- Mowing or foam may be used in buffers to minimize transmission of fire into Native Dune communities.

Cultural Resources

- If any items of potential cultural or archeological significance are encountered during excavation operations, work within 100 feet of the potential find would be halted immediately, and the contractor would notify the Park Service's Cultural Resources staff. If a previously unknown archaeological site is discovered, the site's significance would be evaluated based on the criteria for listing in the National Register of Historic Places (NRHP). Contractor would cease continued treatment until advised to proceed by the Park Service.

- No prescribed burning could be conducted in known cultural resource sites.

- Use of herbicide in known cultural resource sites would require evaluation prior to operations to ensure that herbicide does not adversely affect any future potential for carbon dating of resources or artifacts.

Water Resources

- Mechanical removal performed directly adjacent to regulated wetlands would require installation of silt fencing in between the wetland and the work area to ensure that there are no incidental spills of excavated sands into wetlands. If no silt fencing is installed, a 5-foot buffer would be maintained.

- Herbicide treatment would be subject to a 25-foot buffer between regulated wetlands and work areas.

- Even if herbicide treatment does not occur in wetlands, only aquatic label herbicides would be used. As these do not contain surfactants or chemicals that increase adhesion of chemicals to plant leaves, surfactants would be used to minimize run-off of herbicide onto the ground surface. Only surfactants believed to have the least amount of environmental impact would be selected for use.

- All herbicide application would be used strictly in accordance with label restrictions and environmental regulations, including restrictions on application during certain weather conditions that could result in drift or run-off of herbicides into wetlands. There would be no spraying during rainfall events or moderate or heavy fog or 24 hours after a rainfall event or 24 hours preceding a predicted rainfall event with at least a 20% probability of occurring. Herbicides would also not be applied when the average wind speed exceeds 10 mph at the level of the targeted plants or when maximum wind speed gusts frequently exceed 10 mph.

- Herbicide treatment would occur typically during the dry season (May – October), although it could occur during prolonged dry or drought periods during the wet season. This would minimize runoff and contamination of water and soil and allow for maximum degradation of herbicide.

- Calibrated backpack sprayers with adjustable single-wand nozzles would be used to avoid potential overspray into wetlands.

- No burning would be conducted in wetlands.
- A 25-foot buffer would be established between prescribed burn activities and wetlands, and firebreaks would not be established in wetlands.

Wilderness

- Based on Minimum Requirements for past dune restoration projects conducted in the park within wilderness, mechanical removal would be required to be minimized to the maximum extent practicable. The number of days that heavy equipment are present within wilderness portions of the dunes would also be minimized to the maximum extent practicable.
- Any changes proposed to these measures would potentially require that the park undergo a new Minimum Requirements Analysis process to evaluate any new potential impacts associated with the proposed activity to wilderness.

Visitor Experience and Soundscapes

- To minimize impacts on the natural quiet of beach and dune areas, heavy equipment would be required to have sound-control devices at least as effective as those originally provided by the manufacturer, and no equipment would be operated with an unmuffled exhaust.
- No more than 10 minutes of equipment idling would be allowed.
- Signs in the project vicinity and on the park website would provide information on the Park Service contact person for any noise concerns. This staff person would record and monitor construction-related noise complaints to determine if adverse effects can be mitigated further.

Adjacent Land Use

- In project areas that adjoin pastures managed as organic, a minimum buffer of 25-feet between herbicide application and pastures as suggested by NCAT (2004) and the County of Marin would be maintained. In addition, all of the restrictions related to spraying during adverse weather would be adhered to ensure that there is no impact from drift onto adjacent lands.
- For projects involving mechanical removal, monitoring of vegetation and sedimentation rates in adjacent ranchlands would be conducted before and after the project to provide information on restoration impacts.

Public Health and Safety

- The park would post notices regarding work activities, including herbicide treatment, prescribed burning, or mechanical removal and associated closures at all entry points to the project areas, including any major trailheads prior to start of the restoration activity.
- Where appropriate for specific project tasks, adequate training and/or certifications would be required for staff and/or contractors. All herbicide applications would be conducted by state-certified applicators.

- Herbicides would be used in accordance with a PUP approved by the Pacific West Regional IPM Coordinator. Approvals require tracking of herbicide quantities and locations of applications.

- All herbicide application would be in compliance with manufacturers' labels and would occur only under prescribed weather conditions.

- Areas where heavy equipment is operated or where herbicide is being applied would be closed to the public during construction hours.

- All herbicide treatment areas would be closed to the public for a minimum of 24 hours even if no Restricted Entry Interval (REI) is specified by the label on the chemical. Should the label require longer REIs, these would be adhered to by park staff.

- Contractors operating heavy construction equipment would be required to comply with all OSHA safety regulations, including wearing of construction hats. Park staff would also be required to wear construction hats if they are in the vicinity of working heavy equipment.

- All Park Service staff taking part in prescribed burning as part of Plan implementation would meet the qualifications for training and experienced in the Interagency Standards for Fire and Fire Aviation Operations and the Wildland and Prescribed Fire Qualification System Guide including annual safety refresher training and exams for medical and physical fitness.

- Park Service and cooperating fire crews are expected to conduct any necessary burns, and they would be responsible for preparing a burn plan and developing the criteria for determining the conditions under which burning is appropriate (season, time of day, prevailing winds, relative humidity, etc.). The restoration crew would consult with the fire crew prior to scheduling all other treatments, including herbicide application, hand removal, and heavy equipment burial to ensure worker safety and appropriate scheduling for controlling beachgrass.

Alternative D – Diverse Mix of Restoration Methods, with Emphasis on Mechanical Removal for Initial Treatment

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas. Manual removal would be used for European beachgrass plants that occur in wetlands and also for non-native invasive or potentially habitat-altering species as European searocket and bush lupine. Manual removal may also be used in buffers adjacent to wetlands or organic pastures.

Restoration Activities

In addition to common staging and access, monitoring and resource protection objectives and measures described above under *Actions Common to All Action Alternatives*, Alternative D includes the following actions:

Dune Restoration Approach

– Initial treatment of European beachgrass in coastal dunes would be conducted using mechanical removal with teams of excavators and bulldozers (Table 1). Different types of mechanical approaches may be used, but the most common one would involve flipping of "dirty" or rhizome-contaminated soils with "clean" sand from below such that dirty material is capped at least 3 feet down with clean sand.

– Potential pre-treatment of European beachgrass mechanical removal areas would be conducted through use of mowing. This treatment reduces and helps to compact the volume of aboveground biomass.

– Re-treatment of European beachgrass would be conducted either through either manual removal or spot-spraying of herbicide (Table 1). During the first six (6) months to one (1) year, retreatment by manual means would need to be conducted monthly due to the fact that it takes time for the buried rhizomes that are still alive to emerge. Spot spraying would involve very limited volumes of herbicide due to the success documented with initial treatment using mechanical removal.

– Manual removal of European beachgrass would be primarily conducted in wetlands and in some upland buffer areas buffers to wetlands and organic pastures (Table 1). Manual re-treatment would be expected to take at least five (5) to eight (8) return visits during the first year.

– Initial treatment and re-treatment of iceplant in coastal dunes would be conducted using manual removal (Table 1). Full re-treatment would be expected to take two years, with at least two (2) re-treatment events each year.

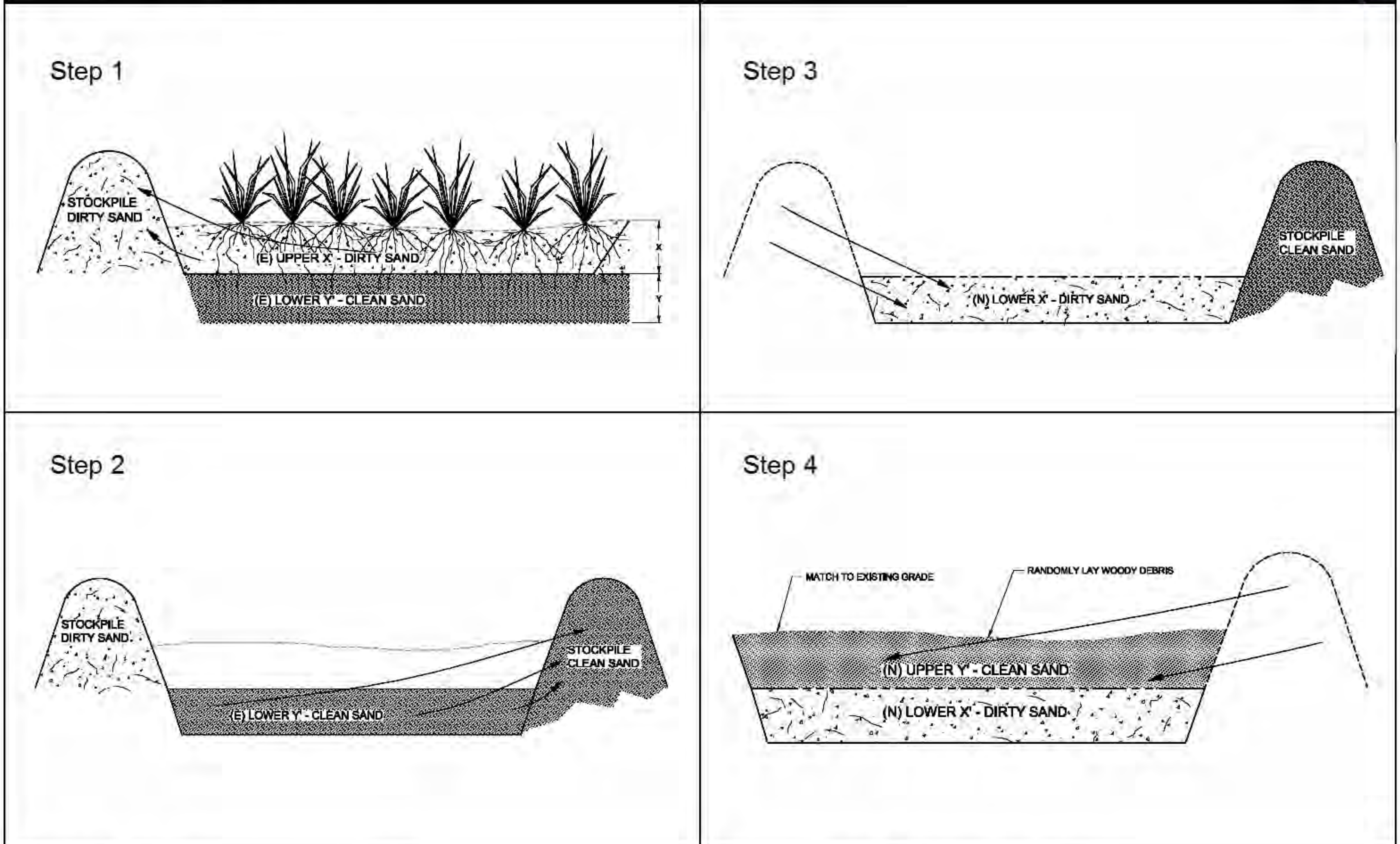
– Initial treatment and re-treatment of other species such as bush lupine and European searocket would be using manual removal methods (Table 1). Full re-treatment would be expected to take two years, with at least two (2) re-treatment events each year.


Excavators with mounds of sand for horizontal flipping

– Under Alternative D, the primary tool that would be used would be mechanical excavation of invasives. Within wilderness, there would be no staging of equipment and tools, but excavators, bulldozers, and, to a lesser extent, haul trucks and UTVs would be used to remove European beachgrass, and the amount of equipment and the duration of excavation activities would be increased relative to Alternative C. Therefore, under Alternative D, the minimum tool necessary to accomplish restoration objectives would include excavators, bulldozers, and other heavy and light equipment, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable.

– For comparative evaluation purposes, based on estimated costs of eradication using this method and current funding availability, selection of this alternative could result in treatment of approximately up to 9- to 10.5 acres of beachgrass would be removed at AT&T,

Coastal Dune Restoration Environmental Assessment
Point Reyes National Seashore



National Park Service
Point Reyes National Seashore
Marin County, CA

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Figure 12. Horizon Flip Method

S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\12_Horizon Flip Method.mxd along with manual removal of 2 acres of iceplant; and approximately up to 17 acres of removal of beachgrass, some of which is intermixed with iceplant, at Limantour (Table 1). There are no current funding proposals approved for the other proposed restoration areas.

The mechanical removal technique used in *Alternative D* (and, to a lesser extent, in *Alternatives B and C*) is discussed below. Manual removal, staging and access, monitoring, and resource protection objectives and measures are discussed in *Actions Common to All Action Alternatives*. Chemical control and mowing methods are discussed under *Alternative C*.

As discussed under *Alternative C*, herbicide use on lands managed by the Park Service requires initiation and approval of a PUP. PUPs are reviewed and approved by the Pacific West Regional IPM Coordinator. Approvals require tracking of quantities and areas where pesticides are used. All herbicide application would be in compliance with manufacturers' labels and would occur only under appropriate weather conditions.

Project logistics greatly depend on the size of the treatment area, location, and number of sensitive resources that must be avoided. However, it is likely that all projects would involve working across the landscape in a sequential fashion to minimize potential for reinvasion of restored areas.

Mechanical Removal Technique for European Beachgrass

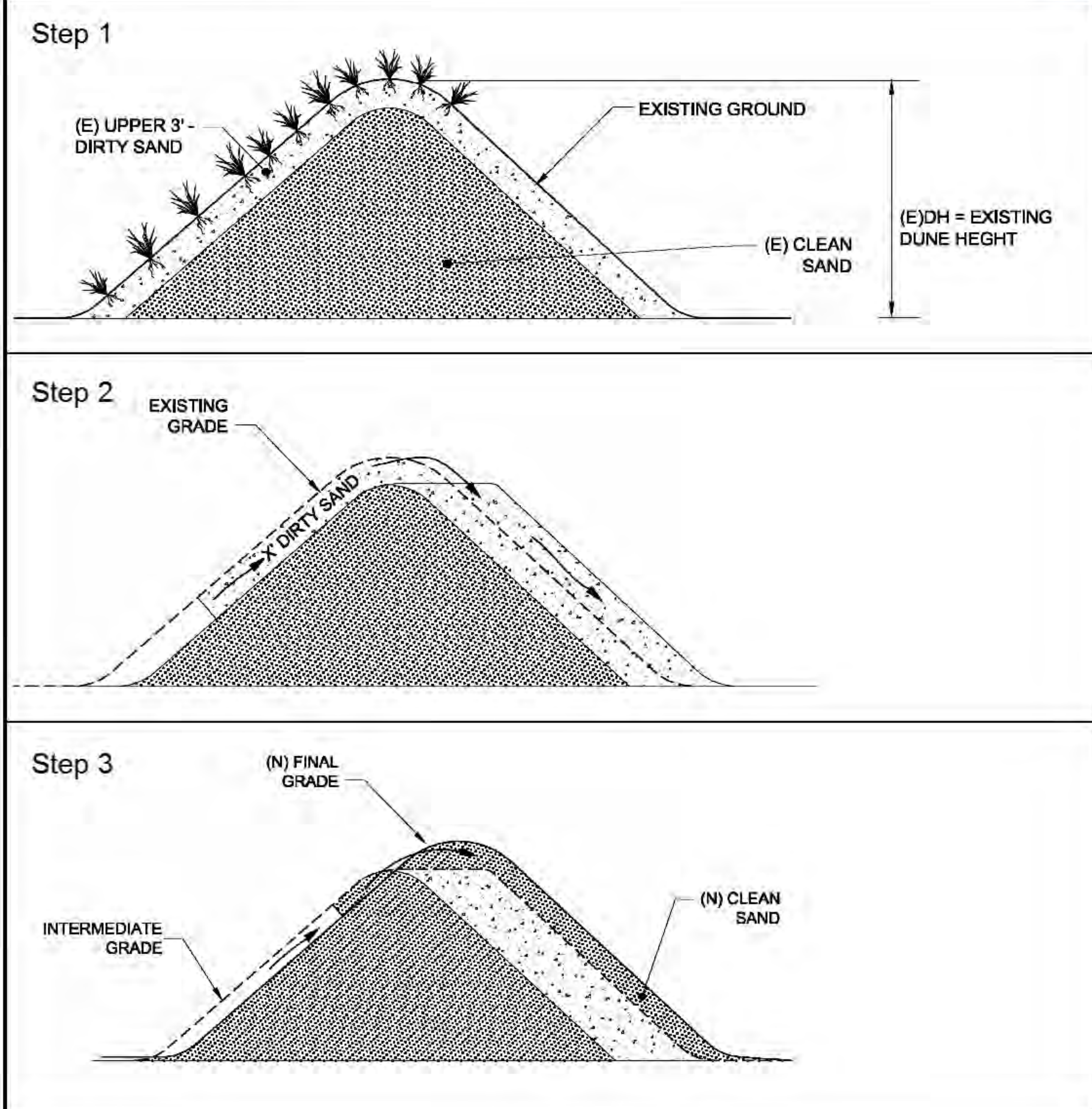
Several different methods for mechanically removing European beachgrass were developed during Phase I of the Abbotts Lagoon Coastal Dune Restoration Project, including horizon flipping, dune push, and valley fill. The primary technique used is typically horizon flipping, although, in some areas, either a dune push or valley fill technique could be more suitable.

Horizon Flipping: Horizon flipping is seemingly simple. An excavator removes aboveground biomass and rhizome-contaminated surface soil horizons and places to one side of a trench; then, clean sand or sand from underneath the dirty sand that either has no or much fewer rhizomes is placed to the other side of the trench (Figure 12). The aboveground biomass contains woody shrubs such as coyote brush, as well as European beachgrass. Compaction of aboveground biomass by tracking over the material with an excavator or dozer is recommended prior to placement of material in the trench. The "dirty" material is then placed into the trench and capped with at least a 3-foot clean sand cap using a second excavator and a bulldozer. A deeper sand cap (3-6') may be desirable in areas where dunes are expected to be more mobile (e.g., foredunes). The depth of dirty sand excavation can vary greatly, particularly as the depth of rhizomes can vary greatly between foredunes and backdunes. In foredunes, rhizomes can extend down to between 6 and 12 feet, whereas, during Phase I, backdune rhizomes typically ranged between 3 and 6 feet. For cost control purposes, the maximum depth of excavation is typically limited to 6 feet total to ensure that contractors do not end up "chasing" rhizomes and increasing the volume and cost of excavation. For Phase I, the maximum excavation depth was set at 3 feet in the backdunes and 6 feet in the foredunes, with a maximum 3-foot clean sand cap.

Potential alternatives to in-situ burying of biomass and "dirty" sand include creation of a central burial location approved by the park, but that would most probably be located in the backdune area, where the potential for remobilization of dunes by strong offshore coastal winds is lowest.

Dune Push: A second technique (dune push) involves using bulldozers and/or excavators to push the aboveground biomass and the top 6 feet of rhizome-contaminated "dirty" sands

Coastal Dune Restoration Environmental Assessment
Point Reyes National Seashore



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Marin County, California

Figure 13. Dune Push Method

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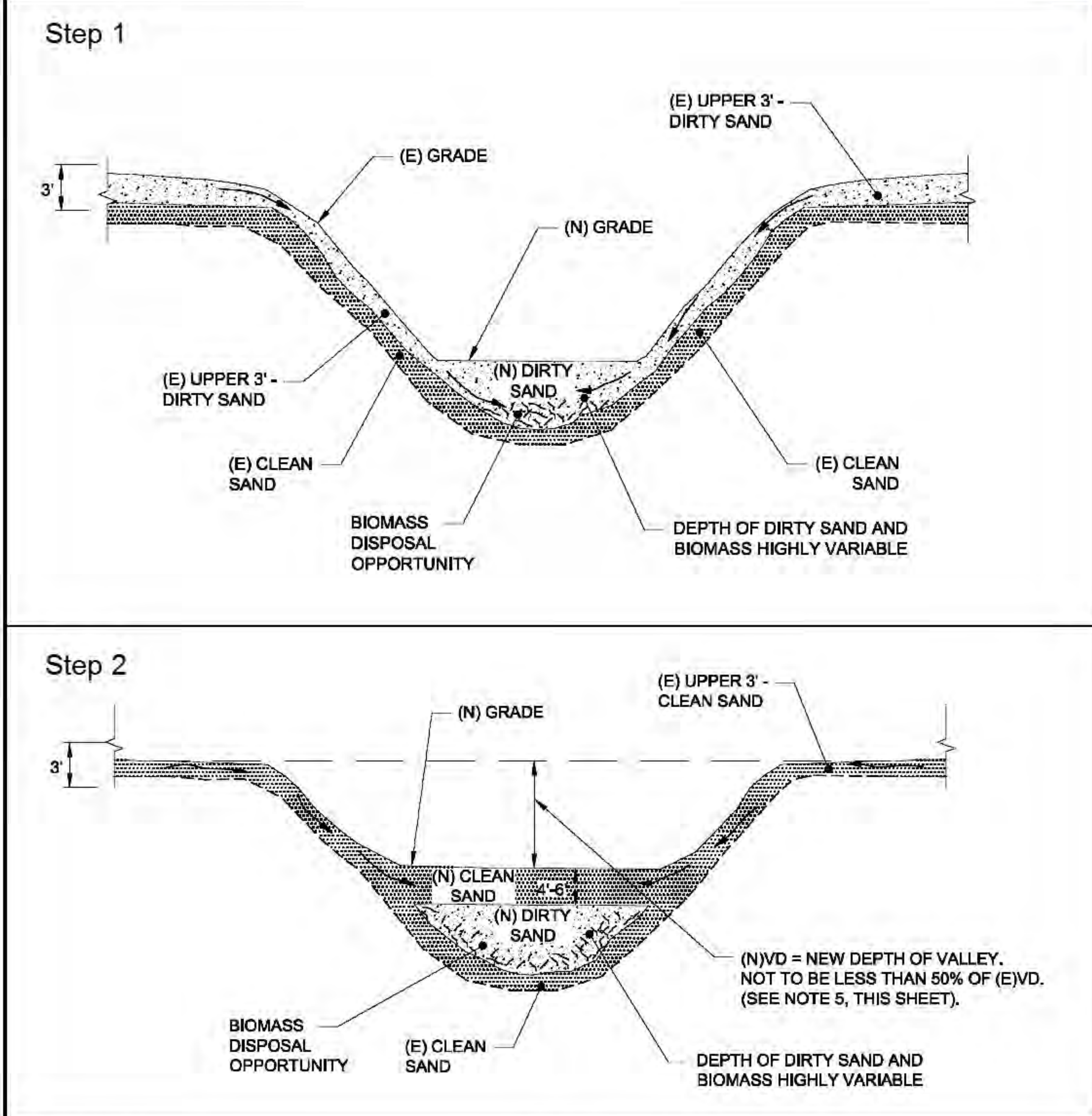

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Figure 14. Valley Fill Method

S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\14_Valley Fill Method.mxd up and over the face of a dune to be deposited as a uniform layer on the opposite side of the dune (Figure 13). In relationship to the prevailing wind direction, sand would be pushed from side to side or from the front face of the dune in a downwind direction. In no instance would sand be pushed from the lee to front face of the dune (i.e., in an upwind direction). Dune ridges are typically aligned in a roughly east to west direction with winds commonly coming from the northwest. After moving the dirty sand from one side of the dune to the other, the process is repeated, moving clean sand from one side to the other, covering the dirty sand with at least a 3-foot thick layer of clean sand.

Valley Fill: A third technique (valley fill) would use bulldozers and/or excavators to push the aboveground biomass and the top 3 feet of rhizome-contaminated "dirty" sands down dune faces into existing non-wetland swales or topographic depressions in the backdunes (Figure 14). This method is appropriate for areas where topographic relief is extreme and may be primarily used as a means of biomass and dirty sand disposal. Wetlands would not be used for disposal. Biomass and the densest rhizome-contaminated sands would be pushed into these topographic low points, and then sands below the excavated 3-foot densest rhizome-contaminated sand layer would be bulldozed over the top of the European beachgrass materials to create a minimum 4- to 6-foot cap. Additional biomass from other work areas (e.g., foredunes) may be imported and buried along with local dirty sand in valley fill areas as long at the required clean sand cover is achieved.

This method would only be used where the treated valley depth would at least one-half or greater of the existing (pre-treatment) valley depth. The valley fill method reduces the exaggerated heights of the European beachgrass-stabilized backdune system, while maintaining the natural topographic low points between foredunes and backdunes. The overall valley depth from adjacent dune crest to valley bottom would be reduced from existing conditions. To ensure that biomass and rhizome-contaminated materials placed in valleys are not remobilized during strong wind events, prior to filling of valleys, sand fence or stacked wattles/coir logs may be installed at the upwind edge of fill and extended upward to include not only the depth of disposal, but also the 3-foot cap.

The valley fill method would not be used in the foredune area or certain backdune areas, designated by the snowy plover buffer zone, as it might leave capped areas exposed to wind erosion that would expose rhizome-contaminated, dirty sand.

For all three mechanical removal techniques, dirty and clean sand would be loosely placed or pushed into excavation areas. No compaction would be necessary although the final surface would be smoothed and leveled to restore the preexisting grade.

Backdune Tapering: An important component of the project includes minimizing post-treatment mitigation of sand off-site. Therefore, mechanical treatment efforts within 300 feet of the eastern project boundary should minimize the potential for off site dune migration and, thereby, reduce the potential for impacts to existing grazing lands and sensitive environmental areas. Treated dunes need to be tapered smoothly into adjacent grades of adjacent off-site and undisturbed lands. The dune slopes would be constructed so that they are less than 4H(orizontal):1V(ertical) and so that the heights of dune crests are progressively reduced by 10% starting 300 feet from the landward project boundary. If this is not possible, dune crest elevations would be reduced in landward treatment areas so that they are lower than existing grades. Under no circumstances would treated dune grades be left at a higher elevation than existing grade.

Time and Cost

Time and cost for manual removal and chemical control are discussed under *Alternatives B* and *C*. Production estimates for the fall 2004 mechanical removal at Abbotts Lagoon ranged from 0.07 acre/day for the foredunes to 0.22 acre/day in the backdunes (Peterson 2004). Production rates improved, particularly over time, for the Abbotts Lagoon Phase I project. Approximately 0.20 to as much as 0.90 acre per day were restored, with rates in the foredunes much lower than those in the backdunes, because excavation depths in the foredunes were deeper for this particular project.

Initial estimates on cost of mechanical removal for the earliest Abbotts Lagoon project ranged from $10,808/acre in the foredunes to $6,814/acre in the backdunes. For the Abbotts Lagoon Phase I project, mechanical removal costs using contractor crews and equipment ranged from $25,000 to $30,000 per acre depending on the location within the dunes (e.g., foredunes, backdunes). In addition to inflation, differences in costs between the earlier and later Abbotts projects resulted from the fact that in-house crews and rented equipment were used for the 2004 project, while contractors were hired for the 2011 one. For this document, costs are estimated at $28,000 to $33,000 per acre, as some follow-up by hand or by spot-spraying would be required.

Staging and Access

Staging and access operations would be as described above for *Actions Common to All Action Alternatives*.

Monitoring

Staging and access operations would be as described above for *Actions Common to All Action Alternatives*.

Environmental Protection

Resource protection measures would be as described under the *Actions Common to All Action Alternatives*.

Preferred Alternative

The preferred alternative is *Alternative C*. A preferred alternative was identified by assessing and comparing potential benefits and impacts associated with four alternatives, with the preferred alternative being the one that offers the most benefits with the least impact to resources (Table 2).

Preliminary results of the 2001-2004 and 2011 Phase I Abbotts Lagoon mechanical removal projects suggest that these projects did improve the condition of specific resources, but also had impacts on dune, wetland, and grassland resources due to remobilization of decades of accumulated dune sands following European beachgrass removal. While no definitive conclusions can be made so soon after project completion, the potential for native dune plant species to colonize these newly restored areas is also in question, at least in the 2011 project area, due to the unstable nature of the dunes, although some species appeared to have prospered, including the federally endangered Tidestrom's lupine and, to a lesser extent, bush lupine and beach pea (*Lathyrus littoralis*).

While not as dramatic in terms of immediate results, areas restored through chemical control change more slowly, therefore, allowing native plants to establish and perhaps minimizing extensive shifting or movement of sands (Peterson et al. 2003, Pickart and Sawyer 1998). Even during the first year after chemical treatment, monitoring has shown that other plants, including native ones, rapidly colonize treated areas. In addition, changes in recent years in the types and concentration of herbicide used appears to have reduced the total volume of chemical needed for treatment and re-treatment, thereby decreasing implementation impacts. Based on this comparison of recent project results, it cannot still be stated that mechanical removal has fewer adverse impacts than chemical control, at least during and shortly following implementation (Table 2). The manual removal technique outlined in *Alternative B* has not been historically successful for treatment of European beachgrass within the Seashore due to rhizomatous nature of this invasive species and the depths to which its rhizomes extend, its propensity for re-establishing through rhizome or vegetative fragments, and the constant re-treatment necessary to maintain restored areas. As was concluded during the 2009 EA process, manual removal would still appear to fall considerably below either *Alternatives C* or *D* in meeting the park's resource objectives.

One factor that plays into the ability of an alternative to prevent loss of resources or maintain and improve condition of resources is, undeniably, cost. With funds for restoration limited, large-scale ecosystem restoration efforts greatly rely on finding cost-effective approaches for implementing and maintaining restoration. Higher cost approaches typically result in less total area being restored or even no restoration at all, because funding agencies typically prefer to award monies to projects that can show considerable benefit for reasonable costs – or "more bang for less buck." Costs of implementing Phase I of Abbotts Lagoon were much higher than anticipated, and, despite considerable post-project strategic analysis, no reasonable alternative was found to lower these costs for future mechanical removal projects. At this time, the Seashore does not have the staff or equipment to conduct large or even moderate-sized mechanical removal projects in-house. With costs of both mechanical and manual removal of European beachgrass being 10 times higher than chemical control, the total area of coastal dune that could be restored at AT&T (or any other of the proposed restoration areas) under *Alternatives B* and *D* would probably be much lower under these alternatives than under *Alternative C*.

Environmentally Preferable Alternative

Alternative C is also the alternative deemed by the Seashore to be environmentally preferable. The environmentally preferable alternative is defined by the Council on Environmental Quality (CEQ) as the one which "causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves and enhances historic, cultural and natural resources."

In this instance, the environmentally preferable alternative was determined using the CEQ criteria by weighing the net benefits of the alternatives against impacts to natural, cultural, and other resources during and after implementation (Table 2). In general, the intensity of benefit comes down to the extent of dunes at AT&T/North Beach, B Ranch/A Ranch/Davis, and Limantour that could be restored and the degree to which listed species at these project areas would benefit from each alternative (Table 2). Due to a combination of costs and logistical factors, a higher percentage of dunes at AT&T and the other project areas would potentially be restored under *Alternative C*, with the next highest percentage being under *Alternative D,* followed by *Alternative B*. Similarly, *Alternative C* would probably have the greatest benefits for listed species, followed perhaps by *Alternative D*, which could greatly benefit disturbance-adapted species such as Tidestrom's lupine, and then *Alternative B*.

In terms of impacts, *Alternative B* would probably have the least impacts during or shortly after implementation, followed by *Alternative C*, and then *Alternative D*. Impacts posed by *Alternative B* relate largely to the disturbance caused by contractor crews and use of all-terrain vehicles such as UTVs. *Alternative C* would pose risks to resources through use of herbicide and potentially mowing or prescribed burning used as pre- and post-treatment measures. Some of the same herbicide risks would exist under *Alternative D*, albeit to a lesser degree, as spot spraying would be used only for re-treatment under that alternative. While data is far from conclusive, herbicides proposed for use by the park would appear to have the potential for no more than negligible to at most minor impacts on a short-term basis to the Seashore's dune resources, particularly as re-treatment needs may be greatly reduced relative to manual removal. Burning and mowing could also have short-term impacts on resources. Mechanical removal would have impacts during implementation from the disturbance caused by heavy equipment, contractor crews, and UTVs, but could also have longer term indirect impacts on adjacent native dunes, wetlands, and grasslands due to remobilization of sands accumulated over decades due to stabilization by European beachgrass and iceplant.

In summary, then, *Alternative B* would have the least impacts during and shortly after implementation, but would also deliver the least benefit on either a project-area or park-wide scale. This alternative would restore fewer acres, offer fewer benefits for listed species and natural processes, require more frequent re-treatment, and have the highest potential for failure of the four alternatives. *Alternative C* may result in slightly more impact than *Alternative B* during and shortly after implementation, but, over the long-term, it would restore more acres and offer more benefits for listed species and natural processes. *Alternative D*, on the other hand, would have more impact than *Alternative C* during and after implementation and would deliver fewer benefits to the Seashore's dunes on a park-wide scale, although there may be considerable benefits on a project-area scale. Based on this analysis, *Alternative C* would be the approach that best "protects, preserves and enhances historic, cultural and natural resources."

Alternatives Considered, but Dismissed

During the alternatives development process, the project team may evaluate a wide range of options before selecting alternatives or alternative components that will be carried forward for further analysis. Decision-making on whether an alternative or component is reasonable and distinct during the alternative development process should be strongly tied to the ability of alternative or alternative components to meet the project purpose and objectives and available information on existing natural and cultural resources, conflicts with existing land uses, human health and safety needs, and potential for socioeconomic impacts. Through consideration of objectives and planning criteria and use of available information, the project team eliminates alternatives or alternative components or actions (specific tasks or actions within alternatives) that are considered infeasible for technical or economic reasons and that are, therefore, not carried forward for further analysis.

In general, this EA follows the same structure as the 2009 EA for Abbotts Lagoon Coastal Dune Restoration Project, which evaluated alternatives that varied in the primary approach to control of European beachgrass, but often incorporated multiple control methods. Other potential alternatives that could be considered would involve use of other approaches for removing European beachgrass and iceplant, such as application of saltwater, hydromechanical obliteration (HMO), or hot foam treatments. However, as discussed earlier in this chapter, application of saltwater is still considered by most restoration practitioners to be experimental and has not had demonstrated success in treating invasives such as European beachgrass and iceplant in dune systems as yet. No examples of use of HMO or hot foam for treatment of European beachgrass could be found, however, limiting factors on application of the former would be volume of non-saline water required for high pressure water jets or hot water-foam to "obliterate" biomass and rhizomes, given rooting depth of at least European beachgrass. In addition, HMO treatment and other water-intensive treatment methods may be logistically constrained by access difficulties for equipment within sandy dunes, as the sheer weight of heavily laden HMO equipment precluded access during the winter for at least one other non-dune invasives removal project (Alvarez et al. 2012). Should practicable alternative treatment methodologies be developed in the future, the Seashore and managers at other dune systems may opt to re-evaluate invasive treatment options in future years.

Table 1. Comparison of the Elements of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Restoration Activities – Primary Compliance and Treatment Methods	No near-term restoration at AT&T/North Beach, B Ranch/A Ranch/Davis, and Limantour except for previously permitted projects. Dune restoration could be conducted at some later point time in these areas or in other areas of the Seashore under separate compliance processes.	Manual removal for initial treatment of ***European beachgrass***, ***iceplant***, and ***other non-native invasive or habitat-altering species***. For comparative evaluation purposes, use of this method would result in 5-7 acres of beachgrass and 2 acres of iceplant removed at AT&T based on the authorized funding amount.	Chemical control primarily used for initial treatment of ***European beachgrass***. Manual removal or chemical control of ***iceplant***, depending upon density and extent of iceplant. Manual removal of ***other non-native invasive and habitat-altering species.*** For comparative evaluation purposes, use of this method would result in up to 77 acres of beachgrass and 1.5 acres of iceplant at AT&T using chemical control, along with manual or mechanical removal of another 3 acres of beachgrass and 0.5 acre of iceplant.	Mechanical methods primarily used for initial removal of ***European beachgrass*** Manual removal of ***iceplant*** and ***other non-native invasive and habitat-altering species*** For comparative evaluation purposes, use of this method would result in 9-10.5 acres of beachgrass using mechanical removal and 2 acres of manual iceplant removal at AT&T.
– ReTx Methods	NA	Manual removal 5- 8 ReTx events needed	Manual removal and chemical treatment (spot-spraying) – 1 to 3 annual ReTx events needed for chemical control	Manual removal and chemical treatment (spot-spraying) 1 to 5 ReTx events needed for manual removal or chemical treatment
– Wetland Tx Methods	NA	Manual removal	Manual removal preferentially used except in heavily infested edges where mechanical removal may be used	Manual removal preferentially used except in heavily infested edges where mechanical removal may be used
– Wetland and Organic Pasture Buffer Tx Methods	NA	Manual removal	Manual or mechanical removal	Manual or mechanical removal

Table 1. Comparison of the Elements of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
– Pre- or Post Tx Methods	NA	None	Mowing or prescribed burning	Mowing for pre-treatment
– Estimated $/Acre for Initial and Full Re-Tx of European Beachgrass	NA	Up to $52, 879	Up to $4,500	$28,000 - $33,000
Staging and Access	NA	Most staging and access in inland dune or adjacent grasslands/pasture. Existing ranch and park roads used as much as possible; staging preferentially located outside pastures, if possible. Access at North Beach and Limantour may involve use of park roads, with potential staging in parking lots.	Similar to Alternative B, although potentially much more access and staging required due to heavy equipment potentially used for beachgrass removal in buffers, as well as possibly mowing equipment and fire vehicles.	Similar to Alternative C, but much more access and staging required due to increased use of heavy equipment.
Monitoring	NA	Current monitoring programs continued, as funding and staff allows. Programs vary depending on resource and project.	Same as Alternative B.	Same as Alternative B.
Resource Protection	NA	Seasonal, geographic, climatic, and other restrictions used, as outlined in current USFWS Biological Opinions. Contractor Education held at beginning of project.	Similar to Alternative B, but burn plans may also be prepared.	Same as Alternative B

Table 1. Comparison of the Elements of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Snowy plovers	NA	No major treatment activities within 500 feet of active nests. Nest activity is monitored by Seashore biologists trough nesting season (March/April – mid-September).	Similar to Alternative B. Prescribed burning scheduled in fall, outside of plover nesting season.	Same as Alternative B
Myrtle's silverspot butterfly	NA	Access routes in adjacent grasslands surveyed to ensure no impact to larval plants in adjacent grassland; 10 MPH speed limit for all vehicles during flight season of June 15-Aug 31. Limiting of work during flight season in main population areas.	Similar to Alternative B. Prescribed burning scheduled in fall, outside of butterfly flight season. Mow or foam buffer around dune mat to avoid burning habitat.	Same as Alternative B
California red-legged frogs	NA	Surveys required during breeding season (December 1 – July 31) prior to treatment. No equipment (e.g., UTV) access through wetlands.	Similar Alternative B. Buffer of 60 feet set for chemical control around wetlands currently supporting California red-legged frogs. Detection of frog requires setback of 100 feet during mechanical removal and presence of construction monitor or installation of silt fencing and re-survey/clearance of work areas for frogs.No prescribed burning conducted in wetlands, with 25-foot buffer established.	Same as Alternative C
Breeding birds	NA	Surveys required during breeding season (March 15 – July 31) prior to treatment. Detection of nest requires setback of 100 feet.	Same as Alternative B	Same as Alternative B

Table 1. Comparison of the Elements of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Listed or rare plant species	NA	Surveys conducted prior to treatment and individuals or patches of listed and rare plants mapped and flagged for avoidance (e.g., UTVs) during removal. No access for equipment through native dune communities.	Similar to Alternative B. 10-foot buffer between rare plants and spraying, unless drift shield used. Rare plants largely avoided through protection of native dune during prescribed burning.	Same as Alternative C
Wetlands	NA	Wetlands within project areas delineated. No access of equipment (e.g., UTVs) through wetlands.	Similar to Alternative B. No spraying within 25-feet of a wetland. Mechanical removal adjacent to wetland requires installation of untrenched silt fence on wetland perimeter. 25-foot fuel break enforced for burning.	Same as Alternative C
Dune mat	NA	Native dune communities identified as Sensitive Resource Areas. Very limited access allowed unless no other route, and no staging or stockpiling allowed.	Similar to Alternative B. 10-foot buffer between rare plants and spraying, unless drift shield used. 20-foot fuel break enforced for burning.	Same as Alternative C
Hazardous spill/fuel containment	NA	Spill Prevention and Response Plan required. 100-foot buffer for fueling near wetlands and waters. Fueling area covered with impervious material and bermed. Equipment checked for leaks daily.	Similar to Alternative B. 100-foot buffer for fueling or chemical mixing near wetlands and waters. Fueling/mixing area covered with impervious material and bermed.	Same as Alternative C

Table 1. Comparison of the Elements of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Cultural Resources	NA	Cultural resource surveys required prior to project start. Areas denoted as archaeologically sensitive may require avoidance or presence of cultural resource monitor. Contractors to halt immediately and contact park staff if potential remains, artifacts, or other resources found.	Similar to Alternative B. No mechanical excavation below into dark-colored soil horizons that may be more likely to contain archaeological resources.	Same as Alternative C
Wilderness	NA	No staging in wilderness areas. Access minimized to the maximum extent practicable. Vehicles parked outside wilderness when not being used. Any changes to these measures would require reinitiation of Minimum Requirements analysis.	Similar to Alternative B. Additional Minimum Requirements measures would include minimizing the amount of mechanical removal to the maximum extent practicable. Any changes to these measures would require reinitiation of Minimum Requirements analysis.	Same as Alternative C
Visitor Experience / Soundscape	NA	Information on project provided at trailhead, Visitor's Centers, and website. Idling of equipment (e.g., UTVs) limited to 10 minutes.	Similar to Alternative B. Information on prescribed burning provided at trailhead, Visitor's Centers, and website. Heavy equipment required in good operating conditions in terms of noise reduction components.	Same as Alternative C

Table 1. Comparison of the Elements of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Adjacent Land Use	NA	Coordinate all projects, including staging, access, and implementation, with adjacent land owners, lessees. Use existing ranch roads, where possible. Stage operations outside of pastures, when possible. Maintain all roads, fencing, and gate in original condition. Conduct active revegetation, phasing in backdune areas, possible sand stabilization measures to minimize sand remobilization.	Similar to Alternative B. Minimum 25-foot buffer between spraying and organic pastures. Taper back dune slopes to minimize sand remobilization when mechanical removal used.	Same as Alternative C
Public Health and Safety	NA	Contractors required to submit an approved Accident Prevention Plan. No closure needs anticipated.	Similar to Alternative B. Herbicides used in strict accordance with weather restrictions, PUP requirements. Herbicide treatment areas closed during and 24 hours after treatment or as required by label. Mechanical removal areas closed to public. Closures posted at access points, Visitor's Centers, and website. Burn Plans submitted for approval prior to prescribed burn activities. Prior notice provided to sensitive receptors within potentially affected areas. Notice of proposed burns posted at trailheads, access points, Visitor's Centers, and website.	Same as Alternative C

Table 2. Impacts of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
VEGETATION RESOURCES				
Native Dune Vegetation				
Long Term	Negligible to Minor Adverse	Negligible to Minor Beneficial	Minor to Moderate Beneficial	Minor to Possibly Moderate Beneficial
Access/ Staging	No Effect	Negligible to Possibly Minor Adverse	Negligible to Minor Adverse	Negligible to Minor Adverse
Implement-ation/ Short-Term	No Effect	Negligible Adverse	Negligible to Minor Adverse	Negligible to Minor Adverse
Coastal Grassland-Prairie and Associated Wetlands				
Long Term:	No Effect	Negligible Adverse	Negligible Adverse	Negligible to Minor Adverse
Access/ Staging	No Effect	Negligible Adverse	Negligible to Minor Adverse	Negligible to Minor Adverse
SPECIES OF SPECIAL CONCERN				
Beach Layia (FE)				
Long Term	No Effect to Minor Adverse	Negligible Adverse (AT&T) to Negligible Beneficial (B Ranch)	No Effect to Moderate Beneficial	No Effect to Minor Beneficial
Access/ Staging	No Effect	No Effect to Very Negligible Adverse	No Effect to Negligible Adverse	No Effect to Minor Adverse
Implement-ation/ Short-Term	No Effect	No Effect to Minor Adverse	No Effect to Minor Adverse	No Effect to Minor Adverse
Tidestrom's Lupine (FE)				

Table 2. Impacts of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Long Term	No Effect to Possibly Moderate Adverse	No Effect to Negligible Beneficial	No Effect to Possibly Moderate Beneficial	No Effect to Moderate Beneficial
Access/ Staging	No Effect	No Effect to Very Negligible Adverse	No Effect to Negligible Adverse	No Effect to Negligible Adverse
Implement-ation/ Short-Term	No Effect	No Effect to Possibly Minor Adverse	No Effect to Minor Adverse	No Effect to Minor Adverse
Sonoma Alopecurus (FE)				
Long Term	No Effect	No Effect to Possibly Minor Adverse	No Effect to Possibly Moderate/(Minor***) Adverse	No Effect to Moderate/(Minor***) Adverse
Access/ Staging	No Effect	No Effect	No Effect	No Effect
Implement-ation/ Short-Term	No Effect	No Effect to Very Negligible Adverse	No Effect to Very Negligible Adverse	No Effect to Very Negligible Adverse
Myrtle's Silverspot Butterfly (FE)				
Long Term	Negligible to Possibly Minor Adverse	Negligible to Possibly Minor Beneficial	Minor to Moderate Beneficial	Negligible to Minor Beneficial
Access/ Staging	No Effect	Negligible Adverse	Negligible Adverse	Negligible to Minor Adverse
Implement-ation/ Short-Term	No Effect	Negligible Adverse	Negligible to Minor Adverse	Negligible to Minor Adverse
California Red-Legged Frog (FT)				
Long Term	Negligible Adverse	Very Negligible to Minor Adverse	Negligible to Possibly Moderate/(Minor***) Adverse	Minor to Moderate/(Minor***) Adverse
Access/ Staging	No Effect	Very Negligible Adverse	Negligible Adverse	Negligible Adverse

Table 2. Impacts of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Implement-ation/ Short-Term	No Effect	Very Negligible to Minor Adverse	Negligible to Possibly Moderate Adverse	Negligible to Moderate Adverse
Western Snowy Plover (FT)				
Long Term	No Effect to Minor Adverse	Negligible Beneficial	Negligible to Minor Beneficial	Negligible to Possibly Minor Beneficial
Access/ Staging	No Effect	Very Negligible to Negligible Adverse	Negligible Adverse	Negligible Adverse
Implement-ation/ Short-Term	No Effect	Negligible Adverse	**Localized**: Very Negligible to Minor/(Negligible***) Adverse	Very Negligible to Minor/(Negligible***) Adverse
Other Federally Listed Species that Occasionally Visit Dunes				
Long Term	No Effect	No Effect	No Effect	No Effect
Access/ Staging	No Effect	No Effect to Very Negligible Adverse	Very Negligible Adverse	Very Negligible Adverse
Implement-ation/ Short-Term	No Effect	No Effect to Very Negligible Adverse	Very Negligible Adverse	Very Negligible Adverse
Plant Species of Concern				
Long Term	No Effect to Negligible Adverse	Possibly Minor Beneficial to Negligible Adverse	Possibly Moderate Beneficial to Minor Adverse	Minor Beneficial to Minor Adverse
Access/ Staging	No Effect	Negligible Adverse	Negligible to Minor Adverse	Negligible to Minor Adverse
Implement-ation/ Short-Term	No Effect	Negligible Adverse	Negligible to Minor Adverse	Negligible to Minor Adverse
Animal Species of Concern				
Long Term	No Effect to Negligible Adverse	Negligible Beneficial to Negligible Adverse	Minor Beneficial to Minor Adverse	Negligible Beneficial to Possible Moderate Adverse

Table 2. Impacts of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Access/ Staging	No Effect	Very Negligible Adverse	Very Negligible Adverse	Very Negligible Adverse
Implement-ation/ Short-Term	No Effect	Very Negligible to Negligible Adverse	Negligible to Possibly Moderate Adverse	Negligible to Minor Adverse
WILDLIFE				
Small Mammals				
Long Term	Negligible Beneficial (deer mice) to No Effect	Negligible Beneficial to Possibly Minor Adverse (deer mice)	Negligible to Minor Adverse (deer mice)	Minor to Possibly Moderate Adverse (deer mice)
Access/ Staging	No Effect	Negligible Adverse	Negligible to Minor Adverse	Negligible to Minor Adverse
Implement-ation/ Short-Term	No Effect	Negligible Adverse	Very Negligible to Possibly Moderate Adverse	Very Negligible to Moderate Adverse (deer mice)
Large Mammals				
Long Term	No Effect	No Effect to Negligible Adverse	No Effect to Minor Adverse	No Effect to Possibly Moderate Adverse
Access/ Staging	No Effect	Very Negligible Adverse	Negligible Adverse	Negligible to Minor Adverse
Implement-ation/ Short-Term	No Effect	Negligible Adverse	Very Negligible to Possibly Minor Adverse	Very Negligible to Possibly Moderate Adverse
Birds				
Long Term	Negligible Beneficial to No Effect	Negligible Beneficial to Negligible Adverse	Minor Beneficial to Negligible Adverse	Possibly Minor Beneficial to Minor Adverse
Access/ Staging	No Effect	Very Negligible Adverse	Negligible Adverse	Negligible to Possibly Minor Adverse
Implement-ation/ Short-Term	No Effect	Negligible Adverse	Very Negligible to Possibly Minor Adverse	Very Negligible to Minor Adverse

Table 2. Impacts of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Amphibians and Reptiles				
Long Term	No Effect	Negligible Beneficial to No Effect	Minor Beneficial to Negligible Adverse	Possibly Minor Beneficial to Minor Adverse
Access/ Staging	No Effect	Very Negligible Adverse	Negligible Adverse	Negligible to Minor Adverse
Implement-ation/ Short-Term	No Effect	Negligible Adverse	Very Negligible to Minor Adverse	Very Negligible to Possibly Moderate Adverse
Other Species				
Long Term	No Effect to Negligible Adverse	Negligible Beneficial to No Effect	Possibly Moderate Beneficial to No Effect	Minor Beneficial to No Effect
Access/ Staging	No Effect	Negligible Adverse	Negligible Adverse	Negligible Adverse
Implement-ation/ Short-Term	No Effect	Negligible Adverse	Negligible to Minor Adverse	Negligible to Minor Adverse
NATURAL PHYSICAL PROCESSES AND SOILS				
Dune Processes and Response to Climate Change				
Long Term	Negligible to Possibly Minor Adverse	Very Negligible to Negligible Beneficial	Negligible to Minor Beneficial	Negligible to Moderate Beneficial
Soils				
Long-Term	Very Negligible Adverse	Very Negligible to Possibly Minor Beneficial	Negligible to Minor Beneficial	Very Negligible to Moderate Beneficial
Access/ Staging	No Effect	Very Negligible Adverse	Negligible to Possibly Minor Adverse	Minor Adverse
Implement-ation/ Short-Term	No Effect	No Effect	Minor to Moderate Adverse	Negligible to Moderate Adverse
WATER RESOURCES				

Table 2. Impacts of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Wetlands and Adjacent Water Bodies				
Long Term	No Effect to Very Negligible Adverse	Negligible Beneficial to Negligible Adverse	No Effect to Possibly Moderate ***/(Minor) Adverse (Mechanical Removal-Buffers)	No Effect to Moderate***/(Minor) Adverse (Mechanical Removal)
Access/ Staging	No Effect	No Effect to Very Negligible Adverse	No Effect to Minor Adverse	Negligible to Minor Adverse
Implement-ation/ Short-Term	No Effect	Very Negligible Adverse	No Effect to Possibly Minor Adverse	No Effect to Minor Adverse
WILDERNESS				
Long Term	Negligible to Possibly Minor Adverse	Very Negligible to Negligible Beneficial	Very Negligible to Moderate Beneficial	Very Negligible to Minor Beneficial
Access/ Staging	No Effect	No Effect to Very Negligible Adverse	No Effect to Negligible Adverse	No Effect to Possibly Minor Adverse
Implement-ation/ Short-Term	No Effect	Very Negligible to Negligible Adverse	Very Negligible to Possibly Moderate Adverse	Very Negligible to Moderate Adverse
SOUNDSCAPES				
Long Term	No Effect	No Effect	No Effect	No Effect
Access/ Staging	No Effect	Negligible to Possibly Minor Adverse	Negligible to Minor Adverse	Minor to Possibly Moderate***/(Minor) Adverse
Implement-ation/ Short-Term	No Effect	Very Negligible to Negligible Adverse	Very Negligible to Moderate***/(Minor) Adverse	Very Negligible to Moderate***/(Minor) Adverse
CULTURAL RESOURCES				
Access/ Staging	No Effect	Negligible Adverse	Negligible to Possibly Minor Adverse	Negligible to Possibly Minor Adverse

Table 2. Impacts of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Implement-ation	No Effect	Very Negligible to Possibly Moderate***/(Minor) Adverse	Very Negligible to Possibly Moderate***/(Minor) Adverse	Very Negligible to Moderate***/(Minor) Adverse
VISITOR EXPERIENCE				
Long Term	Negligible Adverse	Negligible Beneficial	Negligible to Possibly Moderate Beneficial	Negligible to Minor Beneficial
Access/ Staging	No Effect	Very Negligible to Negligible Adverse	Very Negligible to Minor Adverse	Very Negligible to Moderate Adverse
Implement-ation/ Short-Term	No Effect	Very Negligible to Possibly Minor Adverse	Very Negligible to Minor Adverse	Very Negligible to Moderate Adverse
ADJACENT LAND USE				
Sand Movement				
Long Term	No Effect	No Effect to Possibly Minor Adverse	No Effect to Minor Adverse	No Effect to Possibly Moderate Adverse
Organic Operations				
Long-Term	No Effect	No Effect to Very Negligible Adverse	No Effect to Negligible Adverse	No Effect to Very Negligible Adverse
Implementation-Related/Short-Term Effects				
Access/ Staging	No Effect	No Effect to Very Negligible Adverse	No Effect to Possibly Minor Adverse	No Effect to Minor Adverse
Implement-ation	No Effect	No Effect to Very Negligible Adverse	No Effect to Negligible Adverse	No Effect to Negligible Adverse
PUBLIC HEALTH AND SAFETY				
Long Term	Very Negligible Adverse	Very Negligible Beneficial	Negligible Beneficial	Very Negligible Beneficial
Access/ Staging	No Effect	Very Negligible to Negligible Adverse	Very Negligible to Possibly Minor Adverse	Very Negligible to Minor Adverse

Table 2. Impacts of Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Implement-ation/ Short-Term	No Effect	Very Negligible Adverse	Very Negligible to Minor Adverse	Very Negligible to Minor Adverse
PARK OPERATIONS AND MANAGEMENT				
Long Term	No Effect	No Effect to Negligible Adverse	No Effect to Negligible Adverse	No Effect to Possibly Minor Adverse
Implement-ation/ Short-Term	No Effect	Very Negligible Adverse	Negligible Adverse	Negligible Adverse

Affected Environment

Vegetation Resources

The Seashore preserves some of the last remaining high quality coastal dune habitat in the United States. The coastal dunes in the Seashore provide habitat for federally listed plants, as well as several rare or state-listed plants. These special status plant species inhabit some of the largest remaining expanses of two rare native plant communities – native American dunegrass (*Leymus mollis*) and dune mat foredunes. Each is a unique habitat along the coast of the western United States from central California to Washington. Both communities have been reduced in size, structure, function and biodiversity through coastal development and the introduction of non-native species. Relegated to small areas under conservation status, these communities have become a critical refuge for a variety of rare plant and animal species. Across the Seashore, dunes provide habitat for at least eight federally listed plant and animal species and several other species that are rare or otherwise of concern.


Coastal dune vegetation

In general, species composition in dune vegetation along the Pacific Coast of North America does not vary greatly relative to latitude (Pickart and Sawyer 1998). The most significant ecological boundary for dunes on the Pacific coast occurs at 37 degrees North, where foredunes shift from being herb-dominated in the south and grass-dominated in the north (Barbour et al. 1976). Species composition, as well as species richness, appears more strongly correlated with distance from the shoreline than geographic location (Barbour 1978, 1992) or physical dune forms (Parker 1974).

Dunes are a harsh environment for plants. In general, constant cycles of sand burial make available critically-limiting nutrients that normally would not be available, given the lack of organic matter in the soil, as well as the very poor nutrient-binding characteristics of sand (Pickart 1997). Specifically it appears that phosphorous, nitrogen and potassium are most limiting in sand dunes and appear to have the ability to restrict and/or bolster growth habits of both beachgrass (Willis 1965) and native plants.

The type of communities and assemblage of species within communities can be strongly driven by physical processes and structure within dunes. Initially, scientists felt that vegetation communities within dunes were determined by salt spray, but in later years, more have come to think that communities are shaped by species' ability to tolerate sand burial (Maun and Perumal 2002). Another study found that species composition in dunes was driven by exposure to wind (Lortie and Cushman 2007), which in itself may be indirectly related to the degree of sand movement and burial. Very few coastal plant species have the ability to survive burial of greater than 1-2 feet at a given time. Non-native European beachgrass (*Ammophila arenaria*) has a distinct advantage over many native dune plants in that it thrives in areas of increased sand burial and is adapted to survive single burial events of up to 3 feet (Ranwell 1958, Huiskies 1979). Only a few other plant species at the Seashore have shown resilience and vigor in response to sand burial of greater than 1-2 feet at a single time – salt rush (*Juncus lescurii*), Pacific wildrye (*Elymus pacificus*), and Tidestrom's lupine (*Lupinus tidestromii*; FE) are surprisingly capable of surviving and growing through such large-scale sand deposition. Species that are not adapted to sand burial through physiological adaptation mechanisms such as adventitious roots (European beachgrass) or rapid vegetative growth rates cannot survive these burial events. In this way, sand burial has the ability to "reset" the structure of a plant community to favor burial-tolerant species.

Regulatory and Policy Setting

Many native vegetation communities within the United States have been adversely impacted by introduction of non-native plant species, as well as a host of other anthropogenic factors such as commercial, residential, and agricultural development, resource extraction, etc. Vegetation in the Project Area has been subject to human activities for 7,000 - 10,000 years, the period believed to be when this area first became occupied by the Coast Miwok. Although data are not available on the effects of Miwok activities on vegetation, it is assumed that they gathered plants for food and for shelter materials and probably used fire to manipulate growth of certain plant species. Beginning in the mid-nineteenth century and continuing into the present, activities such as land clearing, timbering, cultivation, cropping, road building, commercial development and livestock grazing have markedly affected the vegetation.

These activities have affected all vegetation communities, but the most highly publicized and pervasive threats are perhaps those to wetland and riparian communities: in California, more than 91 percent or 4.6 million acres of wetlands have been lost to development, and losses for the rest of the country are estimated at 50 percent (Dahl 1990). Other communities such as California coastal prairie have received less national attention, but the introduction of non-native annual and perennial grasses of European origin have almost extirpated this unique habitat, which may have once dominated large expanses of California's coastline.

In recognition of these threats, federal and state agencies have moved to protect individual species under federal and state Endangered Species Act (ESA). The California Department of Fish and Wildlife, formerly California Department of Fish and Game (CDFW), has designated certain types of vegetation communities as deserving of special consideration as special habitats or Natural Communities, although these designations do not carry the same regulatory implications as federal or state listing for endangered, threatened, or rare plant species. Many special status plant and wildlife species either reside in or use some of these sensitive vegetation communities for all or part of their life cycle. Some of these special habitats such as wetlands and riparian areas are often subject to regulatory oversight under the Clean Water Act (federal) or other state and local legislative mandates such as the Porter-Cologne Act, Streambed Alteration Agreement, and Coastal Zone LCP, because of the important role or functions that these habitats provide to both wildlife and humans.

Beyond regulatory mandates, the Park Service Management Policies (2006) require parks to preserve and restore the natural abundances, diversities, dynamics,

"Park Service Management Policies direct parks to manage and, if possible and prudent, eradicate invasive species that interfere with natural processes and the perpetuation of natural features, native species or habitats"

and habitats of native plant and animal populations and the communities and ecosystems in which they occur (NPS 2006; Section 4.4.1). The Park Service is also specifically urged to not only avoid impacts to wetlands, riparian vegetation, and threatened endangered species, but to look for opportunities to increase, restore, or reintroduce them when these habitats or species have been threatened or extirpated (NPS 2006; Section 4.4.2.3). In addition to protecting and restoring habitats and species affected by non-native species, parks are also moving towards eradication of invasive species that pose substantial threats to the integrity of native habitats and viability of special status plant species populations. Park Service Management Policies (2006) direct parks to manage and, if possible and prudent, eradicate invasive species that interfere with natural processes and the perpetuation of natural features, native species or habitats (Section 4.4.4.2). In addition, "exotic species will not be allowed to displace native species if displacement can be prevented" (Section 4.4.4).


American dunegrass foredune vegetation

Native Vegetative Communities

Native American Dunegrass

This plant community is mostly restricted to the foredune area of a coastal dune system. Prior to development and the introduction of non-native species, native American dunegrass was common along the U.S. west coast from Monterey northward. Currently it can be found only at Point Reyes (near Abbotts Lagoon) and the Humboldt Bay dunes (Pickart and Sawyer 1998). This community is ranked by the Nature Conservancy as critically imperiled, which means five or fewer global occurrences of fewer than 2,000 acres remain. Vegetation in the native dunegrass community is sparse (25%-75% cover) and is dominated by American dunegrass. Other associated species include beach bursage (*Ambrosia chamissonis*), Douglas's bluegrass (*Poa douglasii*), beach morning glory (*Calystegia soldanella*), yellow sand-verbena (*Abronia latifolia*), and beach evening primrose (*Camissonia cheiranthifolia*).

American dunegrass occurs within several of the areas prioritized for restoration. Along the beach adjacent to the AT&T project area, 0.77 acres of American dunegrass were mapped in 17 separate patches, the largest of which occurs just north of the AT&T project area. Also, Geographic Information System (GIS) data and photos from 1999 depict American dunegrass near B Ranch in several locations, including along the beach and more inland. One large patch of American dunegrass occurs mixed with European beachgrass and iceplant along a drainage on the boundary of A and B Ranches. The park has not been completely mapped for American dunegrass, so its extent at North Beach, Davis Property, A Ranch, and Limantour Spit is unknown.

Dune Mat

Dune mat communities are comprised of mat-forming vegetation that is often variable and sparse. Species include beach bursage, dune sagebrush (*Artemisia pycnocephala*), buckwheat (*Eriogonum latifolium*), Douglas's bluegrass, sand-verbena, beach pea (*Lathyrus littoralis*), beach strawberry (*Fragaria chiloensis*) and beach evening primrose. Dune mat habitat is considered rare and has been severely impacted by European beachgrass (Pickart and

Sawyer 1998). Many federal, state and locally listed species are restricted to dune mat communities, including the federally endangered beach layia (*Layia carnosa*; FE) and Tidestrom's lupine, as well as curlyleaf monardella (*Monardella sinuata* ssp. *nigrescens*; California Native Plant Society (CNPS) List 1B.2-Proposed) and dune gilia (*Gilia capitata* ssp. *chamissonis*; CNPS List 1B.1). In 2012, bluff wallflower (*Erysimum concinnum*) was also listed (CNPS List 1B.2): the Seashore reputedly has one of the largest remaining populations of this species. At Limantour, a few patches of pink sand-verbena (*Abronia umbellata* var. *breviflora*; CNPS List 1B.1) also occur along the beachward side of the dunes where European beachgrass and iceplant grow intermixed.


Dune mat vegetation at B Ranch

Native dune vegetation communities occur throughout the Seashore's dunes, but they are often isolated remnants of once large communities that are now fragmented by expanding monocultures of European beachgrass and iceplant (*Carpobrotus edulis*). At the three general areas prioritized for near-term restoration, approximately 25 acres of dune mat have been mapped at B Ranch, with 8.5 acres mapped at AT&T. Dune mat vegetation alos exists at North Beach and Davis Property, with a very small amount in the northern portion of A Ranch. No dune mat has been mapped at Limantour specifically, although pockets of dune mat vegetation may exist within invaded areas.

Species within these dune mat communities seem to differ slightly depending on age or successional status of the dunes. Younger dunes with less differentiated soils support beach bursage, beach pea, beach morning glory, sand-verbena, Tidestrom's lupine, and non-native species such as European sea rocket (*Cakile maritima*). Slightly more mature dune systems support vast numbers of Douglas's bluegrass, as well as beach evening primrose, although numbers of the latter are also often very high in stabilized dunes. As dune systems become even more stabilized – perhaps because they are surrounded by European beachgrass or iceplant stands that demobilize dunes or because they are on the inland edge of the inland-migrating dune systems – the composition of dominant species shifts again slightly towards species such as dune buckwheat, dune sagebrush, sea thrift (*Armeria maritima*), gumplant (*Grindelia stricta*), sand mat (*Cardionema ramosissimum*), and woolly lotus (*Lotus heermanii*). A few species appear to occur across a range of successional stages, such as seaside daisy (*Erigeron glaucus*; moderate to highly stabilized), beach layia (unstabilized to moderately stabilized), and evening primrose (moderately to highly stabilized).

Dune Scrub

In the inland portions of active dune fields, a more shrub-dominated vegetation community can occur. Dune scrub once established on stabilized dunes stretching from Bodega Head to Los Angeles, but, by the 1970s, only Point Reyes-Dillon Beach and Morro Bay-Purisima Point still supported sizeable dune scrub areas.

Most of the dune scrub establishes in the more stabilized backdune areas. A study from 1979 defined at least four (4) predominant dune scrub communities. On stabilized dunes, bush lupine (*Lupinus arboreus*) was dominant, with yarrow (*Achillea millefolium*), ripgut


Scrub species growing amidst European beachgrass in the dunes.

grass (*Bromus diandrus*), and sheep sorrell (*Rumex acetosella*) also present (Holton and Johnson 1979). A second association also occurred on stabilized slopes on inland sites and included bush lupine, mock heather (*Ericameria ericoides*), and coyotebrush (*Baccharis pilularis*), with beach bursage and curlyleaf monardella as understory species (Holton and Johnson 1979). This tends to be a drier, more open type of site than in the first association (Holton and Johnson 1979). Deep, recently reworked sands on the top of ridges supports a community dominated by chamisso lupine (*Lupinus chamissonis*) and mock heather, with bush lupine much more infrequent (Holton and Johnson 1979). Even more exposed locations tend to be established only by chamisso lupine (Holton and Johnson 1979).

Intermediate between dune scrub and dune mat are two associations that are colonized by more herbs and subshrubs than the other associations. Bush lupine and lizard tail (*Eriophyllum staechadifolium*) occur on exposed slopes nearest the ocean (Holton and Johnson 1979). Even less stable sands play host to a mix of lizard tail and beach bursage, with Douglas's bluegrass and dune sagebrush also high in cover, particularly on semi-stable dunes immediately behind the foredunes (Holton and Johnson 1979). Bush lupine showed strong association with the highest nitrogen and organic matter content and smallest particle size of any of the scrub species (Holton and Johnson 1979). In terms of distance from the ocean, mock heather was restricted more to inland sites, while lizard tail occurred at more seaward locations: Dune sagebrush showed no relationship with distance to ocean, possibly because it colonizes recently disturbed sites, but is eventually replaced by other dune shrub species (Holton and Johnson 1979).

In general, most of the these dune scrub areas have now been invaded by European beachgrass or iceplant, with dune scrub existing principally as "pockets" of native shrubs within dense European beachgrass stands or strongly intermixed within European beachgrass stands. Currently, most of these dune scrub pockets are dominated by coyotebrush and mock heather, although other species may occur, including poison oak (*Toxicodendron diversilobum*), California blackberry (*Rubus ursinus*), bush lupine, bracken fern (*Pteridium aquilinum*), wild cucumber (*Marah fabaceus*), miner's lettuce (*Claytonia perfoliata*), and fairy mist (*Pterostegia drymarioides*). Some limited Dune Scrub exists at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and at Limantour, although its extent has not been conclusively mapped.


Seasonally wet area of the dunes

Seasonally Wet Areas

In addition to rare foredune communities, many dune systems also include "dune swale" or "dune slack" wetlands. Coastal interdunal wetlands are common components of larger active and stabilized coastal dune fields, ranging from Coos Bay, Oregon, and south to San

Luis Obispo County, California. They can be referred to as "slack dune ponds" when associated with larger and deeper water or "coastal dune swales" when water is shallow. A more detailed discussion of how these features are formed can be found in *Water Resources*. In general, most of the dunes swales and slacks within the Seashore tend to be large meadow or seasonal wetland features in low basins behind active foredunes or narrow drainages between dune ridges that are oriented perpendicular to the shoreline. Seasonal or even perennial ponding occurs when either sand supply is disrupted or sand is blown out, leaving certain areas closer to the groundwater table, or when dune movement interrupts and even "dams" surface water flow.

Dune wetland

While obviously wetter than the adjacent dune communities, these seasonally wet areas may not be wet enough to be regulated as wetlands by regulatory agencies such as the U.S. Army Corps of Engineers (USACE). In some cases, only the lowest elevation portions of these distinct areas are wet enough to qualify as regulated wetlands. Most of these areas would be regulated by the California Coastal Commission (CCC) as species are typically listed as at least facultatively hydrophytic or occurring in wetlands at least 50% of the time, and the CCC only requires one parameter to be met to qualify as a wetland subject to oversight under the Coastal Act.

The vegetation at these sites typically falls into the sedge series and is dominated by a mix of sedge and rush species. Slough sedge (*Carex obnupta*), dune sedge (*Carex pansa*), and salt rush are the dominant species of the seasonally wet sedge series. Associated species include Pacific silverweed (*Potentilla anserina*), springbank clover, (*Trifolium wormskioldii*), marsh baccharis (*Baccharis douglasii*), beach starwort (*Stellaria littoralis*; CNPS List 4), and California blackberry. A few wetlands even support sparse stands of arroyo willow (*Salix lasiolepis*; Baye 2008). Cover commonly approaches 100% (Pickart and Sawyer 1998). Dune swale wetlands with a mix of meadow and riparian species represent an unusual plant association that is uncommon in central California coast dunes, although none of the component species are themselves that rare (Baye 2008). They appear to be intermediate between typical dune swale wetlands and freshwater fens, which are characterized by freshwater marsh and wetland scrub vegetation in low-flow systems that form on acid sandy substrates (Baye 2008). One of these features occurs at Abbotts Dunes.

Wetland communities at AT&T and North Beach are very similar to those at Abbotts Dunes. At AT&T Dunes, a large diffuse wetland complex fed primarily by groundwater and surface run-off drains into narrow valleys or basins between large, heavily vegetated dunes. These valleys or basins support a moist meadow-type habitat visually distinct from the adjacent dune vegetation. At the lowest elevation of these valleys or basins are very narrow drainages that are often permanently ponded or saturated. This permanently flooded drainage is dominated by rush (*Schoenoplectus pungens*), Pacific silverweed, hydrocotyle (*Hydrocoytle ranunculoides*), and watercress (*Nasturtim officianale*), but also supports the federally endangered Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*) and numerous other species. At the upland boundary of the moist meadow occurs a small stand of arroyo willow, suggesting some higher elevation groundwater seeps. Many of these narrow valley moist meadow-drainage complexes terminate in more expansive moist meadows that have established in large basins behind the active foredunes.

A similar wetland structure exists at B Ranch, A Ranch, and Davis Property, although the adjacent pastures are not quite as wet. At least one of these wetlands at the southern end of B Ranch has historically supported the state-endangered Point Reyes meadowfoam (*Limnanthes douglasii* ssp. *sulphurea*; CNPS List 1B.2). Point Reyes meadowfoam also occurs in two of the three small seasonal ponds in the backdunes at the Davis Property and one dune swale in the A Ranch backdunes. Small, deeply incised drainages cut through the dunes occasionally, with at least some of the drainages apparently draining quickly enough that they do not support wetland or hydrophytic plant species. Also, there are very few, if almost no, moist meadows behind the active foredunes.

Wetland communities at Limantour are different from either of these other general project areas. Wetlands border the dunes, but do not cross through them. To the south lies beach and the Pacific Ocean; to the north lies Estero de Limantour and fringing salt marsh, brackish marsh, and freshwater marsh vegetation communities.

Grasslands

Coastal grasslands often fringe the backdunes of many Seashore dune systems. Among these coastal grasslands are coastal prairies. Coastal prairies are interconnected grasslands interspersed with scrubs or forests and they occur where there is a convergence of moisture availability, climate, terrain, and various disturbance regimes (such as grazing, fire or drought), usually within 60-70 miles of the coast (Sonoma State University 2013). Given the wide range in which coastal prairies occur, soil textures can vary from highly porous types (sand) to extremely dense, nutrient rich soils largely composed of organic matter (SSU 2013). Coastal prairie habitat is not contiguous and can occur in a number of topographically distinct areas, generally ranging from south-eastern Oregon to central California (Barbour et al. 2007).

Douglas iris

Coastal prairies are the sixth most endangered ecosystem type in North America (Noss and Peters 1995). Coastal prairies also have the highest diversity of plant species than all other North American grasslands – in some places sometimes up to 250 species of wildflowers alone (Coastal Prairie Workshop 2006).

The Seashore manages as much as 32,000 acres of grassland in the form of drier coastal grasslands, open scrub, active agriculture or pasture, and moist lowlands, characterized by tall sedges and rushes (Plant Community Classification and Mapping Project 2003). Working cattle and dairy ranches at Point Reyes encompass large portions of the coastal prairie ecotype: In Olema Valley, a number of westward-facing slopes with intermixed forest exist as coastal prairie, dominated by non-native annuals. Ranches exposed to high winds and seasonal fog on the extreme end of the Point Reyes Peninsula have a wide variety of prairies, from high terraces and bluffs to wet, lowland-types.

Some common native graminoid species at coastal prairies within Point Reyes include: California oatgrass (*Danthonia californica*), Pacific reedgrass (*Calamagrostis nutkaensis*), blue wild rye (*Elymus glaucus*), and purple needlegrass (*Stipa pulchra*). Low wet areas generally have different soil compositions and therefore can host more water-tolerant sedges and rushes, such as dense sedge (*Carex densa*), slough sedge, toad rush (*Juncus bufonius*), and brownhead rush (*Juncus phaeocephalus*).

Coastal prairies are immensely diverse habitats and support a large number of wildflowers and forbs. Some native plants include, Douglas iris (*Iris douglasii*), Hayfield tarweed (*Hemizonia congesta*), various clovers (*Trifolium* sp.), as well as plantains (*Plantago* sp.). In drier grasslands, shrubs like bush lupine and coyotebrush are common.

Given their imperiled and diminished nature, coastal prairies also have a number of threatened or endangered plants associated with them. Grasslands in general support 90% of California's rare and endangered plant species (D'Antonio et al. 2002). In addition, populations of endangered and rare plants, including the federally endangered Sonoma spineflower (*Chorizanthe valida*) and CNPS-listed San Francisco spineflower (*Chorizanthe cuspidata* var. *cuspidata* (CNPS List 1B.2), rose leptosiphon (*Leptosiphon rosaceus*; CNPS List 1B.1), large-flowered leptosiphon (*Leptosiphon grandiflorus;* CNPS List 4.2), Marin horkelia (*Horkelia marinensis*; CNPS List 1B.2), and short-leaved evax (*Hesperevax sparsiflora* var. *brevifolia*; CNPS List 1B.2) grow in the grasslands and pastures inland of dune systems. In addition, these areas also support western dog violet (*Viola adunca*), a common species that serves as the only larval plant for the federally endangered Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*).

At B Ranch, two rare plant species have been mapped in the past within pastures: coast rockcress (*Arabis blepharophylla*; CNPS List 4.3) and San Francisco owl's-clover (*Triphysaria floribunda*; CNPS List 1B.2). San Francisco owl's-clover also occurs within the Davis Property grasslands, as well as rose leptosiphon. At AT&T, Marin horkelia, rose leptosiphon, and San Francisco owl's clover are some of the species occur in drier grasslands or moist meadows. Within the past three years, Sonoma spineflower (FE) was reintroduced at AT&T, but this reintroduction occurs in lands almost immediately adjacent to Sir Francis Drake Boulevard and well away from the dunes. The F Ranch pastures adjacent to North Beach supports San Francisco owl's-clover, rose leptosiphon, Marin horkelia, Gairdner's yampah (*Perideridia gairdneri* ssp. *gairdneri*, CNPS List 4.2), Harlequin lotus (*Hosackia gracilis*; CNPS List 4.2), woolly-headed spineflower (*Chorizanthe cuspidata* var. *villosa*; CNPS List 1B.2), and Blasdale's bent grass (*Agrostis blasdalei*; CNPS List 1B.2).

Wetlands or seasonally wet areas within these grasslands support other listed or rare plant species, including Sonoma alopecurus (FE), Point Reyes blennosperma (*Blennosperma nanum var. robustum*; CNPS List 1B.2), swamp harebell (*Campanula californica*; CNPS List 1B.2), Point Reyes checkerbloom (*Sidalcea calycosa* ssp. *rhizomata*; CNPS List 1B.2), beach starwort (CNPS List 4.2), Point Reyes meadowfoam (SE; CNPS List 1B.2), and coast lily (*Lilium maritimum*; CNPS List 1B.1). AT AT&T and North Beach, Sonoma alopecurus, swamp harebell, Pt Reyes checkerbloom, coast lily, and Thurber's reed grass (*Calamagrostis crassiglumis*; CNPS List 2.1) have historically occurred in freshwater marshes within the pastures. Point Reyes meadowfoam is also quite common within wetlands in the pastures and grasslands bordering the Davis Property, B Ranch, and A Ranch, occurring with Point Reyes blennosperma and Point Reyes checkerbloom.

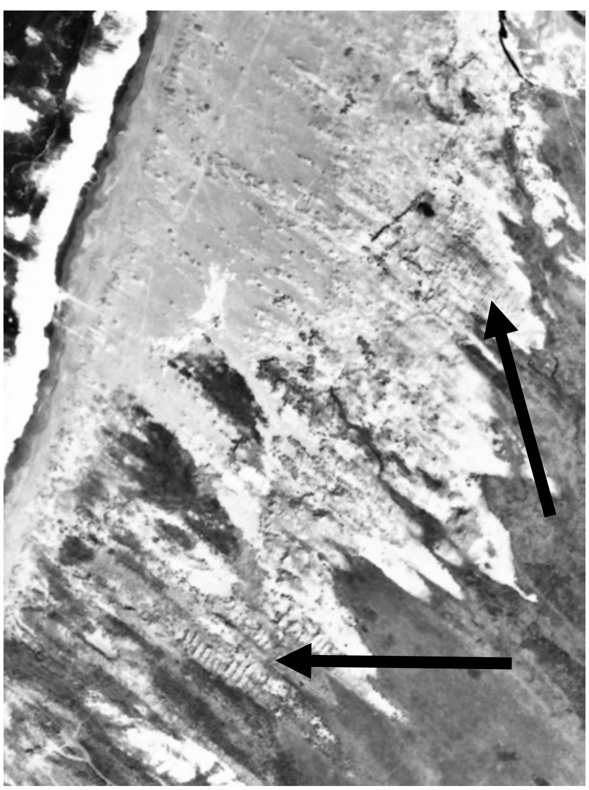
Given the climate and various anthropogenic activities associated with coastal California, native-dominated coastal prairies have degraded and been lost over time. Large-scale disturbances can sometimes increase the number of invasive plant species. Some common invasive graminoids include slender wild oat (*Avena barbata*), rattlesnake grass (*Briza maxima*), ripgut brome, and Italian ryegrass (*Festuca perennis*). Many invasive thistles and forbs like lesser hawkbit (*Leontodon taraxacoides*), burclover (*Medicago polymorpha*), and English plantain (*Plantago lanceolata*) are commonly found in coastal prairies. In fact, many prairies can be largely dominated by non-natives, such as common velvet grass (*Holcus lanatus*) or bent grass (*Agrostis* sp.).


European beachgrass covering a dune

Non-native Vegetation

European beachgrass

European beachgrass is a native perennial grass of Europe and North Africa introduced to California in the late 1800s to help stabilize blowing sand dunes. It is now recognized as an invasive species in North America, Australia, and New Zealand (Johnson 1982, Heyligers 1985, Wiedemann 1987). Throughout its range, beachgrass grows in sand dunes and adjacent coastal habitat (i.e., wetlands, grasslands, etc.). However, it grows most vigorously on open foredunes comprised of mobile and semi-fixed sand, where it tolerates extremes of substrate instability, water drainage, nutrients, organic matter content, and soil texture (Huiskes 1979). Beachgrass can actively grow in soil pH varying from 4.5 - 9.0 and soil temperatures varying from 10 - 40°C, although it appears less tolerant of higher salt concentrations, preferring levels between 1.0 and 1.5 % (Slobodochikoff and Doyen 1977; Pickart 1997). In Britain, beachgrass tends to occur in two communities – mobile dune, where it is the dominant species, and semi-fixed dunes, where sand is less mobile, and European beachgrass becomes less competitive (British National Vegetation Classification System).


Beachgrass plantings (striped features) in backdune areas south of Abbotts Lagoon; photo taken in 1943

Because of this extreme adaptability, European beachgrass became a popular choice for stabilizing unstabilized dunes. European beachgrass was first planted on the west coast of North America at Golden Gate Park in San Francisco in the late 1800s (Lamson-Scribner 1895, Lamb 1898). The species was heralded as a desirable sand stabilizer and was eventually embraced by U. S. Soil Conservation Service and other agencies (Pickart 1997). Along the Pacific Coast, European beachgrass has spread to inhabit areas from Santa Barbara County, California, in the south to Canada in the north. Initially, beachgrass invasion appeared more severe in areas north of San Francisco more than in areas south, but, in recent years, beachgrass has been apparently rapidly expanding in some central and southern California coastal dune systems, including Guadalupe-Nipomo Dunes and Vandenberg Air Force Base (Chestnut 1997).

While European beachgrass was present in San Francisco as early as the late 1800s, there is no reliable information as to when this species arrived in the Seashore, which is approximately 30- to 40 miles northwest of San Francisco Bay. Anecdotal information suggests that ranchers and other landowners probably planted both European beachgrass and iceplant to stabilize the dunes: The Seashore did not acquire most of these lands until 1963 or later. Historical aerial photographs from the 1940s show scattered pockets of European beachgrass at Abbotts Lagoon and other beach areas such as the dunes near B Ranch. Since then, this species has rapidly spread along the Great Beach and at Limantour Beach. Beachgrass tends to be more prevalent than iceplant along some of the northern sections of the Great Beach, stretching from North Beach northward to north of Abbotts Lagoon, and at Limantour Beach. While European beachgrass is present south of North Beach to the dunes near the Lighthouse, iceplant often either co-dominates certain areas or is actually even more dominant. The reason for this geographic pattern in extent of particular invasive species is unknown, but may be related to what species was originally planted in particular dune areas by landowners prior to park ownership and to the structure of the dune system present.

Depth of European beachgrass rhizomes can be over 6 feet

European beachgrass predominantly spreads vegetatively through rhizomes or belowground root structures. Past research has documented that, as plants are buried by blowing sand, their shoots can grow up to 3.3 feet per year (Ranwell 1972, Barbour et al. 1985), however, other studies have documented rates as high as 6.6 feet in six months (Bossard et al. 2000). If broken off, these rhizomes can re-establish plants from even the smallest rhizome fragment (<2 inches). Based on recent excavations in dunes at the Seashore, the depth of rhizomes can differ between foredune and backdune systems: In the foredune, rhizomes can extend anywhere from 6 to 12 feet, while in the backdune, rhizomes tend to be shallower, averaging between 3 and 6 feet. This agrees well depths from other studies, which showed a range between 3.3 feet (Salisbury 1952) to as much as 15 feet (Buchenau 1889).

The differences in backdune and foredune rooting depth may relate to a phenomenon known as the "Ammophila problem" (Marshall 1965) in which a lack of fresh sand accumulation results in reduced vigor of European beachgrass: Plants produce less roots (Wallén 1980, Gray 1985), which may potentially relate to the fact that roots of European beachgrass in stabilized dunes are infected by microorganisms that reduce formation of new tillers (Van der Putten et al. 1988 *in* Pickart and Sawyer 1998). Fresh sand accumulation also provides nutrients (Pickart 1997) and inputs of arbuscular mycorrhizal fungi (symbiotic organisms that improve water uptake and nutrient acquisition) and prevents build-up of pathogens (Van der Putten et al. 1988 *in* Pickart and Sawyer 1998). Apparently, fragments can even withstand prolonged seawater immersion, with viable fragments surviving in cold marine waters for as long as eight (8) tidal cycles (Baye 1990), although the plant itself can tolerate only lower salt concentrations in dune soils than native plants (1.5%; Huiskes 1979).

Seed of European beachgrass is viable, but establishment by seedling is not common as vegetative establishment (Pickart and Sawyer 1998, Huiskes 1977) and may be more likely to occur only under certain climatic conditions or in certain types of microhabitat. A study in Great Britain found that seed only germinated in places where sand was comparatively damp, specifically at the base of slopes where direct rainwater concentrations and leaching was highest (Huiskes 1977). Most critically, seedlings of beachgrass require some form of retained moisture, decreased sand burial, and an overlay of damp, clay-like soil (Huiskes 1977).

Iceplant growing over dune mat vegetation

Up to approximately 758 acres of European beachgrass occur along the Great Beach on the outer coast of the Seashore, and another 109 acres occur along the Limantour Spit, with the northern portion of the Great Beach and Limantour more heavily dominated by beachgrass than iceplant (Figure 1).

Iceplant

Iceplant, a succulent, prostrate member of the Aizoaceae family, was introduced to California in the early 20th century to stabilize dunes adjacent to railroad tracks and was later planted along highways and on coastal sand dunes (Albert 1995a). Its popularity as a planting along California's highways and freeways has led to Hottentot fig (*Carpobrotus edulis*) to be also called, "freeway iceplant." At one point, the California Department of Transportation was maintaining almost 6,000 acres of this species along roadways (Schmalzer and Hinkle 1987). *C. edulis* comes from South Africa, but the origins of another member of this family, *Carpobrotus chilensis*, is disputed (Albert 1995a). *C. chilensis* is not considered invasive, but hybrids of *C. edulis* and *C. chilensis* are (Albert 1995a). Unless otherwise noted, when this EA refers to iceplant, it is denoting *C. edulis*.

Iceplant invades a number of coastal plant communities in California, including grasslands, dunes, and coastal scrub (D'Antonio 1993). Over time, in these habitats, this species forms dense, clonal mats up to 20 in thick that may overtop even native shrubs (D'Antonio and Mahall 1991).

Iceplant flower

This succulent spreads both vegetatively and by seed. In one study, recruitment of seedlings accounted for only 1% to 2% of the change in cover measured over four years, suggesting that clonal growth often represents the primary means of expansion (D'Antonio 1993), although this is not always the case (de la Peña et al. 2010). Germination of iceplant seeds shows no effect from fire, but is enhanced by passage through animals' digestive system, with animals being important dispersers of *C. edulis* seeds (D'Antonio 1993). Seeds can remain viable in soils for at least two years, and the species is both self-fertile and self compatible, meaning that it can successfully fertilize

Iceplant-invaded dunes at B Ranch

itself (D'Antonio 1990, Suehs et al. 2004). In terms of vegetative reproduction, a single individual of iceplant, specifically *C. edulis*, can form dense, circular mats over 33 feet wide and up to 20 inches deep (D'Antonio and Mahall 1991). This species can spread radially at rates high as 3.3 feet per year by growing from multiple axes and rooting where nodes can contact the soil (Wisura and Glen 1993).

While iceplant can be sensitive to water stress (MacDonald et al. 1984), this species can employ a special type of mechanism called crassulacean acid metabolism (CAM) that increases its ability to tolerate water-limited, nitrogen-limited, and saline environments (Schmalzer and Hinkle 1987).

Other factors that affect iceplant include frost sensitivity (MacDonald et al. 1984), scale insects introduced to California from the species' native South Africa (Tassan et al. 1982, MacDonald et al. 1984, Washburn and Frankie 1985), and hybridization (Albert 1995b, Albert et al. 1997). In one study, only 25% of the plants retained the original parental genotype, leading researchers to conclude that the overall species complex in California appears characteristic of a so-called hybrid swarm (Albert et al. 1997).

Iceplant can obviously directly affect other plant species by displacing them and even overgrowing them, which reduces biomass, life span, and reproductive output of adjacent plants (Pickart and Sawyer 1998). Iceplant reduces native species diversity (Vilà et al. 2006, Carboni et al. 2010), the fitness of neighboring native plants (D'Antonio and Mahall 1991), and the pollination network in invaded communities (Bartomeus et al. 2008). However, it also has indirect effects, as well, by lowering pH, reducing nitrogen content and available water, increasing organic matter and carbon, and even changing the soil biota (higher levels of chytrid fungi and pathogens; lower levels of mycorrhiza (D'Antonio and Mahall 1991, Vilà et al. 2006, Conser and Connor 2009, de la Peña et al. 2010, Santoro et al. 2011). (These indirect effects are discussed more in *Natural Physical Processes and Soils*). The species' dense fibrous root system, which is concentrated in the upper 25 inches of the soil, may enable it to compete more effectively for water with native plant species (D'Antonio and Mahall 1991).

B Ranch dune with iceplant growing amidst native shrubs and other dune species

These direct and indirect effects work differently in different environments to promote iceplant establishment: In one study, iceplant established more readily in dunes than in coastal scrub due to lower abundance of brush rabbits and, therefore, reduced herbivory intensity (D'Antonio 1993). In grasslands, existing plants precluded establishment of iceplant seedlings, with disturbance and creation of gaps in the canopy cover required for successful seedling recruitment (D'Antonio 1993).

In dunes, resistance to invasion by iceplant in portions of its non-historic range may be mediated by soil biota (Vilà et al. 2006, de la Peña et al. 2010), with the resistance eventually broken down over time by the prolific seed rain (>1,000 seeds per fruit; de la Peña et al. 2010). As noted above, expansion by iceplant changes the soil by negatively affecting water availability for other plants, reducing soil pH, and altering nutrient and potentially soil biota dynamics (higher levels of chytrid fungi and pathogens; lower levels of mycorrhiza; D'Antonio and Mahall 1991, Vilà et al. 2006, Conser and Connor 2009, de la Peña et al. 2010, Santoro et al. 2011). These soil changes may cause iceplant to switch from sexual to asexual reproduction modes (de la Peña et al. 2010). In other regions, iceplant invasion appears to be successful, because the species is not affected by pathogenic species that are normally present in its native dune soils (Reinhart et al. 2005, Van Grunseven et al. 2009 *in* de la Peña et al. 2010).

Approximately 388 acres of iceplant are present along the Great Beach, with iceplant being more dominant than beachgrass toward the central and southern portions. On the Limantour side, iceplant accounts for approximately 32 acres of converted dune habitat, with most of this intermixed with European beachgrass (23 acres; Figure 1).


European sea rocket

Other Non-Native or Invasive Species

Other non-native invasive or habitat-altering species can also occur in the dunes. These include European sea rocket and bush lupine. European sea-rocket reproduces by seed, which is distributed by ship ballasts, sand transport, tidal movement, and human activity (Cal-IPC 2012). In comparison to native dune plants, it produces more seed, disperses greater distances, and tolerates more disturbances (Cal-IPC 2012). Laboratory experiments demonstrate that the plant may have allelopathic effects, but these effects have not been observed in field experiments (Cal-IPC 2012). Within the Seashore, European sea rocket's distribution is much more limited relative to European beachgrass and iceplant, although its numbers did seem to potentially increase after Phase I at Abbotts Lagoon.

Bush lupine is native to California, but its historic range apparently incorporated only central and southern California. In 1902, Davy reported that bush lupine did not occur north of Point Reyes, while the Jepson Manual (1993) listed the historic range as Sonoma County south to Ventura. Botanical experts still question whether this species is native to Marin County (Pickart and Sawyer 1998, Baye 2008). There are some indications that bush lupine was planted with European beachgrass for stabilization and reclamation of coastal dunes after 1870 (McLaren 1924) and was introduced to North Coast dunes where it is highly invasive (Baye 2008).


Bush lupine

As with other coastal areas in Sonoma County, bush lupine establishes in both grasslands and dunes (Pickart and Sawyer 1998). Without grazing, numbers of this species can increase dramatically in the park's coastal grasslands. In dunes at the Seashore, it can co-occur with European beachgrass in backdune areas, but it appears much less prevalent in these invaded communities than coyote brush and mock heather. At Tomales Dunes, it dominated the dune scrub community, however, and, after initial restoration at Abbotts, it established well in open sand conditions within the park's dunes. In addition to altering soils and, therefore, potentially altering vegetation communities (see *Natural Physical Processes and Soils*), this species is also known to hybridize with other native lupine species such as manycolored lupine (*Lupinus variicolor*) and seashore lupine (*Lupinus littoralis*), so it could threaten viability of other lupine species within the dunes, including Tidestrom's lupine and chamisso lupine (Baye 2008).

The following subsections describe invaded habitat types.

European Beachgrass-Dominated Foredune

These sites are identified by a steep foredune complex dominated by a high density of European beachgrass. The foredune area extends approximately 160 feet inland from the beachfront and is classified separately because of the tendency to develop a much deeper and more dense root mass than in reardunes. Cover of beachgrass tends to be dense, but other plant species that can establish and persist in "pockets" of open sand within the beachgrass stands include beach bursage, beach pea, sea rocket, yellow sand verbena, beach morning glory, and Douglas's bluegrass. This community occurs in the northern portion of the Great Beach, near AT&T/North Beach, B Ranch/A Ranch/Davis, and along Limantour Spit (Figure 13).

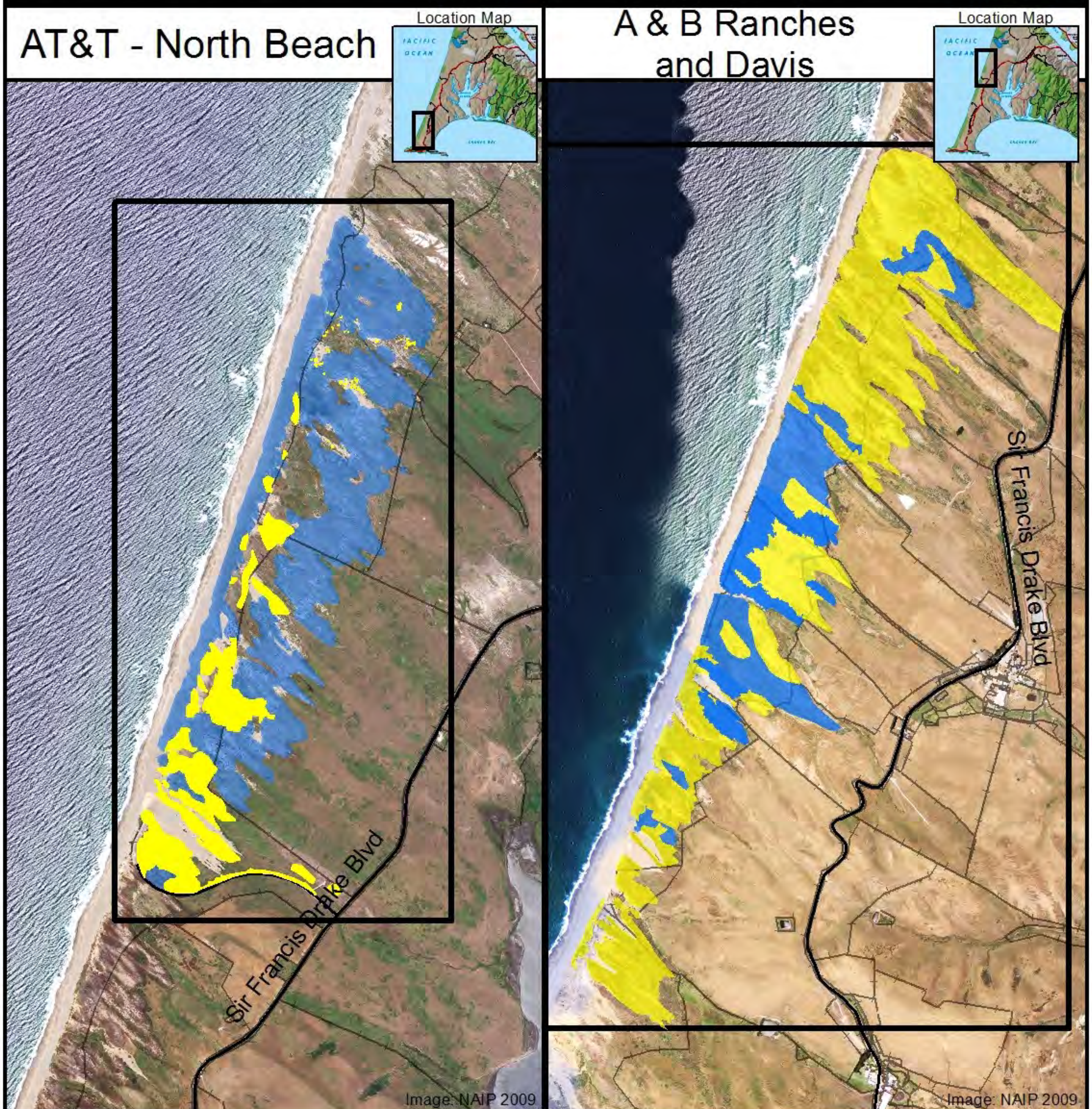
European beachgrass-dominated foredune

European beachgrass-dominated backdune

European Beachgrass-Dominated Backdunes

These sites are characterized by high densities of European beachgrass, but occur further inland than 160 feet from the beachfront. In some backdune areas, the vegetation cover includes a small percentage of native shrubs: coyotebrush, mock-heather, and bush lupine. This community occurs in the central and northern portion of the Great Beach, including at AT&T, and more sporadically further south such as at B Ranch, A Ranch, and Davis Property (Figure 13). There is not a well-developed European beachgrass-dominated backdune at Limantour.

Coastal Dune Restoration Environmental Assessment
Point Reyes National Seashore



National Park Service
Point Reyes National Seashore
Marin County, California

0 0.25 0.5 Miles

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Figure 15. Non-native Vegetation Communities as of 2012 - Proposed Project Areas

Fence
European Beachgrass
Iceplant

S:\GIS\projects1\Dune restoration\Dune EA 2012\Project-based EA Figures\15 Non-native Vegetation Communities - AT&T and B Ranch.mxd

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Iceplant-Dominated Dunes

Iceplant forms large monotypic mats in all dune areas, although fewer true foredune areas have been completely invaded by this species: It tends to occur in backdune and higher elevation dune areas adjacent to the beach. Over time, iceplant can exclude almost all other species, but prior to this point, other species can subsist within "pockets" of open, sandy areas within iceplant stands. As noted earlier, the presence of iceplant appears to drive the successional status of native dune "pockets" towards a more mature, late successional community supporting species such as dune buckwheat, dune sagebrush, sea thrift, beach bursage, and woolly lotus. A few species appear to occur across a range of successional stages, including beach evening primrose (moderately to highly stabilized), which can be quite common in iceplant-dominated dunes. Iceplant becomes more dominant between North Beach and South Beach and further south near B Ranch, A Ranch, Davis Property, and at the Lighthouse (Figure 13). Most of the iceplant at Limantour Spit occurs intermixed with European beachgrass, although there are approximately 9 acres of pure iceplant patches.

Native Dunes with Sparse Beachgrass and Iceplant

These sites are characterized by low densities of European beachgrass and iceplant. They require special planning during restoration, because they often contain or are directly adjacent to known rare- or endangered-plant habitats, or they are adjacent to known wetlands. Native, rare or endangered plant species within these areas include: seaside daisy, beach layia, beach pea, American dunegrass, and Tidestrom's lupine. These vegetation communities occur along the Great Beach, including at AT&T/North Beach and B Ranch/A Ranch/Davis Property, and along Limantour Spit (Figure 13).

Native dune with sparse beachgrass and iceplant.

Species of Special Concern

Policy and Regulatory Setting

Many plant and wildlife species within the United States have been adversely impacted by increasing urbanization, resource extraction, contamination from pesticides, metals, and other pollutants, and introduction of non-native wildlife species. A number of regulations and policies have attempted to protect plants and wildlife from these negative impacts, with most of these focused either on recovery of the species itself or preservation of key or critical habitat.

Federal and state agencies have moved to protect individual species under federal and state Endangered Species Act. The federal Endangered Species Act (ESA) protects threatened and endangered species from unauthorized "take" and directs federal agencies 1) to ensure that their actions do not jeopardize the continued existence of listed species or result in the destruction or adverse modification of Critical Habitat and 2) to utilize their authorities by carrying out programs for conservation. Section 7 of the ESA defines federal agency responsibilities for consultation with the U.S. Fish and Wildlife Service (USFWS) for most mammal, bird, and fish species or with the National Marine Fisheries Service (NMFS) for anadromous or ocean-going fish. Once a species has been listed under the federal ESA as threatened or endangered, the USFWS is required to identify and protect Critical Habitat. Even bird species that are not necessarily protected under federal or state ESA receive some protection under the Migratory Bird Treaty Act of 1918 (16 U.S.C. §703-712). The Migratory Bird Treaty Act protects almost all migratory wild birds and their parts (including eggs, nests, and feathers) and makes it unlawful to take, possess, buy, sell, purchase, or barter any migratory bird or to cause a "taking," which is defined as disturbance that causes nest abandonment and/or loss of reproductive effort (e.g., killing or abandonment of eggs or young).

Beyond regulatory mandates, the Park Service Management Policies (2006) require parks to preserve and restore the natural abundances, diversities, dynamics, and habitats of native animal populations and the communities and ecosystems in which they occur (NPS 2006; Section 4.4.1). The Park Service is also specifically urged to not only avoid impacts to threatened or endangered species, but to look for opportunities to increase, restore, or reintroduce them when these habitats or species have been threatened or extirpated (NPS 2006; Section 4.4).

"The Park Service is also specifically urged to not only avoid impacts to threatened or endangered species, but to look for opportunities to increase, restore, or reintroduce them when these habitats or species have been threatened or extirpated"

The incredible diversity of habitats in Point Reyes has led to an incredible biodiversity in both rare and common plant and animal species, the latter of which is discussed more under *Wildlife*. This region is recognized as only one of two Biodiversity Hotspots within the continental United States by Conservation International. The entire central California area, including the San Francisco Bay region, has been characterized as one of the highest, if not the highest, ranked regions in terms of being a Hot Spot of Species Rarity and Richness by NatureServe (2000).

Not surprisingly, among these species are species of special concern that are either federally or state-listed or are not listed formally, but are of concern to the state, park, or other regional agencies.

There are at least 36 species within the Seashore and its waters that are federally listed as threatened or endangered. Species of special concern include plants and animals on the list of threatened and endangered species at both the state and federal level and species that are not listed but are of concern to the state or park. The Seashore ranks sixth in the Park Service in terms of the number of listed plant and animal species, and Golden Gate National Recreation Area (GGNRA) is tied for third: the Seashore manages the north district lands of GGNRA (NPS 2011). Species with potential to occur in the Seashore's dune systems are discussed below.

Rare plant community associations are discussed in *Vegetation Resources*.

Listed Plant Species

Layia carnosa (Beach layia) – Federal and state endangered Beach layia is an annual, usually prostrate member of the Asteraceae family found in dune sites on the northern and central California coast from Humboldt to Santa Barbara counties (USFWS 1998). A total of 14 populations of beach layia have been identified at the Seashore. These populations lie along the a 10 mile stretch of the "Great Beach," which runs roughly north to south along the western shore of Point Reyes and includes AT&T, North Beach, Davis Property, and B Ranch. Beach layia is not known to occur at A Ranch or along Limantour Spit.

Generally, it grows on sparsely vegetated semi-stabilized dunes and open, shifting or poorly stabilized dunes. In the more stabilized locations, the cover of associated vegetation protects beach layia from sand dune movement and erosion. These associated species include coast buckwheat, dune sagebrush, Douglas's bluegrass, sand verbena, and beach bursage.

Beach layia reproduces exclusively from seed. Beach layia germinates during the fall to mid-winter rainy season and blooms in the spring and early summer, although some plants are still flowering in mid-summer. Seeds are dispersed by wind in the late spring and summer.

In general, over the last decade, the status of beach layia in the Seashore has been considered generally stable and has been characterized as medium-low priority for monitoring, because "it is widespread and relatively abundant within the range of suitable habitat" (Benson 2004). As an annual, this species can experience large fluctuations in plant numbers.


Beach layia

However, recent monitoring of fixed census plots in 2012 show plant numbers to have dropped in most sub-populations since monitoring was last conducted in 2004. On average, plant numbers have dropped by 48% in most of the census plots, with decreases ranging from a low of 17% to a high of 99% (NPS, unpub. data). Only one census plot located north of North Beach showed an increase (NPS, unpub. data). Declines in plant numbers between 2004 and 2012 were estimated to average 17%, 61%, 75% at AT&T, B Ranch, and Davis Property, respectively (NPS, unpub. data).

Range-wide, this species is threatened by invasive non-native plants, recreational uses such as ORV activities and pedestrians, cattle grazing, and urban development (USFWS 1998). Twelve of the 14 occurrences in the park have been characterized as threatened by the presence of the non-native European beachgrass and iceplant nearby, as the monotypic stands of either species crowd out less competitive native species (Benson 2004; USFWS 1998). Iceplant, in particular, forms "dense, smothering mats" that take over prime beach layia habitat (Benson 2004). "Continued efforts to manage non-native weeds will be essential for the protection of this species" (USFWS 1998).

So far, this species has not responded as dramatically to restoration efforts as Tidestrom's lupine. Following mechanical removal of European beachgrass near the mouth of Abbotts Lagoon in 2003-2004, 182 Tidestrom's lupine and 18 beach layia seedlings were found growing (Rodgers 2006). Establishment of beach layia in newly restored areas south of Abbotts Lagoon was initially reduced relative to that of Tidestrom's lupine, with most of the new beach layia plants found on the edges of the restored area adjacent to native dunes or along access roads. While these plants were not counted, they probably numbered less than 50 to 100. However, in 2014, beach layia were observed growing in the interior portions of mechanically and herbicide-treated dunes.

Lupinus tidestromii (Tidestrom's lupine) – Federal and state endangered


Tidestrom's lupine

Tidestrom's lupine is a creeping perennial herb and a member of the pea family. Tidestrom's lupine is presently known from 19 extant occurrences that range from the Monterey Peninsula in Monterey County to the Russian River in Sonoma County (CNPS 2013). Ten (10) of the populations remaining as of 2014 occur at the Seashore; the rest are on private, municipal, or State Park beach properties. All occur along the Point Reyes Beach, which stretches from Historic A Ranch (Nunes) to Abbotts Lagoon: among these populations are those at AT&T, North Beach, Davis Property, and B Ranch. Tidestrom's lupine does not occur at Limantour or A Ranch.

The major threats to this species range-wide include invasion by non-native plants such as iceplant and European beachgrass, development, and trampling by hikers, equestrians and, to a lesser extent, trampling and grazing by cows (USFWS 1998). At the Seashore, threats include habitat loss due to the encroachment of European beachgrass and iceplant: "Most of the populations at PRNS (Seashore) exist within islands of native dune communities surrounded by beachgrass and/or iceplant" (Rodgers 2006). In fact, encroachment by iceplant may have eliminated one population (Population #5; Rodgers 2006).

The areal extent and numbers of Tidestrom's lupine vary widely between the Seashore's populations (Parsons and Minnick 2012). Historically, the Seashore's populations range in size from over 100,000 individuals to less than 5 individuals (Parsons and Minnick 2012).

This species reproduces exclusively by seed. Seeds are large, long-lived and are primarily deposited in the vicinity of the plant base. Seeds require some type of seed coat degradation, such as scarification in blowing sand, for germination. In fact, germination can occur in the fall even before winter rains, perhaps due to scarification or seed coat rupturing of the seeds (NPS staff, *pers. obs*.). For this reason, seedbank dynamics are extremely important for this species. An initial Population Viability Analysis for Tidestrom's lupine conducted by researchers at Washington University (WU; St. Louis, MO) found that that at least two of the three populations (located at Abbotts Lagoon and North Beach) were, under current conditions, projected to decline in numbers towards extinction (Dangremond et al. 2010). The one exception, located at AT&T dunes south of Abbotts Lagoon, appeared barely stable (Dangremond et al. 2010).

Viability of park populations appears to be primarily threatened by non-native invasive species such as European beachgrass and iceplant (Dangremond et al. 2010). In general, Tidestrom's lupine is affected by these non-native invasive species both through direct displacement from dune habitat – European beachgrass typically accounts for more than 90% of the plant cover in invaded areas – as well as indirect factors, such as contributing to elevated predation levels and reducing the availability of early successional microhabitats. European beachgrass typically provides habitat for native deer mice (*Peromyscus maniculatus*), which appear to occur in higher numbers in beachgrass and other dense vegetation than they do in native dune areas (Pitts and Barbour 1979). Deer mice have been documented to eat up to 82% of the seeds of lupine both from the plant and off the ground, effectively reducing the potential for successful reproduction of this species (Dangremond et

Deer mouse eating lupine seed pods. (Photo: Steve Kroiss)

al. 2010). Pre-dispersal fruit predation and post -dispersal seed predation has been shown to be statistically significantly higher near European beachgrass than further away (at least 75 m), with seed predation 70% higher near European beachgrass (Pardini and Knight, unpub. data). The Population Viability Analysis demonstrated that these levels of seed predation dramatically decrease the population growth rate of the Seashore's populations of Tidestrom's lupine (Dangremond et al. 2010).

Based on censuses conducted between 2000/2001 and 2011, numbers of Tidestrom's lupine had declined over the decade by roughly 36% at North Beach and 54% at B Ranch South, with the most dramatic decline recorded at B Ranch North (Parsons and Minnick 2012). Historically, both the Abbotts Lagoon population and the B Ranch North population were large enough that censusing (flagging and counting all individuals) was not feasible so the populations were sampled using the same monitoring approach every year to develop estimates of total population size. However, in recent years, the B Ranch North population has crashed so drastically that the entire population is now censused by counting all individuals. Numbers have dropped from an estimate of 11,000 to 12,000 individuals between 2001 and 2007 to 1,835 individuals in 2011 and 1,685 individuals in 2012, an approximately 83% decrease in population size (Parsons and Minnick 2012; Johnson et al. 2012). Preliminary estimates of numbers in 2013 showed a slight, but probably insignificant, increase in numbers to 1,843 individuals, with another slight bump in 2014 to 2,186 due to seedling establishment (Parsons and Minnick 2014; NPS, unpub. data). In general, numbers reported between 2011 and 2014 are probably within the range of sampling error expected from a census-style monitoring approach, which would suggest that population numbers have not fluctuated much in recent years.

Not surprisingly, in a follow-up Population Viability Analysis of eight (8) populations conducted using data collected in 2008-09, three (3) populations in particular appeared to be especially vulnerable, including B Ranch South, B Ranch North, and Davis (Pardini and Knight, unpub. data). B Ranch South is completely surrounded by European beachgrass, and, therefore, seed predation, depletion of the seed bank, and other factors may contribute to decline at this site (Pardini and Knight, unpub. data). The B Ranch North population is also likely threatened by seed consumption and seedbank depletion (Pardini and Knight, unpub. data). In populations with European beachgrass where consumption is substantial (e.g. B Ranch South, AT&T, B Ranch North, Abbotts Lagoon), removing seed consumption improved the projected population growth in models (Pardini and Knight, unpub. data). In some instances, however, factors other than seed consumption appear to be influencing population dynamics: at Davis Property, direct impacts from encroachment by iceplant, as well as the population's particularly exposed and windblown location, may be impacting plant survival. Interestingly, during the past two years, more seedlings have attempted to establish at Davis, which has actually increased the population by almost seven (7) times its low of 49 plants in 2007 (Parsons and Minnick 2014).

Estimates of Tidestrom's lupine population size at four populations – North Abbotts Lagoon, Abbotts Lagoon, Historic F Ranch, and AT&T,– have showed either relatively consistent numbers between the 2000-2005 period and 2014 or, in the case of Historic F Ranch, a 121% increase since 2003 (Parsons and Minnick 2014). At AT&T, the main threats to this population have been characterized by researchers as invasive species, primarily European beachgrass and iceplant (Pardini and Knight, unpub. data). Other threats to this population include trampling by cows: In 2010, very few fruits were produced, because many reproductive plants reverted to non-reproductive status after trampling in spring 2009 (Pardini and Knight, unpub. data). The Population Viability Analysis conducted by Washington University on three populations using data collected between 2005 and 2008 suggested that, based on reproduction rates, this population might be the only population with a stable or slightly increasing population growth rate (Dangremond et al. 2010). Reduction in seed predation pressure would potentially boost population growth rates in this population (Dangremond et al. 2010). While data from 2005 – 2008 suggested that this would be sufficient to induce a strongly positive population growth rate (>1; Dangremond et al. 2010), an analysis conducted using data collected from one year later (2008-2009) showed more equivocal results (Pardini and Knight, unpub. data).

At Abbotts Lagoon, restoration during Phase I through removal of 80 acres of European beachgrass around this large Tidestrom's lupine population appeared to have possibly reduced predation pressure, at least immediately after the project was completed. Prior to implementation, the mean percentage of racemes or flowering stalks of the Abbotts Lagoon Tidestrom's lupine population that suffered predation ranged from 38% to 94% across a six year observation period (Pardini and Knight 2013; Figure 14). Predation rates were significantly lower in the two years following the restoration (19% in 2011 and 6% in 2012 (Pardini and Knight 2013; Figure 14). In 2013, predation rates dropped even lower to 4%, but climbed a little to 9% in 2014, but rates are still much lower than prior to restoration (WU, unpub. data).

Estimates of Tidestrom's lupine population size at least four populations – North Abbotts Lagoon, Historic F Ranch, and AT&T – have showed either relatively consistent numbers between the 2000-2005 period and 2011 or, in the case of Historic F Ranch, a 121% increase since 2003 (Parsons and Minnick 2012). At AT&T, the main threats to this population have been characterized by researchers as invasive species, primarily European beachgrass and iceplant (Pardini and Knight, unpub. data). Other threats to this population include trampling by cows: In 2010, very few fruits were produced, because many reproductive plants reverted to non-reproductive status after trampling in spring 2009 (Pardini and Knight, unpub. data). The Population Viability Analysis conducted by Washington University on three populations using data collected between 2005 and 2008 suggested that, based on reproduction rates, this population might be the only population with a stable or slightly increasing population growth rate (Dangremond et al. 2010). Reduction in seed predation pressure would potentially boost population growth rates in this population (Dangremond et al. 2010). While data from 2005 – 2008 suggested that this would be sufficient to induce a strongly positive population growth rate (>1; Dangremond et al. 2010), an analysis conducted using data collected from one year later (2008-2009) showed more equivocal results (Pardini and Knight, unpub. data).

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A) B)

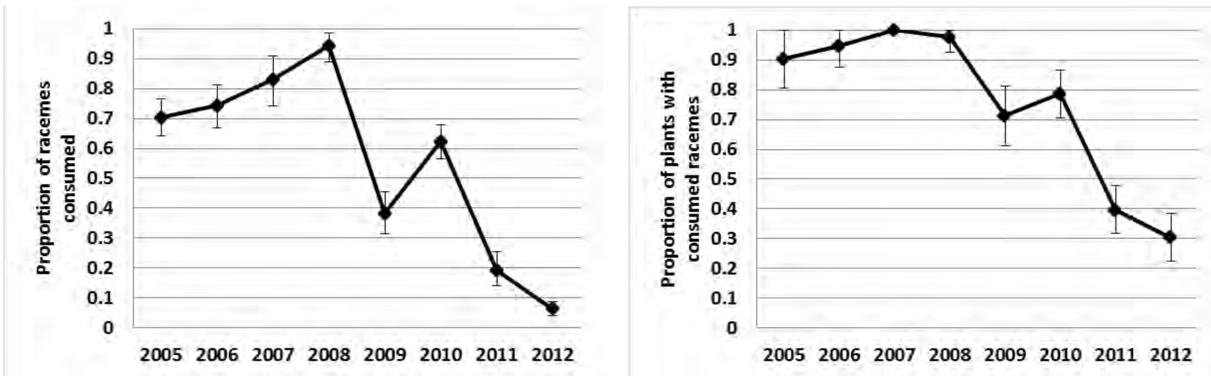


Figure 17. **Pre-dispersal seed predation of Tidestrom's lupine at Abbotts Lagoon for 2005-2012.** Predation levels are presented as population-level estimates, calculated as the proportion of racemes consumed (panel A) or as the proportion of plants that experienced any consumption (panel B). Error bars represent 95% confidence intervals. Graphic courtesy of Washington University.

While restoration appears to have reduced predation pressure, it also increased the amount of sand re-mobilization, and the native dune habitat inland of the foredunes has been impacted, with burial of many common and listed plants quite evident. In certain instances, flowering stalks of Tidestrom's lupine have been buried, which actually reduces success of reproductive efforts. Population numbers at Abbotts Lagoon have remained fairly consistent before and after restoration, given statistical confidence intervals, ranging from 156,552 (±26,770) in 2012 to 183,726 (±24,290) in 2011, with numbers very similar to 2012 in 2010. In 2013, estimated plant numbers totaled 195,994 (±40,977), with the estimated number of plants per plot increasing by as much as 20 plants from 2012.

In addition to reducing predation pressure, restoration also created more suitable habitat for native plants near the historic Abbotts Lagoon population. Another way that European beachgrass negatively impacts Tidestrom's lupine and other early successional native dune species is by reducing the availability of early successional microhabitat. The dense root structures of European beachgrass stabilize sand and increase foredune height compared to native dunes (Buell et al. 1995). These processes decrease the historically natural process of frequent sand movement within interior dunes (Pickart 2008; Pickart and Barbour 2007). Together, these effects reduce the overall proportion of early successional microhabitat, which is created by small blowouts and moving sand. A study conducted by Pardini and Knight in 2012 showed that early successional habitat is not common at Abbotts Lagoon, where a study of 145 vegetation plots spaced evenly across the site showed that only 15% were early successional, characterized by high amounts of bare ground (84.4%; Pardini and Knight 2013). The remaining 85% of plots were either mid-successional (60% bare ground) or late successional (18.8% bare ground), which was characterized by much higher vegetation cover (Pardini and Knight 2013).

The same study showed the endangered Tidestrom's lupine (and beach layia) were more frequently found in early successional microhabitats within the site (Pardini and Knight 2013). In addition, early successional habitats were more likely to contain newly recruited individuals or seedlings of Tidestrom's lupine (Pardini and Knight 2013). All or 100% of the early successional plots supported Tidestrom's lupine seedlings, with percentages declining to 81% for mid-successional and 44% for late successional habitats (Pardini and Knight 2013). Habitat preferences were even more dramatic for beach layia, which was not found in any late successional habitats and in only 13% of the mid-successional ones (Pardini and

Knight 2013). Interestingly, these results are in marked contrast to earlier hypotheses on habitat preferences of Tidestrom's lupine: The Recovery Plan characterized Tidestrom's lupine as a later successional species that was intolerant of sand burial (USFWS 1998).

Tidestrom's lupine seedlings in a restored area that was previously covered with European beachgrass

Indeed, removal of European beachgrass resulted in thousands of Tidestrom's lupine germinating in fall 2011 in the now-open sand areas created after European beachgrass was buried through "horizon flipping" (Johnson et al. 2012). These plants persisted through a relatively dry winter and scouring winds in the spring, and, by February 2012, the extent of Tidestrom's lupine totaled 15.8 of the 80 acres that were restored (Johnson et al. 2012). In fact, Tidestrom's lupine was one of the most successful recruiters into the newly restored habitat, with its extent far exceeding that of other species, including beach pea and bush lupine, which appear to be the second and third most successful species in terms of recruitment. Tidestrom's lupine appeared particularly adept at tolerating sand burial. By summer 2012, new Tidestrom's lupine plants totaled approximately 15,884 plants (Johnson et al. 2012), At least 25% of these plants actually flowered and set seed, setting the stage for potentially even more plants to establish in the second year after restoration (Johnson et al. 2012). In 2013, numbers of this perennial species within the restored area had increased slightly to approximately 20,552 individuals.

Flowering Tidestrom's lupine plants in a restored area

Similar expansions were observed during the 2004 30-acre mechanical restoration efforts near the mouth of Abbotts Lagoon. In spring 2005, 182 Tidestrom's lupine and 18 beach layia seedlings were found growing in the recently restored area (Rodgers 2006).

Alopecurus aequalis var. sonomensis (Sonoma alopecurus) – Endangered

Sonoma alopecurus is a federally endangered perennial grass restricted to permanent or seasonally flooded freshwater marshes. As of 2012, the Seashore supported eight out of only nine known extant populations of this plant (Ryan and Parsons 2012a). This includes populations of Sonoma alopecurus newly discovered in the Seashore in 2011 and 2014 (Ryan and Parsons 2012a, A. Ryan, NPS, *pers. comm*.). These eight populations are clustered in a small (4.6-square-mile) area between Creamery Bay and Abbotts Lagoon on the Point Reyes Peninsula and include freshwater wetlands that either fall within coastal dune systems (AT&T Dunes-Population #3) or directly adjacent to them (Abbotts Lagoon-Population #4, North Beach-Population #7).

Because of the low number of populations –and low density of plants within populations – USFWS recommended to the Seashore when it listed the species as endangered in 1997 that the park attempt to introduce at least three (3) new populations of Sonoma alopecurus. Sonoma alopecurus reproduces both through seed and clonally. In 2002, based on these recommendations, park staff conducted four reintroduction attempts at the Seashore, but no plants were found after a few years at any of these locations until NPS staff found plants in 2014 at Population #11 (A. Ryan, *pers. comm*.).

Sonoma alopecurus (Photo: Peter Baye)

Research conducted initially as part of the reintroduction attempt documented that soil moisture and hydrologic conditions were extremely important to at least initial success of reintroduced occurrences, but that other site factors – unidentified environmental or biological variables – seemed to have as strong, if not stronger, effects on preliminary success of outplantings (Gennet 2004). Because these factors may ultimately determine whether reintroduction attempts are successful, Gennet (2004) recommended that further work be conducted to better identify good habitat for future reintroduction attempts.

In addition to problems with introduction of new populations, viability of the remaining wild or natural populations also appears to be threatened. Numbers within five of the eight populations appear to be declining – and, in some cases, sharply declining – in recent years (Ryan and Parsons 2012a): stability of the three new populations is unknown, because they were just discovered. Inflorescence numbers within one of the larger populations (Population #3) have dropped by an order of magnitude (10X) since comprehensive monitoring was initiated, even though rainfall has been roughly normal or slightly above normal (Ryan and Parsons 2012a). Inflorescence numbers at Population #4 have also dropped dramatically during the last two years. Population #7, which occurs in a drainage swale on inland side of North Beach dunes, supported plants with 1,042 inflorescences in 2003, but, by 2010, numbers had dropped to only 18 inflorescences, and no inflorescences have been observed in this area in 2012 or 2013.

In general, for most of the populations, the cause of this decline is unknown, although grazing regime, including intensity and seasonality, may play an important role (Ryan and Parsons 2012a). Sonoma alopecurus typically occurs in freshwater marsh systems within historically grazed coastal grasslands or dune swales. Many rare plant species thrive in disturbed environments and expand by colonizing freshly disturbed areas. Grazing and other disturbance regimes benefit rare plants by decreasing cover and biomass of other species that would otherwise decrease light intensity for rare plant seedlings, create thatch that could interfere with rare plant seed germination, and increase competition for limited resources (Davis and Sherman 1992, Pavlovic 1994, Scanga and Leopold 2012).

Grazing may prove particularly important to this species now that many coastal grasslands have been invaded by non-native grasses such as common velvetgrass, many of which create dense monocultures through rapid spread by rhizomes and seeds. Gennet (2004) attempted to mimic the effects of grazing through vegetation clipping: she found a significant increase in Sonoma alopecurus seed output, although she also felt that grazing may be important during germination and seedling establishment stages, as well (Gennet 2004).

The potential importance of judicious grazing is evident from the history of some of the park's populations. Populations 1 and 2 and part of Population 5 were extirpated subsequent to the installation of fences that prevented cattle grazing (Ryan and Parsons 2012a). While reintroduction of grazing does not always revive dwindling populations – Population 1 did not revive when grazing was reintroduced 5 years after grazing removal – in 2010, plants were found in areas of Population 5 that had been reopened to grazing after being fenced off from cows for nearly 12 years (Ryan and Parsons 2012a). With the reintroduction of grazing, the number of plants in this newly grazed area initially increased exponentially, starting with only 37 inflorescences in 2012, 640 inflorescences observed in 2011 and 3,823 observed in 2012 (Ryan and Parsons 2012a). The portion of Population 5 that has been grazed continuously also had very high numbers in 2012: 2,738 inflorescences were tallied there, which is more than four times as many as have ever been recorded in that area (Ryan and Parsons 2012a). In 2013, numbers were lower, with a total of 1,643 inflorescences observed, 908 in the newly grazed area. Though 2013 numbers were lower than the previous year, this was still the second highest tally for the site ever.

Grazing is not the only factor that may affect this species, however. In one instance, one of the populations has been impacted by burial from sand movement following dune restoration. After decades of sand being accumulated by non-native invasive species such as European beachgrass, removal of beachgrass south of Abbotts Lagoon using mechanical methods has remobilized these sands, and they are now burying a drainage swale directly adjacent to the restored dunes where Population #4 occurs. Inflorescence numbers have varied considerably in this population even prior to restoration, with counts of 8,334 in 2003; 667 in 2004; 1,214 in 2005; 474 in 2008; 321 in 2009; and 1,273 in 2010 (Ryan and Parsons 2012a). Dune restoration was initiated in spring 2011, and later during that year, inflorescence numbers totaled 315 (Ryan and Parsons 2012a). Similar numbers of inflorescences were recorded in 2012 (304), however, by summer 2013, there were only four (4) inflorescences found in the drainage swale, which was now largely buried. In 2014, no inflorescences were found. A pilot project to construct a new drainage swale nearby was implemented in fall 2013, and additional restoration efforts are planned for fall 2015: the park hopes to introduce Sonoma alopecurus transplants from Population #4 genetic material to this constructed wetland starting in winter 2014.

Chorizanthe valida **(**Sonoma spineflower) **–** Endangered

Sonoma spineflower is a member of the Buckwheat family and is a small annual that grows on sandier grassland areas inland of coastal dune systems. It is thought to have originally occurred in both Marin and Sonoma counties and was, at one point, believed to be extinct as a result of agricultural and urban development. However, in 1980, the species was rediscovered in the Seashore south of Abbotts Lagoon in the same pasture at G Ranch in which the Abbotts Lagoon Sonoma alopecurus is located.

Sonoma spineflower (Photo: Doreen Smith)

Surveys since 1980 provide only coarse estimates of plant numbers: Monitoring of this species became more systematic over the last decade. Census and sampling data from 2005 to 2014 show this population has ranged widely in size, from 30,000 plants in 1993 to 960,500 plants in 2010: the last four years appear to be significantly lower in population size than peak estimates from 2009 and 2010 (NPS, unpub. data). Fluctuation in numbers may be related to sampling effort, detectability, and variations in area monitored, but may also be due to the fact that annual species can show great interannual variability in numbers (Pitt and Heady 1978, Levine et al 2008), especially, as in some systems, rare annual plants have been found to bank seeds until favorable years (Higgins et al. 2000, Levine and Rees 2004). Some recent analyses by the Seashore showed spineflower numbers to be at least partially related to weather patterns, with abundance negatively correlated with October-December (fall) rainfall, but positively correlated with April-June (spring) rainfall (Ryan and Parsons 2012b). In addition, earlier analyses by Seashore (Ryan and Parsons 2011) suggest that the phenological cycle and plant height of Sonoma spineflower appears to be strongly correlated with intensity of solar radiation.

One of the requirements for downlisting Sonoma spineflower is to establish and maintain two new populations (USFWS 1998). Since 1988, the park has conducted several reintroduction or introduction attempts in grazed pastures at G Ranch, F Ranch, and AT&T Ranch: These have had varying levels of success, but some have persisted for more than two decades.

While Sonoma spineflower occurs in grasslands inland of coastal dunes, it is located well outside the footprint for any project activities. None are located near B Ranch, A Ranch, Davis Property, North Beach, or near Limantour, and the one reintroduced location at AT&T is quite some distance from the dunes.

Listed Animal Species

Speyeria zerene myrtleae (Myrtle's Silverspot Butterfly) – Endangered


Myrtle's silverspot butterfly

Myrtle's silverspot is a medium-sized butterfly with a wingspan averaging 2.1 - 2.3 inches. This species inhabits coastal dune, coastal prairie, and coastal scrub habitats at elevations ranging from sea level to more than 600 feet and ranges as far inland as 3 miles (USFWS 1998). Two populations are believed to occur in the Seashore, along with several populations in coastal Sonoma County (USFWS 2009). Within the Seashore, it occurs in areas surrounding Drake's Estero, Drake's Beach, and north of Estero de Limantour; the Great Beach from north of South Beach to just north of Abbotts Lagoon; and Tomales Point from Marshall and Kehoe Beaches to White Gulch and just north of McClure's Beach.

A critical factor in the distribution of Myrtle's silverspot larvae is the presence of the larval host plant, western dog violet (*Viola adunca*). It is possible that, like other subspecies of *Speyeria zerene* and other species of silverspots, Myrtle's silverspot use other violet species as larval hosts, although this has not been observed (USFWS 2009). Western dog violet is found in grasslands, grassy areas within coastal scrub, and other habitats. The species does not occur in coastal dune systems, but typically in the grasslands adjacent to them, which could be used for staging, stockpiling, and access. While the violet is rather common in grasslands near the coast, distribution of the species is patchy (Launer et al. 1992). Abundance of western dog violet alone is not a good predictor of silverspot presence (Launer et al. 1992).

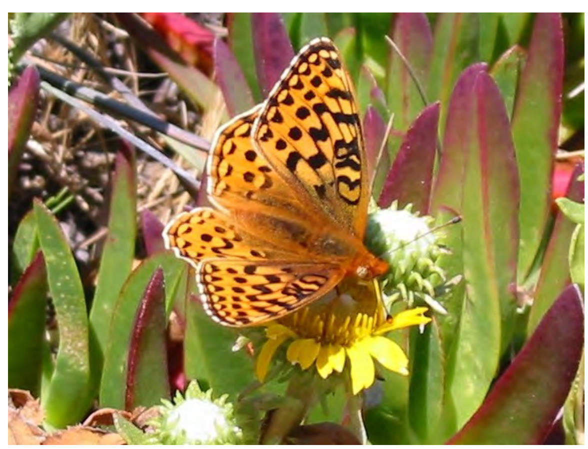
The emergence of adult butterflies from the larval stage typically occurs from mid-June to mid-July (USFWS 2009). Although Myrtle's silverspot adults only live for about two to five weeks, because of individual variation in emergence time the species has a 2- to 3-month flight period (USFWS 2009), ranging from mid-June to early October with the bulk of flight

Western dog violet

taking place during the period from June 15 to August 31. Eggs are laid singly by the female on dried leaves and stems of western dog violet, and within a few weeks of the eggs being laid, the larvae (caterpillars) emerge (USFWS 2009). Caterpillars crawl a short distance into the surrounding foliage or litter and spin a silk pad on which they spend the fall and winter (USFWS 2009). In the spring, the caterpillar finds a nearby violet and begins feeding for 7-10 weeks, after which the larvae form pupae (USFWS 2009). The adult butterfly emerges from the pupa after about two weeks (USFWS 2009).

Once the butterfly emerges, it begins looking for nectar sources. A 2002 study found that several dune plant species were preferentially foraged upon by Myrtle's silverspot, including, in order of preference: curlyleaf monardella, gumplant, seaside daisy, and yellow sand verbena (Adams 2004). Less used nectar species in the dunes included: yarrow, beach evening primrose, and mock heather (Adams 2004). In adjacent grasslands, butterflies frequented non-native plant species such as bullthistle (*Cirsium vulgare*) and, to a lesser extent, Italian thistle (*Carduus pynocephalus*) and rough cat's-ear (*Hypochaeris radicata*; Launer et al. 1992, Adams 2004). As a grass species, European beachgrass cannot provide nectar, and iceplant is not a documented nectar source for Myrtle's silverspot butterfly, either (Launer et al. 1992). In addition, these invasives form monotypic stands that exclude native dune plant species that provide nectar.

Myrtle's silverspot butterflies experience large population fluctuations, and increases of tenfold or more in a single year have been observed. A Stanford University (Center for Conservation Biology) study conducted in 1991 through 1993 using a mark/recapture survey method found that there were two separate populations of Myrtle's silverspot butterfly at the Seashore centered at Tomales Point and North Beach and that the North Beach population numbered at least 1,000, but fewer than 5,000, butterflies (Launer et al. 1992). Myrtle's silverspot butterfly population surveys were conducted again by the Center for Conservation Biology from 1994 to 1998 and again in 2001 (USFWS 2009). A small decline in overall numbers was observed up to 1998 and, but this trend apparently reversed in 2001, when higher numbers were observed (Adams 2004). Surveys of both the North Beach and Tomales Point populations in the park in 2002 and 2003 indicated 534 and 558 individuals, respectively, although slightly different census locations and methods were used (Adams 2004; G. Smick, WRA, *in litt in* USFWS 2009).



Myrtle's silverspot butterfly nectaring on gum plant (Photo Geoff Smick)

During surveys in 2011, butterflies were observed in all surveyed areas, with most of the butterflies found at AT&T and North Beach, a moderate number on the bluffs above Drake's spit, and a few at both Bull Point and Home Ranch (G. Smick, *pers. comm*.). In 2012, butterflies were again commonly observed in dunes closest to AT&T, but there were none near Abbotts Lagoon, similar to survey results from the original surveys in 2001-2002 (G.

Smick, *pers. comm*.). Lower numbers occurred in other surveyed park areas in 2012 (G. Smick, *pers. comm*.).

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This species was listed as endangered in 1992, with threats listed as habitat loss due to residential and commercial development, habitat degradation due to invasive alien plant species, and destructive agricultural practices (Launer et al. 1992). In the early 1990s, this species was characterized as being "not in immediate danger of extinction" (Launer et al. 1992), although no detailed censuses or monitoring have been conducted since 2003. The Stanford study suggested that managed grazing may be necessary to ensure establishment of larval host plants and nectar species in grasslands adjacent to dunes, but that use of grazing as a management tool in backdune areas would be inappropriate (Launer et al. 1992). The 2002-2003 study found that nectar source species richness was not significantly affected by grazing, but nectar source species density was greater within grazed areas, although the effects of grazing on the larval plant could not be determined (Adams 2004).

Within backdune areas, the butterfly would benefit more from iceplant removal and dune restoration than grazing, particularly in areas that still support high densities of native plant species that serve as nectar sources (Launer et al. 1992).

Rana draytonii (California Red-legged Frog) – Threatened

The California red-legged frog is the largest native frog in the western United States (Wright and Wright 1949 *in* USFWS 2002). The California red-legged frog once ranged across much of California, including portions of the Sierra Nevada Mountain Range, where it is believed to be the title character of Mark Twain's famed short story, "The Celebrated Jumping Frog of Calaveras County" (USFWS 2002). The name of this species derives from its belly and hind legs, which are often red or salmon pink in adults (USFWS 2002).

California red-legged frog (Photo: Seth Bunnell)

The California red-legged frog was federally listed as a threatened species in 1996. It has been completely extirpated from the floor of the Central Valley (Fisher and Shaffer 1996) and is nearly gone in both the Sierra Nevada foothills and in the southern quarter of its range (Fellers and Guscio 2002). In a few parts of the central Coast Range, there are still large, vigorous populations, some of which probably rival what was present 200 years ago (Fellers and Guscio 2002). Several robust populations still exist in the San Francisco Bay area (especially Alameda and Contra Costa Counties) and in the coastal drainages from San Mateo County (just south of San Francisco) south to Santa Barbara County (Fellers and Guscio 2002).

Some of the largest remaining populations in California are at the Seashore, where there are more than 120 breeding sites with a total adult population of perhaps a thousand frogs (Fellers and Guscio 2002). Most of the breeding sites are artificial stock ponds constructed on lands that have been grazed by cattle for 150 years (G. Fellers, U.S. Geological Survey (USGS), *pers. comm.*). Critical Habitat for this species was designated in 2005 and amended in 2010 and now includes three Critical Habitat Units in Marin County, one which encompasses most of the southern portion of the Point Reyes Peninsula with the other two being located on the east side of the Tomales Bay watershed (USFWS 2005).

California red-legged frogs in wetland vegetation (Photo: Seth Bunnell)

This species is threatened within its remaining range by a wide variety of human activities including urban encroachment, construction of reservoirs and water diversion, contaminants, agriculture, and livestock grazing (USFWS 2002). While bullfrogs have frequently been called a threat, or even a primary cause of the declines, there is almost no direct evidence that this is the case (Fellers and Guscio 2002), and it is at least as likely that non-native fish (e.g., striped bass, green sunfish, catfish, mosquitofish) play a significant role in the decline of native ranid frogs (Hayes and Jennings 1986).

Red-legged frogs require aquatic habitat for breeding, but also use a variety of other habitat types, including riparian and grasslands and other upland areas (USFWS 2002; G. Fellers, *pers. comm.*). Adults often utilize dense, shrubby or emergent vegetation closely associated with deep-water pools that pond at least 20 inches deep for at least six months (~ December through June) with fringes of cattails and dense stands of overhanging vegetation such as willows as breeding and rearing habitat (USFWS 2002). Near coastal dune systems, most of the frogs occur in freshwater marsh wetlands in adjacent grasslands, although frogs have also been detected during the breeding season in dune swale wetlands (USGS, unpub. data; NPS, unpub. data).

During the summer months, frogs will often move out of breeding habitat into adjacent riparian areas (Fellers and Kleeman 2007). Salinity can influence suitability of habitat for red-legged frogs (Fellers and Guscio 2002). Published tolerance criteria indicate that larvae and adults can tolerate salinity levels as high as 7.0 ppt, while eggs require salinities of less than 4.5 ppt (Jennings and Hayes 1990). However, anecdotal information from the Seashore and other areas along the coast suggest that frog populations, including egg masses and tadpoles, can persist in areas with some salinity, possibly because frogs are using pockets or lens of freshwater in otherwise saline environments.

While frogs have historically been documented mainly in more "freshwater" habitats, recent winter surveys conducted in 2013 found California red-legged frogs in 14 of the 19 drainages surveyed (Kleeman 2013). These frogs were located in both the grassland and dune portions of linear swales or drainages, with most of the frogs found in small pools along these drainages (Kleeman 2013). Should pools persist, some of these frogs may use these areas for breeding (Kleeman 2013). Near AT&T, North Beach, B Ranch, and A Ranch, frogs have been documented at five (5) sites in or immediately adjacent to the coastal dunes between Abbotts Lagoon and North Beach (G. Fellers, *pers. comm.*; Kleeman 2013). The closest red-legged frog occurrences to coastal dunes along Limantour Spit are natural and created freshwater marsh areas at Muddy Hollow, south of Limantour Pond, and in downstream sections of Coast Creek: frogs were also found historically in Limantour Pond (P. Kleeman, USGS, *pers. comm*.).

Charadrius alexandrinus nivosus (Western snowy plover) – Threatened

Western snowy plover
(Photo: Bruce Farnsworth)

The Pacific Coast population of the western snowy plover is federally listed under the Endangered Species Act of 1973 as threatened and is a Bird Species of Special Concern in California. In 2012, the USFWS revised Critical Habitat designations for western snowy plover, increasing Critical Habitat by approximately 12,377 acres from its 2005 designation (USFWS 2012).

Western snowy plovers breed primarily above the high tide line on coastal beaches, sand spits, dune-backed beaches, salt pond levees and river bars. In winter, they are found on many of the beaches used for nesting as well as on beaches where they do not nest, in man-made salt ponds, and on estuarine sand and mud flats. Roosting plovers usually site in small depressions in the sand, or in the lee of kelp, other debris or small dunes. When they are disturbed in winter, they typically run a few feet to a new location and may displace other birds. They tend to be social rather than territorial in the winter, and a flock may fly to a different location together when disturbed (USFWS 2007).

Snowy plovers forage on invertebrates in wet sand and surf-cast kelp within the intertidal zone, in dry sand areas above the high tide and along the edges of salt marshes and lagoons. They can probe sand for prey and pick insects of low-growing vegetation. Invertebrates associated with flowering dune plants can be an important food source for snowy plovers.

Western snowy plover nest
(Photo: Callie Bowdish)

Western snowy plovers use the Point Reyes peninsula as both wintering and nesting habitat. In addition to the Great Beach, wintering birds occur around Drake's Beach and Estero and along Limantour Spit. During the 1980s, nesting took place along the entire Great Beach, Drakes Spit, and Limantour Spit. Erosion along the southern portion of the Great Beach near Davis Property, B Ranch, and A Ranch during winter storms in 1994-1995 diminished the upper beach area such that the entire beach can be washed by waves. Nesting still occurs on the northern portion of the Great Beach between the North Beach parking lot and Kehoe Beach, which includes beach fronting AT&T and North Beach Dunes. Snowy plovers also occasionally nest along the western edge of Abbotts Lagoon. Nesting at Limantour Spit is limited by high spring tides, leaving much of the best nesting habitat inundated by water. Snowy

Table 3. Western Snowy Plover Nesting at Point Reyes National Seashore: 1986-2014

Year	Number of nests	Number of nesting birds	Number of chicks fledged	Percent chicks fledged
1986	41	41-44	8	7
1987	75	50-54	15	7
1988	65	40-42	5	3
1989	61	34-37	1	1
1995	20	12	4	7
1996	9	10-11	15	56
1997	25	25	25	40
1998	14	16	23	55
1999	21	20	24	39
2000	28	31-37	14	17
2001	34	27-36	10	12
2002	30	34-37	17	22
2003	22	23-25	19	30
2004	37	34-36	19	18
2005	19	19-21	17	32
2006	24	30-32	23	33
2007	28	30-32	24	29
2008	21	23-24	5	9
2009 2009	21	24	8	13
2010	15	14	7	17
2011	15	14	11	24
2012	7	9	9	43
2013	21	18	15	26
2014	44 (Aug. 2014)	NA	NA	NA

plovers have not nested at Limantour Spit since 2000, although 98 birds were counted during a winter survey in 2007 (USFWS 2012).

While observed snowy plover nesting between 2001 and 2014 has been limited to the northern portion of the Great Beach, the newly revised Critical Habitat designation from 2012 shows Critical Habitat Unit 10A as including all of the Great Beach and Critical Habitat Unit 10B including almost all of Limantour Beach (USFWS 2012). The USFWS classified the Great Beach as having the potential to support 50 breeding birds and Limantour Beach as having the potential to support 10 breeding birds with "proper management" (USFWS 2012). "Control of nonnative vegetation and enforcement of existing human-use regulations are needed to ensure the suitability" of both subunits (USFWS 2012).

Important components of Critical Habitat for plover – called primary constituent elements – include, but are not limited to: 1) areas that are below heavily vegetated areas or developed areas and above the daily high tides; 2) shoreline habitats for feeding with no or very sparse vegetation that are between annual low tide and annual high tide and that support essential food sources; 3) surf- or water-deposited organic debris such as seaweed or driftwood that provides substrates for food and cover or shelter from predators and weather; and 4) minimal disturbance from the presence of humans, pets, vehicles, or human-attracted predators.

Snowy plover monitoring data from the Seashore between 1977 and 1996 showed a decline in the number of nesting birds, dropping to only nine (9) nests in 1996. In 1987, 74 nests were counted. From 1996 to 2009, numbers ranged between 14 and 37 nests (Table 3). Starting in 2009, the number of nests dropped to 15 for two straight years and then dropped again in 2012 to seven (7) nests, the lowest recorded since monitoring was initiated (Hughey 2012; Campbell, *in press*). In 2013, nest numbers rebounded somewhat, climbing to 12, with 15 of 30 chicks fledged (Campbell, *in press*). Preliminary data from 2014 showed an even more incredible rebound in nesting numbers, with 44 nests initiated by August 2014 (C. Campbell, *pers. comm*.).


Docent with education materials

In 1995, a visitor education program to increase snowy plover nesting success was initiated, and this program continues to the present. This program was inspired by data showing that visitation could impact chick survival. Losses of chicks on beaches at the Seashore during weekends and holidays were 72% greater than expected in 1999 and 69% greater than expected in 2000 (Ruhlen et al. 2003). This visitor education program includes roping off sensitive habitat and posting signs to divert visitor traffic. Visitors are advised to avoid walking on upper beach areas used by plovers, and dogs are prohibited within the nesting area (North Beach parking lot to Kehoe Creek; NPS 2007 *in* NPS 2009). Despite this prohibition, illegal dog walking still takes place, and observers found a higher rate of snowy plover chick loss in these areas on weekends, when disturbance by humans and dogs is more likely (NPS 2000 *in* NPS 2009).

Starting in 1996, exclosures were placed over plover nests to reduce avian and mammalian predation. Since use of exclosures, the rate of chicks fledged per egg at Kehoe and North Beaches has increased from between 1% and 8% before 1996 to an average of 30% be-

Plover nest exclosure

tween 1996 and 2011 (Hughey 2012). In 2000, although egg laying remained high, fledging rate started to decline. Of the 36 chicks that were hatched in 2011, only 11 survived to fledging (Hughey 2012), and of the 15 chicks that were hatched in 2012, only nine survived to fledging (Campbell, *in press*). The USFWS has set a recovery goal of maintaining fledge rates of at least one chick per male to attain a sustainable population (USFWS 2007). Since 1996, the average rate at Kehoe and North Beaches has been 1.31 fledged chicks per male.

The Seashore has taken an adaptive management approach to snowy plover recovery by assessing results of previous management actions within Point Reyes and other plover breeding areas and adjusting approaches, when necessary. For example, following the lead of researchers in Oregon and Monterey Bay, the Seashore employed a more precautionary approach to the use of nest exclosures beginning in 2012. While nest exclosures are effective at increasing hatch rates, they run the risk of leaving the incubating adult at a greater risk for predation (Neuman et. al 2004). Video documentation from Oregon, for example, shows a plover taken by a great horned owl in the middle of the night that would likely have escaped predation had it not been for the flight restrictions induced by surrounding nest exclosure (D. J. Lauten, Oregon Biodiversity Information Center, *pers. comm*.). Plovers that lose nests during the breeding season will often re-nest. However, a lost breeding adult cannot be replaced, resulting in a greater impact to the population than a lost nest. With this in mind, the approach at Point Reyes is no longer to automatically exclose every nest discovered during the breeding season. Instead, nests are assessed for proximity to major visitor access points and the level of nearby predator activity before deciding to exclose nests. In some cases, exclosures may only be erected a few days before hatch in order to ensure protection during those last crucial days.

In addition to disturbance, plovers may also be adversely affected by invasive plant species. European beachgrass often encroaches further into beach and shore areas than native foredune species such as American dunegrass, and this encroachment directly impacts western snowy plover that use open beach areas for nesting (USFWS 2007; Zarnetske et al. 2010). The steepened foredunes also effectively restrict breeding snowy plovers to a much narrower strip of habitat between the high tide line and the lower edge of the dunes – the same narrow area of the beach used by visitors and dogs (Wiedemann 1987, USFWS 2007).

In terms of indirect effects, densely vegetated dunes provide cover for predatory animal species that feed on plover eggs and chicks (Stern et al. 1991 *in* USFWS 2007, USFWS 2007). Beachgrass also supports a lower diversity and abundance of sand-burrowing arthropods that are food sources for plovers, which often forage above the high tide line (Stenzel et al. 1981, Slobodchikoff and Doyen 1977). A recent study supported the correlation between increases in European beachgrass cover and decreases in plover nesting attempts, concluding that plovers preferentially select open habitats for courtship and nesting because they facilitate early detection of predators (Muir and Colwell 2010).

Removal of European beachgrass may positively affect the success of Western snowy plover nesting and fledging. Following a project conducted at Sunset State Beach in Monterey County between 2000 and 2003, western snowy plover increasingly used treatment areas as refugia for their broods (Ryan Degadio, *pers. comm. in* Hyland and Holloran 2005). During the 2004 restoration project at Abbotts Lagoon, a total of four Western snowy plover pairs and five plover chicks used the mechanical restoration for chick rearing: This was the first time that the plovers had used the more inland portion of these dunes since plover monitoring had commenced in 1972 (Peterson 2004). Normally, plovers confined themselves to the narrow strip of sand between the foredunes and the high tide line (Peterson 2004).

In 2011, after the foredune restoration component of the Abbotts Lagoon project was completed, plovers nested almost immediately directly adjacent to the restored area, with that one nest successfully fledging all three chicks (Hughey 2012). In fact, of the 11 chicks of 36 hatched that survived to fledging in 2011, almost half (5) ended up using the newly restored dunes at some point (Hughey 2012). In 2012, three (3) of the seven (7) nests initiated at the park were either in or directly adjacent to restored dune areas at Abbotts (Campbell, *in press*). In 2013, six (6) of the 21 nests during that season occurred in or directly adjacent to the restoration area (Campbell, *in press*). However, none of the nests in the restoration area successfully hatched, with only one of the adjacent nests hatching and fledging two chicks (Campbell, *in press*). Preliminary data from 2014 showed a dramatic turnaround with 20 of the 45 nests established in the restoration area or directly adjacent. Ten (10) of the 20 nests hatched, but only three of the nests fledged or came close to fledging chicks (Campbell, *in press*).

While restoration results seem promising, other factors also have a role in determining this species' abundance within the park. An extensive review of monitoring results from European beachgrass removal by repeated treatment of foredune areas and other snowy plover management measures conducted over 20 years along 311 miles of coastline in Oregon and Washington found that most plover metrics responded positively to a combination of treatment techniques (Zarnetske et al. 2010). Mean fledglings per male, number of nests, and exclosed nest success rate were all considerably above null mean values, while unexclosed nest success rate was not sufficiently higher than null means (Zarnetske et al. 2010). In general, this study found little evidence to support any one particular type of management technique (i.e., European beachgrass removal, increasing habitat area, nest exclosures, predator control, addition of human patrols, increased signage and fencing, and public education (Zarnetske et al. 2010).


Male Western snowy plover with chicks (Photo: Callie Bowdish)

Removing European beachgrass increased plover populations, however, plover recovery was not correlated with the reduction in European beachgrass following the first removal event, which suggests that plover recovery likely depends on a combination of repeated beach grass removal over time, and other measures such as predator control, nest exclosures, and human patrols (Neuman et al. 2004, Lauten et al. 2006, USFWS 2007 *in* Zarnetske et al. 2010). Higher nest success rates did correlate with more hectares and a higher proportion of natural habitat (Zarnetske et al. 2010). From these results, it appears that plovers are more likely responding to the result of the European beachgrass removal – more bare ground and less vegetation – than the type of removal. Measurements of vegetation cover in European beachgrass removal areas (1–18%) were similar to those in preferred plover nesting habitat in California (6–18% vegetation cover (Powell et al. 1995, 1996 *in* Zarnetske et al. 2010), suggesting that plovers are responding to the overall barren ground, with some vegetation left for brood cover. However, if areas are too devoid of vegetation after restoration, there may not be enough cover for plovers or plants to support an invertebrate prey community (D. Press, NPS, *pers. comm*.). Native dune areas at Abbotts supported approximately 34% vegetation cover in 2013, while the mechanically restored areas had only slightly more than 1% cover on average (NPS, unpub. data).

Despite over 15 years of protection and restoration, the breeding population of snowy plovers at Point Reyes does appear to have continued to steadily drop since monitoring was first initiated. In some cases, these population trajectories are reflective of more widespread trends: Breeding plover numbers also fell between 2011 and 2012 at Monterey Bay and in lower San Francisco Bay, as well (USFWS 2013). A variety of factors may be influencing the snowy plover population at Point Reyes. Factors such as winter survival rate – during which plovers are exposed to storm events and physical stress endured while traveling to wintering beaches – are beyond the control of resource managers.

Oncorhynchus mykiss (central California coast steelhead) Threatened

Because of dramatic declines in population numbers, NMFS listed central California coast steelhead as threatened in 1997 (NMFS 1997). Only winter steelhead occur in the central California coast ESU (61 FR 41541–41561). Generally, the adults start to enter rivers from October (in larger basins) through late November (in smaller basins) and may be present in streams through June. Locally, adult spawning begins in December/January (depending on flow) and can continue through April, with a peak in February and March. Because little additional life-history information exists for this steelhead ESU, the following life-history information is summarized from Shapovalov and Taft (1954 *in* PRNS 2005), which conducted one of the most comprehensive investigations of steelhead life history as part of studies conducted on Waddell Creek in Santa Cruz County.

Steelhead juveniles

Adult steelhead leave the ocean to migrate up coastal streams and inland rivers with high flows from early November through early May, although the majority probably enter fresh water from late December through late April. The timing and rate of migration depend on several factors, including stream discharge and water temperatures. Spawning can occur either shortly thereafter or some time later, depending on the sexual maturity of the fish, but probably peaks from January through March. Adult steelhead spawn in shallow redds (nests) constructed in relatively clean, loose gravels, typically at the ends of pools and at the heads of riffles that have appropriate water depths and velocities. Unlike all Pacific salmon, which die after spawning, adult steelhead are capable of returning to the ocean after spawning, typically by June of that same year (Shapovalov and Taft 1954.)

Steelhead eggs incubate in the gravel and hatch after about 19 days in 60°F water and in about 80 days at 40°F. The average incubation period is approximately 4–6 weeks. After hatching, the young fish (alevins) remain in the gravel for an additional 2–6 weeks before emerging and taking up residence in the shallow margins of the stream. The juvenile fish feed primarily on aquatic and terrestrial insects for periods ranging from less than 1 year to 4 years. Most juvenile steelhead spend 1–3 years in fresh water before emigrating to the ocean as smolts (Shapovalov and Taft 1954.)

Steelhead smolt, those juveniles developed sufficiently to live in saltwater, typically migrate to the ocean as flow declines and water temperature increases in April, May, and June. Before their downstream migration, juveniles undergo physiological changes (smoltification) to prepare them for life in the saltwater of the ocean. Steelhead live in the ocean for 1–3 years before maturing and returning to fresh water to spawn.

Because juvenile steelhead rear year-round in fresh water, adequate flows and water temperatures and an abundant food source are necessary throughout the year to sustain steelhead populations. Conditions adequate to sustain steelhead populations are especially important during summer, when declining flows could reduce habitat availability, water temperatures might exceed the species' tolerance levels, and rearing juveniles experience increased competition for living space and food.

The central California coast steelhead inhabits river basins from the Russian River, California (inclusive), to Aptos Creek and the drainages of San Francisco and San Pablo Bays (62 FR 159). The abundance of steelhead populations in the Russian and San Lorenzo Rivers is estimated to be less than 15% of that numbers that occurred in the 1960s. Comparable data are not available for other streams in which this ESU occurs, but recent population estimates for Lagunitas, Waddell, Scott, San Vicente, Soquel, and Aptos Creeks suggest that run sizes are 500 fish or fewer in these streams (62 FR 159). Steelhead populations in most tributaries to San Francisco and San Pablo Bays have been extirpated (McEwan and Jackson 1996 *in* PRNS 2005).

Most of the streams in the vicinity of coastal dunes known to support steelhead are in the Limantour and Drake's Estero area and include East Schooner, Home Ranch, Glenbrook, Muddy Hollow, and Laguna Creeks. While only anecdotal observations of ocean-run steelhead have been made in these watersheds, historic photos confirm that they were common into the mid-1900s. It is likely in some of Limantour/Drake's Estero watersheds that reproduction is accomplished by resident steelhead in the system (PRNS 2005). For example, the persistence of steelhead fry in the Glenbrook Creek upstream of the 11-foot culvert outfall is indicative of resident reproduction (PRNS 2005). There have not been any genetic assessments in coastal streams or the Limantour/Drake's Estero area to determine the percentage of ocean-run vs. resident reproduction.

Critical Habitat for the federally threatened central coast steelhead salmon population went into effect in January 2006 and is designated to include river and stream reaches and estuarine areas accessible to listed steelhead in coastal river basins from the Russian River to Aptos Creek, California (inclusive), and the drainages of San Francisco and San Pablo Bays. In Tomales and Drake's Bays, Critical Habitat does not include areas upstream of Peters Dam, Seeger Dam, and Soulajule Dam. The only designated Critical Habitat areas in the vicinity of the Seashore's coastal dunes are Muddy Hollow Creek and Coast Creek.

Oncorhynchus kisutch (Coho salmon – central California coast; Threatened) ***Oncorhynchus tshawytscha*** (California coastal chinook; Threatened)

Central California coast coho salmon and coastal California chinook have not been documented within streams near the Seashore's dunes, although coho are present in larger watersheds draining to Tomales Bay and Bolinas Lagoon. Coho salmon spawn in Olema Creek,

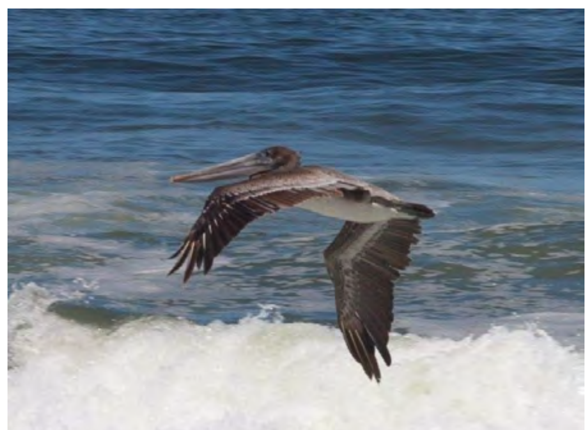
Coho Salmon (Photo: J. Weinberg, NPS)

Lagunitas Creek, Devil's Gulch, and San Geronimo Creek (NDDB 2000 *in* PRNS 2005) and are found as well in Pine Gulch Creek, which drains to Bolinas Lagoon. Fish surveys conducted in Limantour and Muddy Hollow watersheds in 2002 did not find either coho or chinook species present (PRNS 2005).

Critical Habitat for coho salmon was designated in 1999. Critical Habitat is designated to include all river reaches accessible to listed coho salmon from Punta Gorda in northern California south to the San Lorenzo River in central California, including certain tributaries to San Francisco Bay. Excluded are areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Designated Critical Habitat for coho in the Seashore includes all accessible estuarine and stream areas in the coastal watersheds of Marin County except areas above longstanding and naturally impassable barriers or above Peters Dam on the mainstem of Lagunitas Creek and Seeger Dam on Nicasio Creek (NMFS 1996). Critical Habitat has not been designated in Marin County for the California Coastal chinook salmon.

Pelecanus occidentalis californicus
(California brown pelican) Delisted

The California brown pelican is one of six recognized subspecies of brown pelican. The brown pelican is found in estuarine, marine subtidal, and marine pelagic waters along the California coast. This species is present in the summer, fall and winter on open water bodies such as Abbotts Lagoon where it roosts, feeds and bathes, but does not occur within the dunes themselves.



Brown pelican (Photo: Jim Rolka)

Sternula antillarum (=***Sterna***, = ***albifrons***) ***browni*** (California least tern) Endangered

The California least tern is an extremely rare fall migrant that is unlikely to occur within any of the potential restoration areas. The least tern uses tidal flats like those on the southern end of the lowest lobe of Abbotts Lagoon for roosting and forages over open water.

Empidonax trailii (Willow flycatcher) - all subspecies state endangered; ***extimus*** subspecies also federal endangered.

This is a rare migrant to certain areas of the park, including near Abbotts Lagoon, and is present primarily in August, if at all. The willow flycatcher is an open brush, coastal scrub species that finds habitat at or near the coast. This species utilizes open riparian edges, fields, shrub or dune habitats and has been reportedly observed in shrub-dominated edges of the Limantour Dunes.

Plant Species of Concern

In addition to the federally listed plants described earlier, the park's database includes 12 other rare plant species that are known to occur within coastal dunes that are either listed by the state of California or by organizations such as CNPS. Most individuals or colonies of these plants occur in native dune mat (see *Vegetation Resources*), although some occur in wetlands or adjacent grasslands.

Pink sand verbena (Photo: Doreen Smith)

Abronia umbellata var. breviflora (pink sand verbena; CNPS List 1B.1) is a perennial herb that is native to the dunes of California, Oregon, and Washington and is stated listed in Oregon as endangered (CNPS 2013). Marin is its southernmost extent in California (CNPS 2013). Most occurrences have few plants (CNPS 2013). It is much more uncommon in the Seashore than its congener, yellow sand verbena. This species is threatened by vehicles, non-native plants, and foot traffic (CNPS 2013). Pink sand verbena has been documented along Limantour Spit, at Davis Property, and at A Ranch.

Agrostis blasdalei (Blasdale's bent grass) is considered "fairly endangered" in California by CNPS (CNPS List 1B.2; rare, threatened, or endangered in CA and elsewhere; CNPS 2013). It grows in several central and northern California coastal locations, with Point Reyes being near or at its southern extension. It is a coastal bluff, dune, or grassland species and blooms in late spring and early summer. A combination of agricultural and recreational impacts and competition from non-native plants has adversely affected this species, and fewer than 15 occurrences are known in the state (CNPS 2013). Populations of Blasdale's bent grass have been documented historically inland of the North Beach parking lot, the very northern end of the AT&T Dunes, on the boundary with G Ranch at Ammophila Mountain, as well as near the AT&T facility and access road between the 1940s and 1980s. Recently, there was an unconfirmed report of this species occurring in the grasslands bordering the dunes.

Blennosperma nanum var. robustum (Point Reyes Blennosperma; CNPS List 1B.2) is a California endemic that grows in coastal prairie, coastal scrub, or wetland-riparian communities and blooms in spring (February through April; CalFlora 2013). There are 17 occurrences known in the state (CNPS 2013). This species is threatened by competition and foot traffic and also possibly by grazing and trail construction (CNPS 2013). Point Reyes blennosperma has been documented at wetlands in the pasture and within the dunes at A Ranch, but not within the vicinity of the AT&T, North Beach, Davis Property, B Ranch, or Limantour dunes or access areas.

Erysimum concinnum (bluff wallflower; CNPS List 1B.2) is a perennial herb that was just recently listed in 2012 by CNPS. It is native to California and is found only slightly beyond California borders (CalFlora 2013). It occurs in dunes and northern coastal scrub and blooms in spring (February through April; CalFlora 2013). There are 30 occurrences known in the state (CNPS 2013). Point Reyes supports one of the largest remaining populations, but this population and others may be of hybrid origin (CNPS 2013). This species is threatened by development, habitat loss, competition, and non-native plants (CNPS 2013). Bluff wallflower has been observed at many of the project area dunes.

Bluff wallflower

Gilia capitata spp. chamissonis (blue coast gilia) is a California endemic that is considered seriously endangered in California by the CNPS (CNPS List 1B.1; rare, threatened, or endangered in California and elsewhere; CNPS 2013), although the species does not have federal or state listing status. It has been found at several spots in and around Point Reyes, as well as other locations in Marin, San Francisco, and Sonoma counties (CNPS 2013). It grows in coastal dunes and coastal scrub and is considered threatened by urbanization, recreational development, and non-native plants (CNPS 2013). This species occurs at AT&T, North Beach, Davis Property, B Ranch, and A Ranch.


Blue coast gilia

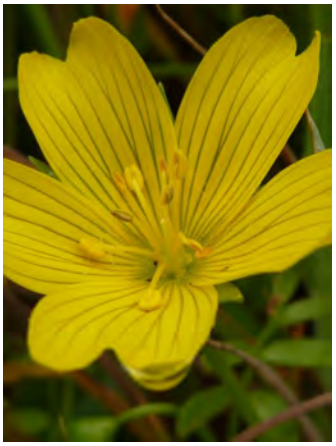
Gilia millefoliata (dark-eyed gilia or yarrowleaf gilia) is ranked as List 1B.2 by the CNPS (2008). It is one of a host of coastal dune plant species that has undergone significant declines in distribution and abundance within north-central and central coast dune systems (USFWS 1998). It occurs along the coast from San Francisco County north to the Oregon state line. It is listed as endangered in Oregon and is adversely affected by development, vehicles, foot traffic, grazing, and non-native plants (CNPS 2013). This species has been mapped as present at AT&T, North Beach, and Davis Property.

Hesperevax sparsiflora var. brevifolia (short-leaved evax) occurs from Santa Cruz County north to Del Norte County in coastal bluff scrub and coastal dune habitat. It is listed as CNPS List 1B.2 (2013), although it is more common elsewhere. Actions such as logging, development, foot traffic, and competition with non-native plants have contributed to its scarcity (CNPS 2013). This species has not been mapped in the dunes within any of the project areas, although it may occur in the AT&T pastures based on presence in adjacent grasslands.


Point Reyes horkelia

Horkelia marinensis (Point Reyes horkelia) is a California endemic perennial herb considered rare, threatened, or endangered in California and elsewhere (CNPS List 1B.2; CNPS 2013). It occurs in Santa Cruz County north to Mendocino County in coastal dune, scrub, and prairie and blooms from May to September. It is known from fewer than 20 occurrences and is affected by non-native plants and residential development (CNPS 2013). This species has not been mapped in the dunes within any of the project areas, but it does occur in the grasslands or pastures adjacent to the AT&T and North Beach dunes.

Leptosiphon rosaceus (rose leptosiphon), formerly known as *Linanthus rosaceus*, is an annual herb that grows in coastal grasslands and coastal bluff scrub in Marin and surrounding counties. Is it considered rare, threatened, or endangered in California and elsewhere (CNPS List 1B.1) and is possibly threatened by competition with native and non-native plants (CNPS 2013). It has been mapped in the northern end of AT&T at the boundary with G Ranch at Ammophila Mountain, in the pastures adjacent to AT&T, North Beach, and A Ranch, and in the northern portion of B Ranch.


Point Reyes meadowfoam

Limnanthes douglasii var. sulphurea (Point Reyes meadowfoam) is a California endemic annual herb that is listed by the state as endangered and by CNPS as List 1B.2 (CNPS 2013). It occurs in coastal prairie, meadows, freshwater marshes, and vernal pools in Marin and San Mateo Counties. There are 12 remaining populations, which are threatened by grazing, trampling, and non-native plants (CNPS 2013). As mentioned earlier, this species has been mapped historically at dune swale wetlands in A and B Ranches and in wetlands within the pastures at B Ranch, Davis Property, and A Ranch.

Monardella sinuata* ssp. *nigrescens (formerly *undulata*; curlyleaf monardella) has limited distribution in California, where it is endemic (CNPS List 1B.2-Proposed; CNPS 2013). While it is considered as occurring in a variety of habitats, including coniferous forest, coastal dune, coastal prairie, and coastal scrub, at the Seashore, it is almost exclusively found in coastal dunes and would be considered one of the most abundant dune rare plant species next to Tidestrom's lupine and beach layia. It is one of several species considered by the USFWS to have experienced "significant declines," and agencies are instructed to incorporate it into restoration and management plans (USFWS 1998). This species occurs at many coastal dune sites in the Seashore, including AT&T, North Beach, Davis Property, B Ranch, and A Ranch.


Curly-leaved monardella

Perideridia gairdneri spp. gairdneri (Gairdner's yampah) is a California endemic perennial herb that is considered to have limited distribution in California (CNPS List 4.2; CNPS 2013). Occurrences have been found in several coastal and near coastal counties from San Diego to Del Norte County. It occurs in chaparral and grassland habitat, including coastal prairie. It can be relatively common in some locales, although it is rarer in the southern portion of its range. Agriculture, grazing, urbanization, habitat alteration and non-native plants threaten this species (CNPS 2013). This species has been mapped in the pastures adjacent to North Beach, but not in or near any of the other project areas.

Other Species: Several other rare plant species can occur either adjacent to or in coastal dune systems within the Seashore. In addition to Sonoma spineflower (*Chorizanthe valida*) discussed earlier, there are two species of *Chorizanthe cuspidata* – San Francisco spineflower (var. *cuspidata*; CNPS List 1B.2) and woolly headed spineflower (var. *villosa*; CNPS List 1B.2). These spineflowers are one of several coastal dune plant species in north-central or central California dune systems that have undergone significant declines but are not listed (USFWS 1998). Like other *Chorizanthe* species, these spineflowers occur on sandy substrates, and the woolly headed spineflower can be found at AT&T, North Beach, Davis Property, and B Ranch, particularly in more backdune or transitional dune habitats near grasslands.

Within adjacent grasslands or coastal scrub or wetlands within these grasslands can be found occasionally other rare plant species, including Point Reyes checkerbloom (CNPS List 1B.2), swamp harebell (CNPS List 1B.2), Thurber's reed grass (CNPS List 2.1), and beach starwort (*Stellaria littoralis*; CNPS List 4.2). Point Reyes checkerbloom grows in freshwater swales near the coast, including in wetlands directly adjacent to dune systems, and is threatened by non-native plants (CNPS 2013). It occurs in Mendocino, Marin and Sonoma counties (CNPS 2013). Swamp harebell and Thurber's reed grass grow in freshwater marshes and also occur in Marin, Sonoma, and Mendocino counties, as well as in a few other locations (CNPS 2013). Beach starwort ranges from San Francisco to Humboldt counties in California and is threatened by grazing, trampling and non-native plants (CNPS 2013), although, within the Seashore, it is quite common. Point Reyes checkerbloom occurs at AT&T, North Beach, and Davis Property, while swamp harebell can be found at AT&T, North Beach, and B Ranch wetlands. Thurber's reed grass also occurs in wetlands within AT&T pastures.

At Limantour, dunes often adjoin coastal salt marsh habitats. At the Seashore, these salt marsh habitats can support several rare plant species, including Point Reyes bird's-beak (*Chloropyron maritimum* ssp. *palustre*; CNPS List 1B.2). This annual species has been documented in fringing salt marshes of Estero de Limantour.

Species that occur in drier grassland areas are San Francisco owl's-clover (*Triphysaria floribunda*; CNPS List 1B.2) and Bodega morning glory (*Calystegia purpurata* ssp. *saxicola*; CNPS List 1B.2). These two species generally occur in San Francisco Bay region and counties north and are threatened by a variety of impacts, including grazing, development, non-native plants, and trampling (CNPS 2013). San Francisco owl's-clover has been mapped at AT&T, pastures adjacent to North Beach, Davis Property, B Ranch, and A Ranch, and coastal scrub areas adjacent to Limantour Spit, while Bodega morning glory is recorded from B Ranch.

Animal Species of Concern

Animal species that are not listed, but that are rare, sensitive, or otherwise of concern that may be present in coastal dune systems at the Seashore include mostly invertebrates and birds. Bird species of concern are noted in Table 4.

Point Reyes jumping mouse (Zapus trinotatus). The Point Reyes jumping mouse is a species of concern listed by the state of California. The isolated population at the park is a race of a more widely spread Pacific jumping mouse and is at the far southern end of its range: The larger population extends north to southwest British Columbia. The jumping mouse occurs in a wide variety of habitats at Point Reyes, including coastal meadow, thickets adjacent to riparian areas, mixed grasslands/coastal scrub, and lupine-dominated coastal scrub. Several dead jumping mice have been found along the Abbotts Lagoon Trail (G. Fellers, *pers. comm*.). Near dunes, mice would be expected to occur at the interface between dunes and grasslands (G. Fellers, *pers. comm*.).

Several insects and other invertebrates are found in dune habitats in the Seashore. Rare species include globose dune beetle (*Coelus glubosus*), sandy tiger beetles (*Cicindela hirticollis gravida*), and bumblebee scarab beetles (*Lichnanthe ursine*), as well as possibly the Point Reyes blue butterfly (*Icaricia icarioides parapheres*).

Globose Dune Beetle (Coelus glubosus). The globose dune beetle is a primarily subterranean beetle that inhabits California's coastal dune systems. The adults, which lack functional wings, tunnel through the sand underneath dune vegetation, usually in foredunes within 100 feet of the wave wash zone. The dune beetles leave a distinct track on the beach that resembles a labyrinth. The dune beetle is fairly easily found in loose sand near the base of rooted plants and less so away from plants that stabilize the dune and is relatively common (G. Fellers, *pers. comm*.).


Tiger beetle (Photo: Ken-ichi Ueda)

***Tiger Beetles (Cicindela spp*.).** Tiger beetles are winged as adults and run and fly rapidly. They have distinct, sharp mandibles that they use to prey on other beetles, flies, caterpillars, ants, grasshopper nymphs, and spiders. Adults escape predation by other tiger beetles, birds, and small vertebrates by running, flying, using their sharp mandibles, and secreting a foul odor. The tiger beetle is a fast diurnal flyer and can move considerably within dunes, probably spending most of its time in the stabilized portions of dunes, particularly where soils are moist (G. Fellers, *pers. comm*.). The spatial extent of this species is unknown, but it has been documented near North Beach (G. Fellers, *pers. comm*.).

Bumblebee Scarab (Lichnanthe ursine). The life history of the bumblebee scarab beetle has been poorly documented. In general, adults are often brightly colored, bristly, diurnal, and strong fliers. Many resemble bumble bees or metallic bees due to colored bands on the abdomen and have been observed visiting flowers. The larvae live in sandy areas such as riparian areas and coastal dunes, feeding on decaying leaf litter and detritus in the sand.

Point Reyes Blue Butterfly (Icaricia icarioides parapheres). The Point Reyes blue butterfly is found only on the Point Reyes Peninsula. Its habitat is stabilized sand dunes with bush lupine and manycolored lupine, the probable host plants. The adult flight period is from mid-April to mid-July. Although they were not seen in a 1995 survey at Abbotts Lagoon, they have been reported there in the past and probably still occur there (G. Fellers, *pers. comm*.).

WILDLIFE


Terrestrial garter snake in dunes (Photo: Seth Bunnell)

The incredible geologic, hydrologic, and floristic diversity within the Point Reyes region has led to a tremendous diversity in the wildlife that use or visit this area. The juxtaposition between the marine environment of the Pacific Ocean and the terrestrial environment of the rugged Marin coastline, combined with the sheltered estuarine environment of Drake's Estero, Estero de Limantour, Tomales Bay and other embayments, translates into an amazing breadth of habitat types or ecological niches for animals. It is largely because of this habitat diversity that Point Reyes has become world-renowned for its importance to marine, estuarine, and terrestrial wildlife species.

Point Reyes falls within the United Nations Educational, Scientific, and Cultural Organization (UNESCO)-designated Golden Gate Biosphere Reserve, a partnership of 13 protected areas in the larger San Francisco Bay region. Largely because of its importance to wildlife, Tomales Bay has been designated as a Wetland of Inter-

Table 4. Rare Birds With Potential to Occur near Coastal Dunes in the Seashore		
Common name	**Latin name**	**Status**
American White Pelican	*Pelecanus erythrorhynchos*	CDFW: BSSC
Tule Greater White-fronted Goose	*Anser albifrons elgasi*	CDFW:BSSC
White-tailed Kite	*Elanus leucurus*	CDFW:FP
Merlin	*Falco columbarius*	CDFW:WL; IUCN:LC
Ferruginous Hawk	*Buteo regalis*	CDFW:WL
Short-eared Owl	*Asio flammeus*	CDFW:BSSC
Northern Harrier	*Circus cyaneus*	CDFW:BSSC
Burrowing Owl	*Athene cuniculata*	CDFW:BSSC
Allen's Hummingbird	*Selasphorus sasin*	IUCN:LC
California Horned Lark	*Eremophila alpestris ctia*	CDFW:WL; ICUN:LC
Saltmarsh Common Yel-lowthroat	*Geothlypis sinuosa*	CDFW:BSSC
Black Brant	*Brant bernicla*	CDFW:BSSC
Elegant Tern	*Thalasseus elegans*	USFWS:BCC
Buff-breasted Sandpiper	*Tryngites subruficollis*	USFWS:BCC
Pacific Golden Plover	*Pluvialis fulva*	USFWS:BCC
Marbled Godwit	*Limosa fedoa*	IUCN:LC
Western Sandpiper	*Calidris mauri*	SCP:SHC
Pectoral Sandpiper	*Calidris melanotos*	SCP:SLC
Baird's Sandpiper	*Calidris bairdii*	SCP:SLC
Peregrine Falcon	*Falco peregrines anatum*	Federal delisted; State candi-date for delisting

CDFW: California Department of Fish and Wildlife; USFWS=U.S. Fish and Wildlife Service; IUCN=The World Conservation Union; SCP=Shorebird Conservation Plan

BSSC: Bird Species of Special Concern; FP=Fully Protected; WL=Watch List; LC=Least Concern; BCC=Birds of Conservation Concern; SHC=Species of High Concern; SLC=Species of Low Concern national Importance by the Ramsar Convention and is one of only 22 sites in the United States with this designation.

Within the coastal waters directly offshore of Marin County, there are four of California's 34 Areas of Special Biological Significance (ASBS) and two of only 11 national marine sanctuaries in the United States, with the boundaries for the Gulf of the Farallones National Marine Sanctuary actually extending into Tomales Bay. In some ways, this recognition of the value of Point Reyes to wildlife reflects the larger importance of California, which has been recognized as only one of two Biodiversity Hotspots within the continental United States by Conservation International (2013). The entire central California area, including the San Francisco Bay region, was characterized as one of the highest, if not the highest, ranked regions in terms of being a Hot Spot of Species Rarity and Richness by NatureServe (2000).


Black-tailed jackrabbit (Photo: Seth Bunnell)

This biodiversity is evident in the number of species that use this area or call it home. The Point Reyes region supports 28 species of reptiles and amphibians, 58 species of mammals, and breeding habitat for 123 species of birds (NPS IRMA 2013). Approximately 488 bird species – representing 45 percent of the avian fauna documented in the United States – have been sighted on land and over near shore waters at Point Reyes based on "A Field Checklist of the Birds of the Point Reyes National Seashore" (Stallcup 2006 *in* Evens 2008). The Point Reyes Peninsula has more varieties of birds than 37 other individual states and provinces in North America (WildBirds 2012). Point Reyes, Tomales Bay, and other open water areas on the Marin coast are important stops for migratory species on the Pacific flyway and provides important alternate habitat for birds using San Francisco Bay, the largest estuary in California.

Some of what draws overwintering and migrant bird species, as well as resident wildlife, are the richness and diversity of aquatic life within the waters of the Pacific Ocean, Tomales Bay, Abbotts Lagoon, Drake's Bay, and other estuaries. Tomales Bay represents the second largest Pacific herring spawning estuary in California (Spratt 1976) and supports 10% of the remaining wild coho salmon (*Oncorhynchus kisutch*) populations along the central California coast (Brown et al. 1994). These resources attract several hundred seals and sea lions every winter that come here to pup. Point Reyes is one of only four primary mainland breeding areas worldwide for northern elephant seals (*Mirounga angustirostris*: LeBoeuf et al. 2011) and provides haul-out and pupping areas for a sizeable number of the mainland California population of harbor seals (*Phoca vitulina*; Lowry and Carretta 2003). One of the pupping and haul-out spots for harbor seals occurs at the very tip or western end of Limantour Spit.

In general, fauna of coastal dunes is more diverse than that of their inland desert counterparts (McLachlan 1991). As with other physical and biological attributes, the diversity and type of wildlife within coastal dunes can shift along the ocean-inland gradient, with insects, vertebrates, and interstitial fauna increasing in abundance landwards as vegetation height, cover, and diversity, as well as soil complexity, increases (McLachlan 1991). There may be a shift from small mammals to birds along this ocean-inland gradient, and species that show dramatic population fluctuations from year-to-year (r-strategists) may be more prevalent near the beach than those with more steady populations year-to-year (k-strategists; McLachlan 1991).

No systematic inventory of wildlife in the Seashore's coastal dunes has been performed, although some information on mammals and some lizards and snakes exists from an inventory at North Beach (Fellers and Pratt 2002). Anecdotal observations of wildlife at or near coastal dunes were also used to compile this description, particularly observations from wildlife monitoring conducted before and during the Abbotts Lagoon Coastal Dune Restoration Project. Based on this monitoring and the above referenced terrestrial invertebrate inventory (Fellers and Pratt 2002), the dunes would appear to support a lower diversity and abundance of wildlife than many other habitats at Point Reyes.

Terrestrial mammals throughout the dunes are likely similar to those reported by Fellers and Pratt (2002) for a dune site vegetated with non-native iceplant south near North Beach. Fewer species of small vertebrates were found at this site – and at the heavily grazed pasture site – than any of the other sites: the number of small vertebrates per site ranged from only seven (7) at the dunes and heavily grazed pasture sites to 15 at the scrub sites (Fellers and Pratt 2002).

Based on results of small mapping trapping and photographs of mid and larger-sized mammals at this dune system, the Seashore's dunes likely support a few small mammal species, including a low number of Trowbridge's shrews (*Sorex trowbridgii*), western harvest mice (*Reithrodontomys megalotis*), and vagrant shrews (*Sorex vagrans*). An earlier study at AT&T dunes (Pitts and Barbour 1979) and the 2002 study also both found evidence of a high number of deer mice (*Peromyscus maniculatus*), with numbers much higher in areas vegetated with European beachgrass and rush (*Juncus*; Pitts and Barbour 1979): Pitts and Barbour hypothesized that European beachgrass may provide a more stable substrate for nesting. The prevalence of deer mice within iceplant stands has been less well studied, but this species was also frequently caught in traps within dense iceplant (Fellers and Pratt 2002). As discussed under *Vegetation*, these mice are implicated in the much higher rates of seed predation and lack of reproductive success found for the federally endangered dune plant, Tidestrom's lupine, occurring near beachgrass stands (Dangremond et al. 2010).

Song sparrow on yellow bush lupine

The Fellers and Pratt inventory (2002) found one reptile at the North Beach Dunes – alligator lizard (*Elgaria* sp.) – at very low densities. Garter snakes, treefrogs, California red-legged frogs occupy wetter habitat on the site as well. During the Abbotts Lagoon dune restoration project in 2011, a number of amphibians and reptiles were observed by biological monitors, including western terrestrial garter snake (*Thamnophis elegans*), northern alligator lizards (*Elgaria coerulea*), western fence lizard (*Sceloporus occidentalis*), Pacific tree frog (*Pseudacris regilla*), and California red-legged frogs (FT).

The Fellers and Pratt inventory (2002) indicated that the number of medium- to large-sized mammals in the dune plot was also among the lowest of any habitat type in the park (Fellers and Pratt 2002). The total number of mammals recorded by camera was 60 at the dune site near North Beach, whereas, at some scrub and forested sampling sites, the total number exceeded 1,100 mammals (Fellers and Pratt 2002). The second lowest number of recorded mammals occurred in a moderately grazed pasture, but was double that found in the dunes (141; Fellers and Pratt 2002).

Medium to larger mammals that may inhabit the dunes, nearby dune slacks, or adjacent grasslands include mule deer (*Odocoileus hemionus*), striped skunk (*Mephitis mephitis*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), American badger (*Taxidea taxus*), black-tailed jackrabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*; Fellers and Pratt 2002; NPS, unpub. data). Long-tailed weasel occurred in shrub-dominated backdunes (ARA 2012). Based on the Fellers and Pratt (2002) camera-based inventory of large mammals, bobcat were some of the most common large mammals seen at the iceplant-dominated site (25 photos), followed by skunk (14), mule deer (8), black-tailed jackrabbit (7), raccoon (5), and coyote (1).

Bird species that were observed in dunes at Abbotts Lagoon during the 2011 restoration project included savannah sparrows (*Passerculus sandwichensis*), song sparrows (*Melospiza melodia*), Nuttall's white-crowned sparrows (*Zonotrichia leucophrys*), California horned lark, killdeer (*Charadrius vociferous*), common raven (*Corvus corax*), and Northern harrier (ARA 2012).


Woolly bear caterpillar eating yellow bush lupine

Prior to restoration, areas at Abbotts Lagoon with European beachgrass supported very little wildlife, with most species either flying over or moving through these stands, not foraging or nesting (ARA 2012). Beach areas oceanward of beachgrass-dominated foredunes were frequented by western snowy plover, common ravens, and migrant and wintering shorebirds such as dunlin (*Calidris alpina*), sanderling (*Calidris alba*), and willet (*Tringa semipalmata*) foraging along the tideline and higher beach (ARA 2012).

Other species that may occasionally occur or occur more near water bodies and flooded wetlands include great blue heron (*Ardea herodias*), osprey (*Pandion haliaetus*), California brown pelican, American white pelicans, red-winged blackbird (*Agelaius phoeniceus*), and a variety of ducks, geese, grebes, scoters and other shorebirds and waterbirds (SF Gate n.d. *in* NPS 2009). Some of these waterbird species can take up temporary residence in flooded dune swale or slack wetlands during the winter. At Abbotts, gadwall (*Anas strepera*), mallard (*Anas platyrhynchos*), cinnamon teal (*Anas cyanoptera*), and bufflehead (*Bucephala albeola*) foraged on the shores of dune swale wetlands when water depth allowed: they may nest occasionally in these areas, but no nesting was observed in 2011 (ARA 2012). The only species that nested near these wetlands was killdeer (ARA 2012).

Several shorebirds also made brief visits to the dune swale wetlands, including Wilson's snipe (*Gallinago delicata*) and long-billed curlew (*Numenius americanus*; ARA 2012). Some of the visiting shorebirds may come from larger water bodies nearby such as Abbotts Lagoon, but dune swales are not large enough features to provide long-term support for shorebird species (ARA 2012). At Abbotts Lagoon, several sensitive or rare species of birds occupied habitat either on Abbotts Lagoon or in vegetation or on tidal flats along its shoreline. Most of these are fall and/or spring migrants, but some winter at the site or even nest in grasslands, riparian scrub and/or the dunes themselves. These are described in the *Animal Species of Concern* section above.

In addition, on warmer days, aerial insectivores such as barn (*Hirundo rustica*) and rough-winged swallows (*Stelgidopteryx serripennis*), common yellowthroat, and black phoebe (*Sayornis nigricans*) also occurred at the Abbotts dunes (ARA 2012). Backdune areas supporting shrubs such as coyotebrush and bush lupine supported fairly high densities of Nuttall's white crowned sparrow and song sparrow, with the latter more abundant where shrubby areas adjoined dune swale wetlands (ARA 2012). Savannah sparrows were more common on the edges of shrub-dominated areas, particularly where it abutted barren ground or more open, dune mat habitat (ARA 2012). The presence of white-crowned sparrow may have attracted brown-headed cowbird (*Molothrus ater*), an opportunistic nest parasite that was also observed (ARA 2012). Other less common passerines nesting in these shrubby backdunes included Bewrick's wren (*Thryomanes bewickii*), wrentit (*Chamaea fasciata*), California towhee (*Melozone crissalis*), and bushtit (*Psaltriparus minimus*; ARA 2012).

Sparsely vegetated native dune areas in between the European beachgrass-dominated foredunes and backdunes supported nesting of California horned lark, a relatively rare breeding species in Marin County (ARA 2012). Few other bird species were noted here other than foraging American pipit (*Anthus rubescens*), western bluebird (*Sialia mexicana*), black phoebe, and swallows (ARA 2012).

Fish are typically not species associated with coastal dune systems, however, in the case of Abbotts Lagoon, dunes occur directly adjacent to a large brackish water impounded estuary. A 2001 published survey of fish in Abbotts Lagoon (Saiki and Martin 2001) found eight (8) species, with non-native Sacramento perch (*Archoplites interruptus*) and Pacific herring (*Clupea pallasii*) the most common species captured by gill nets. Sacramento perch was found most commonly near the shores of the lagoon (Saiki and Martin 2001). However, Pacific herring were more common in the lower lagoon than were Sacramento perch (Saiki and Martin 2001). Silver surfperch (*Hyperprosopon ellipticum*), longfin smelt (*Spirinchus thaleichthys*), and the non-native species, striped bass (*Morone saxatilis*) also were found in the lower lagoon (Saiki and Martin 2001). Other nearshore species include largemouth bass (*Micropterus salmoides*), which is also non-native (Saiki and Martin 2001). As the lagoon is brackish in nature, resident estuarine fish species also occur, including prickly sculpin (*Cottus asper*) and threespine stickleback (*Gasterosteus aculeatus*), with stickleback caught in larger numbers in the lower lagoon (Saiki and Martin 2001).

A more characteristic estuarine fish assemblage occurs in Estero de Limantour, which adjoins dunes along Limantour Spit. Long-term fish monitoring at Limantour Marsh has found a variety of estuarine fish species, including arrow goby (*Clevelandia ios*), threespine stickleback, prickly sculpin, topsmelt (*Atherinops affinis*), longjaw mudsucker (*Gillichthys mirabilis*), starry flounder (*Platichthys stellatus*), saddleback gunnel (*Pholis ornata*), and bay pipefish (*Syngnathus leptorhyncus*; NPS, unpub. data).

Several insects and other invertebrates are found in dune habitats. In addition to the rare species identified above in the *Animal Species of Concern* section, San Francisco forktail damselfly (*Ischnura gemina*), which has been considered by USFWS for listing in the past, woolly bear caterpillars (*Pyrrharctia isabella*), isopods, and other beetles and insects are likely to inhabit any perennial dune slacks or ponds or in and around coastal dunes.

In addition to increasing numbers of deer mice and providing cover to predators of plover, beachgrass appears to significantly alter invertebrate communities, with even relatively small increases of its cover severely depressing arthropod populations (Slobodchikoff and Doyen 1977). The lack of open space may decrease food availability for ground-foraging insects, and lower soil surface temperatures brought about by higher shade from beachgrass appears correlated with strong shifts in arthropod community structure (Slobodchikoff and Doyen 1977).

NATURAL PHYSICAL PROCESSES AND SOILS


Sand dune

Coastal dunes are dynamic ecosystems formed by the combined action of wind and wave. Offshore sandbars and sediment deposited at the mouths of rivers are the most important sources of material for dune building. This sediment is carried by longshore currents down the coast and is deposited on the beach by wave action (CERES 2013). Dune formation begins when wind or so-called Aeolian transport blows dry sand particles landward from the beach (CERES 2013). Objects such as plants and logs can act as "drifts" that disrupt the wind flow and sediment transport, causing mounding of sand. Over time, the wind erodes sand particles from the windward side of these drifts or mounds and deposits them on the leeward side. Gradually, this process results in the dunes migrating inland, with more sand accumulating in these moving hills over time.

In some cases, dunes are formed as spits or long, narrow accumulations of sand. Spits establish from in-coming waves approaching the shoreline at an angle, generating a longshore current: this current transports sand that deposits and forms a bar in front of a bay or lagoon (Old Dominion University 2013). Limantour Spit is an example of a spit type of dune: waves refract around Point Reyes Headland, which leads to an angled wave approach along this section of coastline (Old Dominion University 2013).

Dune Processes and Climate Change

As with many ecosystems, dunes often undergo periods of cyclic stabilization and rejuvenation (Pickart and Sawyer 1998). Rejuvenation events are the result of changes in relative sea level, which, in turn, have been attributed, at least in the past, to tectonic activity, including tsunamis (Vick 1988, Pacific Watershed Associates 1991, Clarke and Carver 1992, Komar and Shih 1993 *in* Pickart and Sawyer 1998). Both uplift and subsidence can trigger reactivation of dunes, with the former potentially building or expanding dunes through increased sediment supply, while the latter can destroy dunes through increased wave action or limit the expansion of new dunes (Pickart and Sawyer 1998). During and in between these major dune-forming and dune-destruction periods, dune morphology continues to be shaped by other factors, including wave action and offshore winds. Offshore winds create "blowouts" or northwest-southeast trending swales or low areas that are parallel with the prevailing northwesterly winds. When dunes are sparsely vegetated, the strength of these winds is sufficient to mobilize sands and cause movement or creep of dunes inland over time. New foredunes and associated parabolic dunes are then created from new sediments supplied by the ocean.

In addition to tectonic activity, another factor that can stabilize or rejuvenate dune systems is climate change. Climate change can affect dune systems through a myriad of direct and indirect effects, including changes in temperature, wind, precipitation, freshwater hydrology, sediment supply and transport, sea level rise, and ocean circulation. Coastal environments are considered among the most vulnerable to changes from climate change, including direct changes (e.g. changes of temperature and precipitation) and indirect changes (e.g. sea level rise, wind and water circulation, increasing storm events). As climate change study is a relatively young science, the exact magnitude and extent– and even the direction – of these changes on the northern California coast is still a matter of active debate.

With rising sea levels, there will be more frequent and more serious flooding of low-lying coastal areas by extreme tides, storm surges, and wave effects. Based on records from the past century, sea level is rising, and sea level rise increases wave action, which can destabilize dune systems. NOAA reports that, based on review of historic (1854-1999) water level gauge data, sea level has risen at a rate of 0.00328 to 0.0079 feet/year over the last century and that sea levels have risen 0.007 feet/year in San Francisco since 1906 (NOAA 2001 *in* KHE 2006a). Based on recent satellite altimetry studies, Cazenave and Narem (2004) report a "very accurate" sea level rise rate of 0.0092 ± 0.0013 feet/year for the 1993-2003 decade. From 25 years of Point Reyes water level records, NOAA predicted a local sea level rise rate of 0.0082 feet/year in this region (NOAA 2001 *in* KHE 2006a). These rates are notably higher than the rate of change estimated by NOAA from measured changes in tide gauges over the preceding half century (KHE 2006a). In 2005, the USGS completed a relative coastal vulnerability study that depicted most of Tomales Bay as having low to moderate vulnerability to sea level rise (Pendleton et al. 2005).

As many in the public are aware, melting of the icecaps has even further increased predicted changes in sea level rise, with some highly publicized studies estimating as much as 3 feet by the end of this century and 13 to 20 feet in coming centuries (Overpeck et al. 2006; Velicogna and Wahr 2006). More recent studies suggest that even some of these more alarming numbers could be underestimates due to the fact these models – including the IPCC ones – did not incorporate key forces such as gravity and changes in the Earth rotation, leading to potentially another 4- to 5 feet in sea level rise if the West Antarctic Ice Sheet collapses (University of Toronto 2009).

In 2009, the Pacific Institute published a report that warned that sea level rise rates in California could climb as high as 1.4 m (4.6 feet) by 2100 (The Pacific Institute 2009). Should sea level rise that high, the report estimated that as much as 41 sq. miles or 26,000 acres of California coastline could be lost due to increases in wave erosion and amplified tides (The Pacific Institute 2009).

Rising sea level will have a direct impact on coastal processes, effectively raising the plane of activity from which waves operate (Carter 1991). This may be most evident during storm surges, when the frequency of attack at any level will increase markedly, so that the so-called 1 in 1000 year flood height in 1990 might reduce to the 1 in 30 year flood height by 2030 (Wigley 1989 *in* Carter 1991). Such increasing frequencies could lead to amplification of coastal erosion, flooding, and avulsion, as well as a general enhancement of sediment fluxes (Carter 1991).

Some of the effects of sea level rise could be countered by increased sediment supplies to coastal areas. If precipitation and associated run-off increases, the supply of sediment from the surrounding watersheds that may eventually be transported to the ocean for deposition in beach areas could also increase. On average, recent projections show little change in total annual precipitation in California or in the Mediterranean pattern of rainfall, with most falling during winter from north Pacific storms (California Climate Change Center 2006). However, one climate model does predict slightly wetter winters, while another predicts slightly drier winters with a 10 to 20 percent decrease in precipitation (California Climate Change Center 2006).

Another climate change factor that could affect coastal areas is a shift in wind patterns and strength. A recent study showed that land temperatures are increasing at a faster rate than ocean temperatures, and this thermal gradient is already resulting in increased winds (Snyder 2008). The University of California, Santa Cruz team ran several regional climate change models based on modern climate (1968 to 2000) and future climate (2038 to 2070) using input from the Intergovernmental Panel on Climate Change (IPCC AR4) for "high-growth" emissions scenarios. Results showed an increase in wind speed of up to 2 meters/second, which is a large change relative to the current average wind speed of 5 meters/second (Snyder 2008). An increase in winds can amplify tidal range or the upward extent of high tides and induce wave-associated erosion of shorelines.

Coastal dunes offer a buffer against storm extreme tides and storm surges. This buffering capacity, however, is minimized and potentially eliminated when dunes are over-stabilized by invasive plant species or other alterations. While dunes that have been "fixed" by ecological and engineering techniques may, at first, be less vulnerable to sea level rise and erosion, eventually, steep cliffs will form and begin actively eroding into the ocean (Carter 1991). If sands are unable to migrate inland in response to erosional pressures, because they are armored in place by species such as European beachgrass or iceplant, then, eventually, the coastal dune field will begin to shrink, and the valuable functions that dunes play not only in providing plant and wildlife habitat, but in protecting inland areas from the devastating impacts of storm surge and high tides may be lost.

Dune Structure

Coastal dune fields form characteristic patterns. Most dune fields consist of two or three sets of parallel dunes, with the most recently formed foredunes nearest the beach, and the older dunes farthest inland; the inland dunes may by as much as 18,000 years old (CERES 2013). A common pattern in some California dune systems is a series of parallel ridges perpendicular to the prevailing winds, called "transverse ridges" (CERES 2013, Pickart and Sawyer 1998). These dunes occurred in Pismo and Santa Maria further south, as well as historically in San Francisco and Dillon Beach (P. Baye, *pers. comm*.).

The other common type of dune system in California is the parabolic dune, which consists of a series of U-shaped dunes with the concave side facing the prevailing wind direction (CERES 2013, Pickart and Sawyer 1998). Most of the California parabolic dunes are attenuated, narrow parabolic or U-shaped dune fields, also called "tongue" dunes (Cooper 1958), with minimal or no dune slack or swale development except in a few cases (Point Reyes, Monterey, Humboldt, and Morro Bay sandspit; P. Baye, *pers. comm*.). At Point Reyes, most of the dune mass occurs in an attenuated lobe rather than on the flanking ridges of the "U," perhaps because these dunes are climbing up over a marine terrace with an erosion-resistant soil and vegetation community (P. Baye, *pers. comm*.).

In these systems, the primary foredune is a ridge of sand that forms parallel with the coast above the mean high tide line (Pickart and Sawyer 1998). It is buffeted by onshore winds and is vegetated by plants that are tolerant of sand burial (Pickart and Sawyer 1998). Under historical conditions (e.g., prior to invasion by non-native species), the foredune typically was a low-elevation, hummocky, non-continuous feature sparsely vegetated by species such as native American dunegrass, which allowed periodic blowouts of sand that leave valleys or openings within the foredune ridge (Pickart and Sawyer 1998). The wind pushes sand inland through these blowouts or valleys, forming crests and valleys or U-shaped dunes perpendicular to the coast.

The longitudinal ridges and valleys behind the foredune are also sparsely vegetated and move slowly inland by the forces of wind and slumping along the lee face as slopes exceed the angle of repose. In northern California, both parabolic and transverse dunes exist behind the foredune complex (Pickart and Sawyer 1998). Parabolic or U-shaped dunes move inland, sometimes merging into a large sand plain or sand sheet devoid of vegetation (Pickart and Sawyer 1998). As this highly mobile, unstabilized sheet moves, a large deflation plain or low elevation areas forms on which dune swale or dune slack wetlands can occur, fostered by a seasonal or perennial groundwater table exposed by sand loss (Pickart and Sawyer 1998). Wetland vegetation grows and stabilizes the dune swales. In some California dune systems, smaller transverse dunes or dunes oriented with crests perpendicular to the prevailing wind can develop on the open sand surfaces of so-called moving dunes, which include parabolic dunes and sand sheets (Pickart and Sawyer 1998).


Steep, iceplant-covered foredune at B Ranch

Both European beachgrass and iceplant have greatly altered the natural morphology of coastal dunes in many areas along the Pacific coast of North America, although European beachgrass more so. With colonization by European beachgrass, the primary foredune topography has changed to a steeply sloped, continuous ridge without blowouts, and the orientation of the ridges and troughs in areas behind the foredune complex are parallel rather than perpendicular to the coast (Cooper 1936; Barbour and Johnson 1988; Pickart and Sawyer 1998). Based on topographic analysis of dunes at Bodega, areas vegetated by European beachgrass can be 7- to 26 feet higher than unvegetated dunes (Cesmat et al. 2012). Rapidly accreting European beachgrass-dominated foredunes have an internal structure of interbedded unconsolidated sand (mostly horizontal or gently sloping beds) formed by pulses of rapid sand accretion (burial episodes) and shallow layers of persistent, dense beachgrass roots, rhizomes, and shoots (Baye 2008). European beachgrass roots and rhizomes concentrate in the upper 8- to 12 inches due to light exposure, but with frequent burial events, young, viable buds formed from rhizome breakage can be distributed throughout the foredune horizon (Baye 2008). This network of rhizomes, combined with the dense aboveground biomass, acts to traps sand and stabilizes the once active foredune, which prevents large-scale sand movement or fresh supplies of sand to dune areas inland of the primary foredune.

A second series of European beachgrass-dominated dunes occurs in the landward portion of the dune system, typically called the backdunes. Backdunes generally refer to dunes cut off from sand supply from the beach, and they are either stabilized or are internally remobilizing sand from blowouts or other mobile dunes inland from the beach (P. Baye, *pers. comm*.). At Point Reyes, most of the backdunes are heads or flanks of formerly migrating U-dune lobes that stabilized decades ago (Baye 2008). They are in early stages of dune scrub succession, as indicated by high frequency of coyotebrush, wild cucumber, and mock heather (Baye 2008). Leading edges of U-dunes often stabilize by lateral, superficial colonization of European beachgrass, as the rate of dune migration inland slows. Because of the lower frequency of sand burial events in backdunes, rhizomes of European beachgrass do not extend as deeply down in the dune horizon in the backdunes as they do in the foredunes (Baye 2008).

At AT&T, just south of Abbotts Lagoon, both European beachgrass-dominated foredunes and backdunes exist, although the distance between foredune and backdunes is more compressed than at Abbotts, where foredunes and backdunes are separated by a large basin or deflation plain. Within the backdunes at AT&T, the ridges run in a perpendicular alignment to the beach, allowing for formation of moist meadow-drainage complexes between backdune ridges. A somewhat similar dune morphology exists at North Beach, although the size of foredune and backdune features is muted relative particularly to the northern portions of AT&T.

The dune systems at B Ranch, A Ranch, and Davis Property are different from those on the northern portions of the Great Beach. At B Ranch, there is a moderately steep drop from the dune "terrace" to the beach, with the oceanward portion of the dunes comprised of low-elevation European beachgrass-dominated foredunes. Behind the foredunes, the dunes slope gently upward in a series of concave basins bordered by marginal ridges to the elevated European beachgrass-dominated backdunes directly adjacent to the pasture. These basins at B Ranch support a more native dune-open sand vegetation community with native plants and patches of iceplant, with ridges either comprised of native dune-open sand or colonized by European beachgrass or iceplant. At the Davis Property, the dune "terrace" is actually perched on a cliff.

Presumably one of the primary differences between natural or native dunes and dunes heavily colonized by European beachgrass is the rate of sand movement, as species such as beachgrass and iceplant were planted to stabilize dunes and prevent encroachment into adjacent lands. In Humboldt, research found that parabolic dunes migrated on average 4.7 feet/year between 1939 and 1988, while some other parabolic dunes and transverse dunes moved as much as 15 to 21 feet/year (Wiedemann 1984; Pacific Watershed Associates 1991). Sand movement rates would be naturally expected to be much lower in invaded dune, as these species were plant to stabilize these systems. European beachgrass-dominated dunes at Bodega were estimated to accumulate on average as much as 5,232 cubic yards (CY) per year (Cesmat et al. 2012). In England, where European beachgrass is native, rates of inland movement of the dunes varied between 5-10 feet/year on the more stable dune sections and up to 22 feet/year on the most mobile dune sections (Ranwell 1958). The study at Bodega showed that, during peak wind conditions, sand transport was 450 times higher in unvegetated areas than in vegetated ones (Cesmat et al. 2012).

Some sediment transport monitoring has occurred in restored dunes. A series of plots at Little River State Beach in Humboldt County where excavation had been conducted to remove European beachgrass experienced sand movement at a rate of 3.9 cubic feet for every 10 square feet per year (Transou et al. 2007). During restoration, dunes moved, on average, 2.5 feet per month in a southeast or inland-trending direction, although the rate of inland dune movement may have been retarded by sand moving over existing European beachgrass stands (Vaughan and Fiori 2007). In the earlier restoration efforts at Abbotts Lagoon conducted by the Seashore between 2001 and 2005, sand movement was also assessed, and, while sand height did change, most of this change appeared to involve redistribution of sand within the treated area rather than actual movement of sand (Peterson et al. 2003).

Monitoring of the recent Abbotts mechanical removal project at Abbotts Lagoon showed that acreage of open sand areas, specifically on the inland perimeter of the dune system, in-

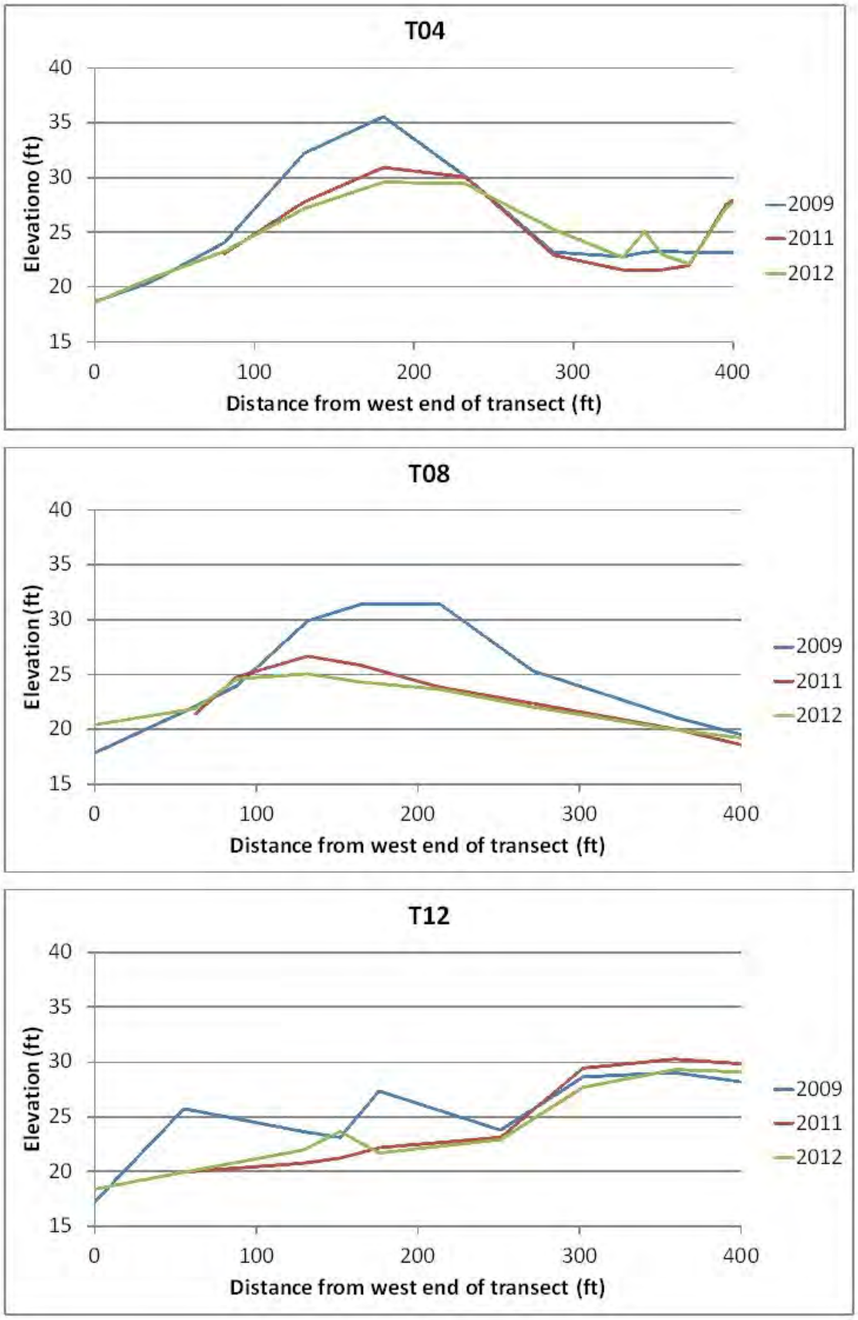
Park staff mapping elevations with RTK GPS equipment

creased from 2011 to 2013 (Johnson 2013a.). By spring 2013, approximately 10.1 acres of grassland, scrub, and wetland had been buried by newly remobilized sand (Johnson 2013a), which is equivalent to about 3% of the entire 300-acre restoration project area. Of the 10.1 acres, 7.3 acres involved inland "creep" of dunes, with the remainder being internal to the dune system (Johnson 2013a).

While the restored dunes visibly looked different in 2012 and 2013 relative to immediate post-construction conditions, this difference was not evident from topographic monitoring that was conducted in 2012 (Figures 15, 16; NPS, unpub. data). Real-Time Kinematic GPS was used to survey longitudinal and latitudinal cross-sections of the Phase I project area and then compared to pre-restoration elevations estimated from LIDAR (2009) and immediate post-restoration elevations that were also collected using RTK GPS (2011). Some sample cross-sections show a considerable reduction in dune elevations immediately after restoration, with little change between 2011 and 2012 (Figure 15): The specifications called for no change in post-construction elevations, so either elevations were lowered, or, more likely, LIDAR data is not directly comparable to the RTK GPS data. Sands also had appeared to bury some of the adjacent native dune areas, as observed from "mounding" or burial of the many existing native dune plants, but, again, RTK GPS results suggest little immediate post-restoration change in elevations in these areas (Figure 16).

Dune movement is not isolated to natural and restored dune systems. While European beachgrass and iceplant were planted to stop movement of the dunes, the dunes have continued to migrate inland over the past 60- 70 years despite rapid expansion of these species. Dune expansion rates during the period 1943-2007 have varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual dune expansion rates during this period of 0.25% to 0.91% (Johnson 2013a). Analysis of historical aerial imagery at 20-year intervals between 1943 and 2007 suggests that this expansion occurred fairly continuously over approximately 65 years rather than in disjunct stages (Johnson 2013a). Coastal dune represents varying percentages of the total leased lands for different ranches, ranging from as low as 2% at G Ranch – currently, most of the dune system is outside the lease boundary at this ranch – to 24% at AT&T, with B Ranch estimated at 22% (Johnson 2013a).

Based on review of historic aerial imagery, the proportion of barren, sandy areas within the pasture adjacent to the restored dunes at Abbotts actually appears lower in 2013 – even with sand remobilization – than in 1963, around the time that the Seashore was established (Johnson 2013a). In general, sand movement since restoration at Abbotts in 2011 has tended to follow established historical sand deposition paths as evidenced by the fact that most of the ungrazeable areas buried were pre-existing dune "fingers" that extended into the pasture, which were already very sandy and dominated by dune and scrub type species. In the 1960s, two decades after European beachgrass was planted at Abbotts, these fingers are very distinguishable on aerial imagery as barren, sandy areas (Johnson 2013a). Over the next 30- to 40 years, these fingers remained within the pasture, but became more vegetated by dune and dune scrub plant species, as can be seen in 2010 aerial imagery (Johnson 2013a). While there has been an inland creep from the perimeter of the Phase I



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Marin County, California

Figure 18. Mechanical recontouring leaves foredunes lower.

Cross-sectional representations of foredune elevations pre-restoration (2009 - data from LiDAR), just after mechanical removal was completed (2011 - data from survey contours), and one year after the completion of mechanical work (2012 - data from RTK GPS survey).

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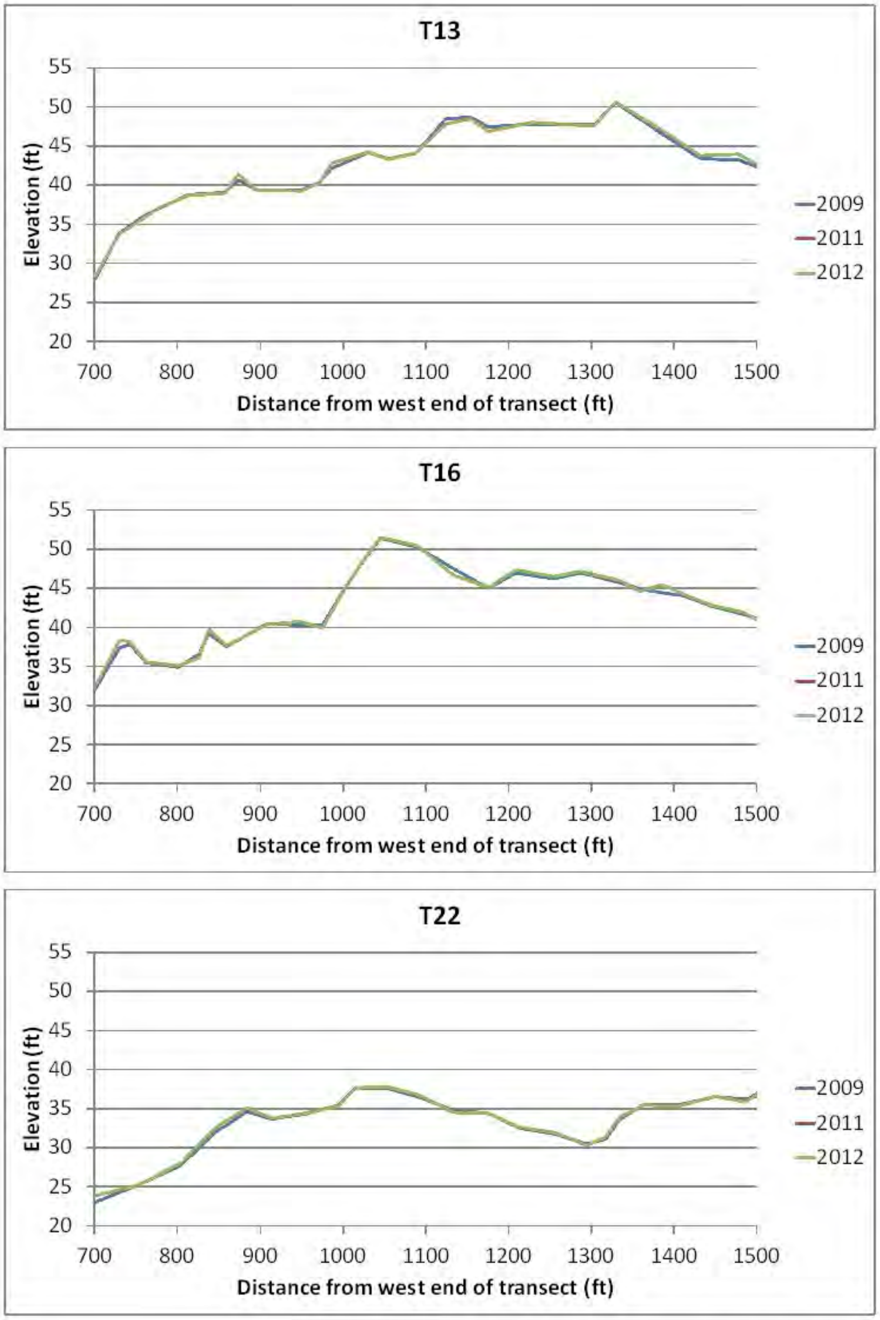

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Marin County, California

Figure 19. Native dune areas show little change in elevation despite sand movement and visible burial.

Cross-sectional representations of foredune elevations pre-restoration (2009 - data from LiDAR), just after mechanical removal was completed (2011 - data from survey contours), and one year after the completion of mechanical work (2012 - data from RTK GPS survey).

S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\18_Native dune areas show little change in elevation.mxd mechanical removal area, this creep has largely been burying areas that have been repeatedly buried by sand in the past, with some very minor (<1.0 acre) exceptions.

Some of the movement during the first two years post-restoration may have been influenced by the two successive dry winters and the fact dry winters allow for reduced establishment by stabilizing vegetation and are accompanied by higher winds that discourage vegetation establishment (Baye 2008). In addition, removal method also appears to influence sand migration rates. In the same year that mechanical removal was performed at Abbotts Lagoon, some of the backdune and foredune areas immediately adjacent to these areas were treated with herbicide. Although European beachgrass was almost completely killed during the initial treatment effort (>99%), the dead aboveground biomass and presumably the rhizomes did not decompose rapidly. This delayed decomposition may have reduced the potential for sands in these areas to remobilize, as they are being held in place by the dead rhizomes. No migration of dune had occurred inland of these herbicide-treated areas by 2013 (Johnson 2013a).

Soils

Movement of sand not only affects dune topography, but nutrient status. Coastal dune sands tend to be nutrient limited, especially for the essential nutrients nitrogen, phosphorus, and potassium (Barbour et al. 1985). Sand deposition is a common means by which plants acquire critically-limiting nutrients in dune ecosystems (Pickart 1997). In addition, dunes also rely on aerosol deposition of certain micronutrients: concentrations of sodium (Na), magnesium (Mg), calcium (Ca), and chloride (Cl) in salt spray and fog are high enough to meet or exceed plant needs (Clayton 1972, Art et al. 1974, van der Valk 1974, Barbour et al. 1985). Organic matter provides nearly all the cation exchange – or nutrient binding – capacity in the coarse-textured sands (Pickart and Sawyer 1998).


Two species of bush lupine that grow in the dunes

While soil nitrogen levels are low, nitrogen content within plants are actually similar to crop plants on fertile soils (Holton et al. 1991). Dune plants obtain nitrogen from episodic inputs of detritus (Ranwell 1972, Holton 1980), nitrogen fixation by symbiotic and associative bacteria (Wahab and Wareing 1980, Holton 1980, Robertson 1982, Rose 1988), and photosynthetic use (Barbour et al. 1985). A 1991 study by Holton and colleagues at a Point Reyes dune system characterized the total nitrogen pool at 348 lbs/acre, of which 78% was soil organic nitrogen; 4% was soil inorganic nitrogen; and 18% was tied up in plant biomass. Nitrogen contributions to this system principally came from fog condensation, bulk precipitation, and symbiotic nitrogen fixation, in decreasing order of importance (Holton et al. 1991). Levels of nitrogen in Humboldt area foredunes ranged from 4.9 ppm for ammonium and 5.9 ppm for nitrates, whereas phosphorous levels were triple those levels (17.7 ppm; Nature Conservancy, unpub. data *in* Pickart and Sawyer 1998).

Based on the Point Reyes study, nodulated legumes, including beach pea, provided only minor nitrogen inputs to dune systems and only at a very localized level (Holton et al. 1991). However, other members of the pea family have been demonstrated to have much more effect on soil nitrogen levels. Bush lupines are tremendous nitrogen-fixers that derive 60% to 70% of their total nitrogen from atmospheric sources (Bentley and Johnson 1991). Nitrogen-enriched litter accumulates under the plants, contributing as much as 72- 185 kg of nitrogen per hectare per year to some systems (Gadgil 1971, Palaniappan et al. 1979, Skeffington and Bradshaw 1980, Maron and Jeffries, unpub. data *in* Maron and Connors 1996). With leaf drop or lupine death, high levels of exchangeable ammonium and nitrate become available to plant colonists, particularly weedy introduced grasses and forbs (Maron and Connors 1996). Once established, these weedy annual exotics create a labile litter that completely turns over organic matter and nitrogen, favoring persistence of weedy annuals (Zink et al. 1995).

Iceplant also effects soil nutrient status, but in a slightly differ manner. Iceplant-invaded soils appear to have higher organic matter content and lower pH than uninvaded areas (D'Antonio and Mahall 1991, de la Peña et al. 2010, Santoro et al. 2011, Winsemius 2013) and, in some areas, organic carbon (Vilà et al. 2006): This may be partially due to the much higher amounts of detritus produced by this species (Vilà et al. 2006). Iceplant leaves have high contents of tannin and antibacterial compounds that may reduce litter decomposition rates (Van der Watt & Pretorius 2001 *in* Vila et al. 2006) and leach into the soils. This leachate may acidify dune soils, which inhibits nitrification (conversion of ammonium to nitrate) and increases leaching of calcium and magnesium (D'Antonio and Haubensak 1998, D'Antonio and Mahall, unpub. *in* Conser and Connor 2009). Magnesium levels in dune soils at the Seashore were found to be lower in iceplant-invaded areas than in native dune (Winsemius 2013). Soil acidification occurs naturally with dune succession, but iceplant invasion speeds up this process (D'Antonio and Mahall, unpub. *in* Conser and Connor 2009). Changes in soil nutrient content appeared more variable, with some studies showing an increase in total nitrogen (Santoro et al. 2011), some showing a decrease (D'Antonio and Mahall, unpub. data), and some showing no change at all (Vilà et al. 2006). The effect of European beachgrass on soil nutrient pools does not appear as well studied of that of iceplant or bush lupine.

Iceplant also appears to compete with native plant species for water (D'Antonio and Haubensak 1998). It could disrupt osmotic levels in the soil in a similar fashion to another member of the iceplant family, *Mesembryanthemum crystallinum*, which retains salts in its tissues that are then released into the soils after plant and leaf senescence (Vivrette 1973; Vivrette and Muller 1977). These salt infusions create an osmotic imbalance in dune soils that draw water out of neighboring plants, resulting in desiccation and death. Higher sodium levels – salts are sodium chloride – have been found in soils invaded by iceplant (D'Antonio and Mahall, unpub. data *in* Conser and Connor 2009), although some studies have found lower levels of sodium in iceplant-invaded soils (Winsemius 2013). Removal of iceplant from the vicinity of two dune shrub species, mock heather and Menzies' goldenbush (*Isocoma menziesii*), resulted in higher pre-dawn water pressure potentials in shrubs compared to shrubs still surrounded by iceplant, suggesting that iceplant was utilizing water that would have otherwise been available to shrubs (D'Antonio and Mahall 1991). The greenhouse study conducted by Conser and Connor (2009) found no differences in soil moisture content between iceplant-invaded soils and native dune soils, but this may point more to a lack of long-term changes in soil properties that could negatively affect soil moisture-holding potential in soils rather than differences in field moisture conditions. Ultimately, even if iceplant does not compete for water, it appears to fare better under drier conditions, with iceplant in germinating in lower moisture soils than native dune plants in Spain (Novoa et al. 2012).

Sand transport and nutrients are not only the factors affected by non-native plant invasion. Despite its seemingly barren appearance, dune soils play host a number of bacterial, fungal, and pathogen species that appear to at least partially drive the dynamics of invasion and succession within dune systems. As noted earlier, legumes or members of the pea family have strong associations with bacteria in their root systems that help them fix nitrogen. Phosphorus uptake by dune plants is enhanced by a symbiotic relationship with arbuscular mycorrhizal (AM) fungi near the roots (Koske and Polson 1984, St John 1990). This type of fungi has also been shown to be beneficial by promoting sand aggradation (Forster and Nicholson 1981a, b) and improving nitrogen fixation in legumes (Rose and Youngberg 1981, Hayman 1983). The percent colonization of vascular plants by AM appears to be higher in level and more stabilized dunes, but has not been found to vary that much by species, plant size, surrounding plant cover, or topography (Pickart and Sawyer 1998).

European beachgrass has been characterized in at least one study as a mycorrhizal-dependent species (de la Peña et al. 2006). In fact, in a European study, germination of European beachgrass in iceplant-invaded soils resulted in lower biomass or aboveground plant mater than in non-iceplant-invaded soils, which the authors hypothesized may relate to suppression of beneficial mycorrhizal interactions (de la Peña et al. 2010). Iceplant is not considered to be a mycorrhizal species (Conser and Connor 2009). Interestingly, experiments suggested that soil biotic community in at least some Mediterranean dune systems – where iceplant is not native – may initially resist the invader, but that, over time, the resistance to invasion breaks down (Vilà et al. 2006, de la Peña et al. 2010). High levels of a symbiotic fungal species, chytrids, were found in soils that had been invaded for some time by iceplant: This species may be detrimental to other native dune species, but not iceplant (de la Peña et al. 2010). However, in other European systems, iceplant invasion is believed to be related more to the fact that iceplant may not be susceptible to existing soil pathogens (Reinhart et al. 2005; Van Grunsven et al. 2009). Ultimately, invasion mechanisms may vary from region to region and depend on initial soil conditions (Knevel et al. 2004 *in* Wolfe and Klironomos 2005).

Also, the viability of invaders may change with time due to changes in soil biota: European beachgrass stabilizes sand, but stabilization may encourage microorganisms that infect beachgrass roots and lead to the decreased vigor and aboveground biomass production evident in backdune communities (Van der Putten al. 1988 *in* Pickart and Sawyer 1998). In Europe, European beachgrass is an early successional dune species that is replaced by other species as surrounding soils accumulate soil organisms that negatively affect its growth (Van der Putten et al. 1993 *in* Wolfe and Klinoromos 2005). In some areas of the world, such as South Africa, this successional dynamic appears to be disrupted, because this negative soil feedback loop does not exist (Knevel et al. 2004 *in* Wolfe and Klironomos 2005). However, this does not appear to account for European beachgrass's invasiveness in California. While the pathogenic nematode present in many European dune systems was absent from California ones, European beachgrass still undergoes equal negative plant-soil feedback as it does in its native range (Beckstead and Parker 2003). Both regions supported a number of common fungal species (Beckstead and Parker 2003). In addition, it is possible that, in California, European beachgrass stands accumulate local generalist pathogens that may, ultimately, have a stronger adverse effect on native dune species, thereby promoting this species' spread (Eppinga et al. 2006).

This evolution in dune morphology and soils continues as dunes move inland. The landward edge of dunes is defined by unconsolidated sand that may have started to develop a soil profile, but does not show the red color of advanced chemical weathering characteristic of older sand deposits (Wiedemann 1984). Adjacent to the dunes are coastal marine terraces with paleodune soils, many of which have been mapped as Sirdrak Sand: Sirdrak Sand represents deposits of latest Pleistocene to Holocene-era Aeolian or wind-driven dune sand deposition approximately 30,000 years before present (Knudsen et al. 2000; Baye 2008).

Centuries of grassland establishment has led to establishment of a mollisol over most of these former dune sands. Mollisols develop through significant accumulation of humus or organic matter in the surface horizon, or uppermost layer, of soils: This organic matter always almost derives from grass vegetation. Mollisols have deep, high organic matter, nutrient-enriched surface soil (A horizon), typically between 60-80 cm thick, that is known as a mollic epipedon. Over time, these grassland-dominated terraces have been subject to_natural dune transgression or migration, probably from specific episodes of climate-driven dune instability (Baye 2008). These are evident in the occurrence of the previously discussed dune "fingers" extending some distance sometimes into pastures or even in the presence of dune "islands" some distance from the beach, such as occurs at F Ranch.

Water Resources

Regulatory and Policy Setting

Increasing concern about polluted waters in the 1960s led to a number of federal and state efforts to improve water quality, some of which led to increasing protection for wetlands, which were recognized for their important role in improving water quality.

The most well-known legislation protecting the nation's waters is the Federal Water Pollution Control Act (Clean Water Act) and subsequent amendments of 1977 (33 USC §1251 et seq.). The Clean Water Act provides for the restoration and maintenance of the physical, chemical, and biological integrity of the nation's waters, primarily through three sections – Section 404, Section 401, and Section 303(d). Section 404 (33 U.S.C. 1344) of the Act prohibits the discharge of fill material into navigable waters, tributaries to navigable waters, and special aquatic sites of the United States, including wetlands, except as permitted under separate regulations by the USACE and U.S. Environmental Protection Agency (USEPA). Under Section 401 (33 U.S.C. 1341), states and tribes can review and approve, condition, or deny all Federal permits or licenses that might result in a discharge to state or tribal waters, including wetlands. In California, authority for Section 401 has been delegated to the State Water Resources Control Board (SWRCB), which shares its authority with nine regional boards (see Porter-Cologne Act below).

Water quality control plans developed by Regional Water Quality Control Boards (RWQCB) designate beneficial uses of water for specific water bodies, establish narrative or numerical water quality objectives to protect those uses, and provide a program to implement the objectives. For example, for Lagunitas Creek, beneficial uses include contact and non-contact recreation, oyster production, municipal and domestic water supply, agricultural supply, cold freshwater habitat, fish migration, preservation of rare and endangered species, recreation, fish, spawning, and wildlife habitat. For certain water quality objectives such as total and fecal coliform, specific numeric criteria have been developed for different beneficial use types.

Dunes between Abbotts Lagoon and the Pacific Ocean

Should water bodies violate water quality objectives for its beneficial uses, the state is authorized under Section 303(d) of the Clean Water Act to declare these areas as "impaired" or unable to perform designated beneficial uses by specified contaminants. Tomales Bay has been declared impaired under Section 303(d) for excessive sedimentation and high levels of nutrients, pathogens, and mercury.

The Park Service Management Policies (2006) support federal and state efforts to either preserve or improve water quality. Parks are required to "determine the quality of park surface and ground water resources and avoid, whenever possible, the pollution of park waters by human activities occurring within and outside of parks" (Section 4.6.3; NPS 2006). Furthermore, parks are mandated to "take all necessary actions to maintain or restore the quality of surface waters and groundwaters consistent with the Clean Water Act and all other applicable federal, state, and local laws and regulations" (Section 4.6.3; NPS 2006).

In addition, Director's Order #77-1 established Park Service policies, requirements, and standards for implementing Executive Order 11990, which directs federal agencies to avoid long- and short-term impacts to wetlands. The Park Service uses the Cowardin classification system (Cowardin et al. 1979) as the basis for creating a Park Service standard for defining, classifying, and inventorying wetlands that might be subject to adverse impacts and Park Service oversight.

Dune Wetlands and Water Bodies

Dunes are not considered "aquatic" ecosystems, but they are dependent on water: Rivers provide sediment to the ocean, which deposits sand on the beach through wave action. These sands are blown inland and create dunes (CERES 2013).

Most of the coastal dune systems have open water only on one side, the western or southern boundary fronting the Pacific Ocean. However, in some areas dunes are bounded by open water on several sides. The dunes west of G Ranch and North District Operations Center (NDOC) border both the Pacific Ocean to the west and Abbotts Lagoon to the north. The Limantour Spit dunes are bounded by the ocean on one side and the Estero de Limantour and Limantour Pond on the other. Dunes at the very tip of Limantour Spit lie directly adjacent to the mouth of Drake's Estero. However, in most cases, the only water-related features within the Seashore's dunes are dune swale or dune slack wetlands.

As noted in *Natural Physical Processes and Soils*, dune swales and slacks often form in the so-called deflation plain behind the primary foredune or as narrow, linear basins between closely spaced successive ridges that are oriented roughly perpendicular to the shoreline (Wiedemann 1984). Dune slacks can also form at the trailing edge of parabolic dunes or between the ridges of parabolic dune systems (Wiedemann 1984, Baye 2004). Absolute elevations are often low enough in these deflation plains or basin areas that the groundwater table becomes exposed (Baye 2004). Most of the dune swale wetlands are only seasonally flooded during the winter, even if they are principally groundwater-fed, but a few wetlands sustain ponding throughout the year. Duration and depth of ponding can determine whether dune swale wetlands are dominated by herbaceous or shrub-type vegetation (Rheinhardt and Faser 2001).

At the Seashore, many of the dunes swales or slacks occur within remnant stabilized parabolic dunes (U-dunes; Baye 2008). However, some of the largest dune swale wetlands at Abbotts appear to have been created by dune migration over pre-existing sloping marine terrace drainages with a strong groundwater influence that has led to a fen-like accumulation of peat, which is very unusual for central California coast dunes (Baye 2008). As natural dunes continue to migrate inland, wetlands features shift in adjustment, destroying and then re-creating features as ridges are re-established elsewhere with wetland vegetation establishment most pronounced during wet periods (P. Baye, *pers. comm*.).

Sand movement not only affects wetlands within dune systems, but adjacent to them: Dunes can obstruct or re-direct seasonal drainages or impound hillslope runoff in gulches and ravines, forming ponds or wetlands. In general, near Abbotts Lagoon, both groundwater and surface water sheetflow appear to flow generally northwest, with some of the surface water drainages being diverted to run directly along the edge of the backdunes out to Abbotts Lagoon. At AT&T Dunes, a large freshwater wetland complex flows generally westward towards the dunes, where some of the flow ends up sustaining the narrow dune swales that break up the backdune complex (Figure 17). A smaller wetland complex also drains into dunes at North Beach. At B and A Ranches, linear wetland swales cross the adjacent grasslands or pastures and flow through the dunes toward the beach (Figure 17).

The rapid spread of European beachgrass in primary foredune areas has probably acted to capture most of the fresh sand deposited in these areas, thereby amplifying the development of a wide dune deflation plain downwind with extensive sand-starved dune slacks (P. Baye, *pers. comm*.). In addition, the stabilization of both foredune and backdune communities by European beachgrass and iceplant has probably rendered many of the wetland features less ephemeral or transitory than they would have been under natural conditions. The 2011 Abbotts Lagoon dune restoration project has already affected wetland morphology within this area by burying at least 2.5 acres of both internal and external or adjacent wetlands (Johnson 2013a). Over time, as sands migrate inland, wetlands can develop in the trough between foredune and elevated areas behind the foredunes where the water table is low enough to sustain seasonal ponding (Pickart and Sawyer 1998).

Water quality within dune swale wetlands in the Seashore has not been monitored. Water quality would be expected to be similar or identical to the quality of groundwater that often feeds these wetlands or, if cattle are present, adjacent surface water bodies within pastures, particularly if wetlands within pastures drain to dune swale wetlands. Lower turbidity and ammonium (nitrogen) levels would be expected in groundwater than nearby surface water bodies due to the filtering action of soils.

With the exception of the Pacific Ocean, the largest water bodies directly adjacent to the Seashore's dune systems are Abbotts Lagoon, Estero de Limantour, and Drake's Estero. Drake's Estero and Estero de Limantour have daily exchange with the ocean, whereas Abbotts Lagoon is only periodically open to tidal flushing.

Wilderness Areas

Policy and Regulatory Setting

The Seashore is one of 46 units within the national park system that includes congressionally designated wilderness areas. The Wilderness Act (PL 88-577) was passed on September 3, 1964, to establish a national wilderness preservation system made up of designated wilderness area.

Wilderness areas are defined, in part, as follows:

> *An area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain… An area of undeveloped*

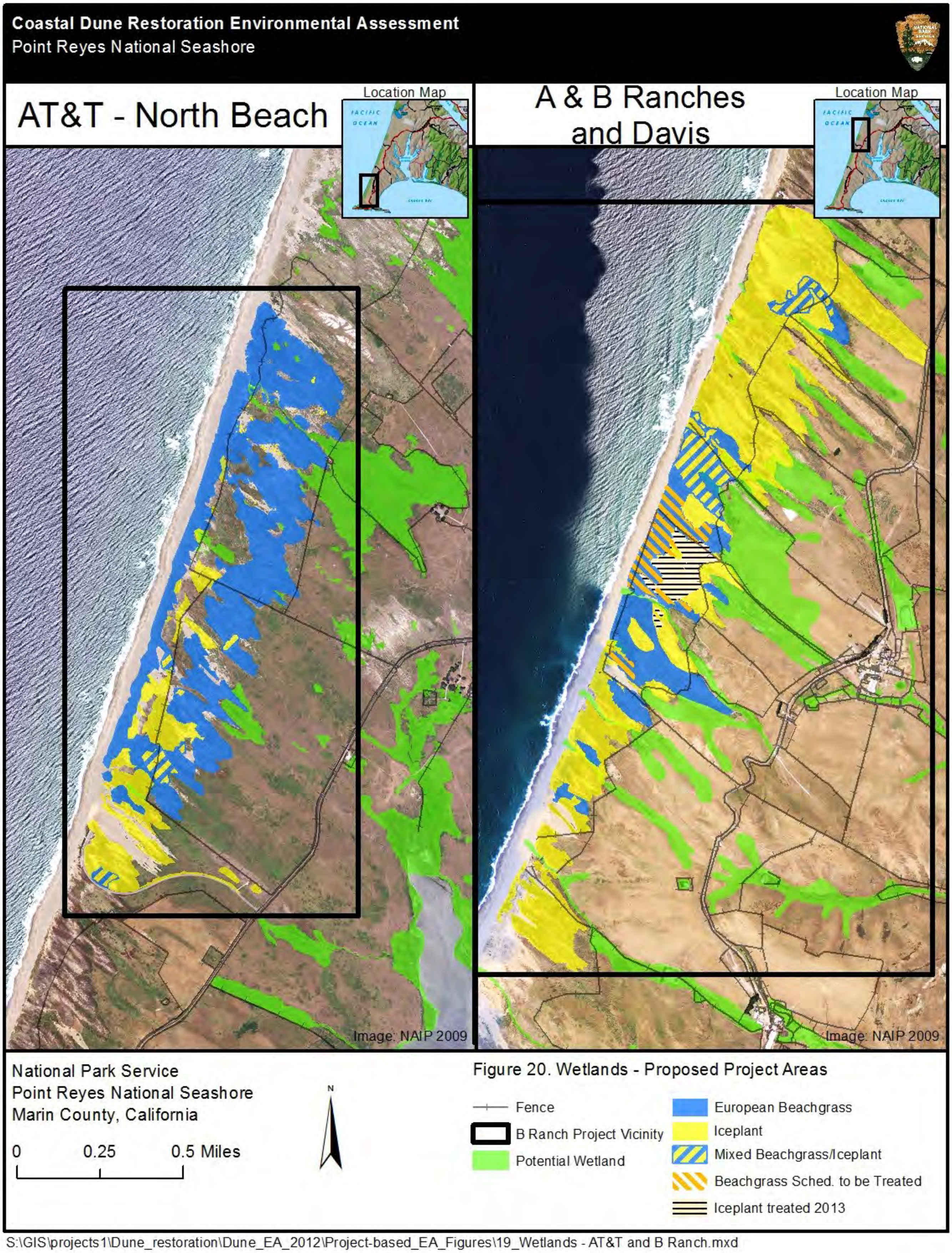

Figure 20. Wetlands - Proposed Project Areas

Figure 21. Wetlands - Limantour

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Federal land retaining its primeval character and influence, without permanent improvements or human habitation. (PL 88-577).

Following passage of the Wilderness Act, Section 3(c) of the Wilderness Act required that the Secretary of the Interior review "every roadless area of five thousand contiguous acres or more" within the national park system and report to the president his recommendation as to the suitability of these areas for preservation as wilderness. The president was then to advise Congress of his recommendation with respect to the designation of each area. A presidential recommendation for designation as wilderness became effective only if so provided by an act of Congress (PL 88-577).

In 1972, the Seashore published its initial wilderness recommendation for an area of about 5,150 acres for the purpose of preservation of wilderness areas. In 1976, Congress designated over 33,000 acres, including 25,370 acres as wilderness and another 8,003 acres of land and water as potential wilderness (PL 95-544, October 18, 1976, 90 Stat. 2515 and PL 94-567, October 20, 1976, 90 Stat. 2695). While the legislative language clearly articulates the acreage above in Section 1, the map filed with the committee as required under Section 2 of the legislation calculated that the actual acreage of those lands and waters was 24,200 acres of wilderness and 8,530 acres of potential wilderness. The wilderness area was named the Philip Burton Wilderness in 1985 (PL 99-68). The areas were designated as potential wilderness at the time due to the nonconforming Wilderness Act uses in those lands. The Philip Burton Wilderness is unique in that it is the only wilderness area between Canada and Mexico that includes marine waters (wilderness.net 2011).

Congress established a process whereby potential wilderness within the Seashore would convert to designated wilderness in Section 3 of PL 94-567. With discontinuation of nonconforming uses in Muddy Hollow, Abbotts Lagoon, and Limantour (including southern Drake's Estero), an additional 1,752 acres of potential wilderness designated in 1976 were converted to wilderness in 1999 (FR 77-23). This area included the waters of Estero de Limantour and the offshore waters of Limantour Spit. No dune areas occur within the portion of Drake's Estero designated as wilderness in 2012.

The Interagency Wilderness Character Monitoring Team, which represents the Bureau of Land Management (BLM), USFWS, Park Service, USGS, and the U.S. Forest Service (USFS), offers an interagency strategy to monitor trends in wilderness character across the national wilderness preservation system in the handbook, "*Keeping It Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System*."

The interagency team outlines four qualities of wilderness from the statutory language of the Wilderness Act that should be used in wilderness planning, stewardship, and monitoring:

– ***Untrammeled*** – Wilderness is essentially unhindered and free from modern human control or manipulation.

– ***Natural*** – Wilderness ecological systems are substantially free from the effects of modern civilization

– ***Undeveloped*** – Wilderness retains its primeval character and influence and is essentially without permanent improvement or modern human occupation

– ***Solitude or a primitive and unconfined type of recreation*** **–** Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation (NPS 2011b *in* NPS 2012; Landres et al. 2008)

Given these objectives, wilderness areas must be managed differently by the Park Service from other lands within the park. According to Section 4(c) of the Wilderness Act, there shall be no commercial enterprise and no permanent road within any wilderness area and, except as necessary to meet minimum requirements for the administration of the area (including measures required in emergencies involving the health and safety of people within the area), there shall be no temporary road; no use of motor vehicles, motorized equipment, or motorboats; no landing of aircraft; no other form of mechanical transport; and no structure or installation within any such area.

The evaluation of whether certain uses or activities can be conducted in wilderness areas occurs as part of a two-step process. The first step, the minimum requirement analysis, is used to determine which administration approach impacts wilderness the least. This step is used to scrutinize the project or activity and make the best decision for wilderness in the long term (BLM 2004). If, after completing step one, the proposal is found to be the minimum required action for administration of the area as wilderness, a minimum tool analysis is completed, which helps determine which method of implementing the proposal would have the least impact on the wilderness resource while still allowing the project to be completed safely and successfully (BLM 2004).

Wilderness Areas Within the Seashore's Dunes

Along beaches and dunes of the Seashore, wilderness is designated from the High Tide Line to 200 yards inland, including beach areas and certain portions of the coastal dune system. Included in wilderness designation are dune areas near the mouth of Abbotts Lagoon, Limantour Spit (~190 acres) and portions of A Ranch (~41 acres), B Ranch (~90 acres),, and North Beach (~42 acres) dunes (Figures 18, 19). At AT&T and other portions of the project areas, wilderness includes just the beach and offshore areas (Figure 19): offshore areas and areas below the High Tide Line are considered potential wilderness, except at Limantour Spit, which is designated wilderness. Of the roughly 2,200 acres of coastal dune, bluff, and scrub within the Seashore, approximately 30% or 660 acres are within designated wilderness.

SOUNDSCAPES

Background and Regulatory and Policy Setting

While noise often has a negative connotation, one of the intrinsic values of national parks remains the potential for hearing "natural" noises such as crashing waves, running streams, thunder, or singing birds. A combination of noises that is intrinsic to a natural landscape is often characterized as a soundscape. The ability to hear these natural noises in a soundscape is somewhat dependent on the absence of unwanted sound such as urban noise. Unwanted sound can be simply intrusive, destroying either a relaxing experience or the comfort of one's home, or harmful to people's health through hearing impairment or loss.

Unlike more urban parks, the Seashore and north district of GGNRA are located in a rural portion of western Marin County and must contend less with the intrusive influences of urbanization than the southern portions of GGNRA. Regardless of location, however, the Park Service is directed to preserve, to the greatest extent possible, the natural soundscapes of parks and to restore soundscapes that have become degraded due to "unnatural sounds" (noise; NPS 2006, Section 4.9). Noise is defined as extraneous or undesired sound (Morfey 2000). The natural soundscape is defined as the aggregate of all the natural sounds that occur in parks, including the physical capacity for transmitting those natural sounds and the interrelationships among park natural sounds of different frequencies and volumes (NPS 2006, Section 4.9). Director's Order 47: Soundscape Preservation and Noise Management (DO-47) further guides toward the maintenance and restoration of natural soundscapes. DO- 47 states that "nearly as many visitors come to national parks to enjoy the natural soundscape (91 percent) as come to view the scenery (93 percent)" (NPS 2000). The Park Service policy is a more stringent standard than set by the federal Noise Control Act of 1972 or most general plans produced by cities or counties.

The federal Noise Control Act required federal agencies to promote an environment free of the noise that can jeopardize public health or welfare. Sound can be characterized using two parameters: amplitude (loudness) and frequency (tone). Many planning agencies use a 24-hour average of noise intensity, with a 10 dB "penalty" added for nighttime noise (10:00 p.m. to 7:00 a.m.) to account for the greater intrusiveness of loud noises during this time of the day (California Code of Regulations 1988). The agency tasked with implementing the Noise Control Act, the USEPA, established outdoor limits of 55 decibels (dB) and indoor limits of 45 dB averaged throughout a 24-hour period. Decibels refer to the amplitude or peak pressure of the sound wave and are interpreted by humans and wildlife as different degrees of sound loudness. For comparison purposes, an average office has mean noise levels of 60 dB, while close proximity to a jet engine has noise levels as high as 140 dB (Egan 1972; HUD, *undated*). The noise level of rustling leaves in a forest -- the sound that many visitors come to parks to experience -- can be as low as 20 dB (Egan 1972).

Noise source data are referenced to a standard measurement distance. All noise source levels in this document are referenced to a nominal distance of 50 feet, which is the reference distance for Park Service noise regulation (36 CFR 2.12) and U. S. Federal Highways construction equipment measurements (FHWA 2006). The limit specified by Park Service regulation is 60 dBA at 50 feet (36 CFR 2.12).

In some cases, the effect of projects on soundscapes is evaluated by determining how much noise increases relative to background noise levels. Region 10 of the USEPA published guidance for evaluating long-term noise increases at residential areas caused by noise from industrial or transportation projects. That guidance suggests a long-term noise increase of 5 to 10 dBA above background noise should be considered to have a noticeable effect (Environmental Protection Agency 1980 *in* ICF 2010).

Measures of acoustical environmental quality more appropriate to national parks address the capacity to hear natural sounds or the capacity for park visitors to communicate without raising their voices. One useful index is the change in the maximum distance at which a sound can be detected (Barber, Crooks, and Fristrup 2010). By this measure, a 10 dBA increase in background sound levels reduces detection (or communication) distance to $1/\sqrt{(10)}$ of its original value, a 68 percent reduction. The area in which this sound could be heard is correspondingly reduced by 90 percent. This metric may be applied to wildlife and human perception of natural events, as well as to speech communication by park visitors.

Noise and Soundscape Resources Within the Seashore's Dunes

The largest noise producers in most areas include highway traffic, trains, planes, boats, and industry-related machinery within industrial zones. In rural areas such as west Marin, producers of undesirable human-caused sound are limited to automobile and truck traffic, jet

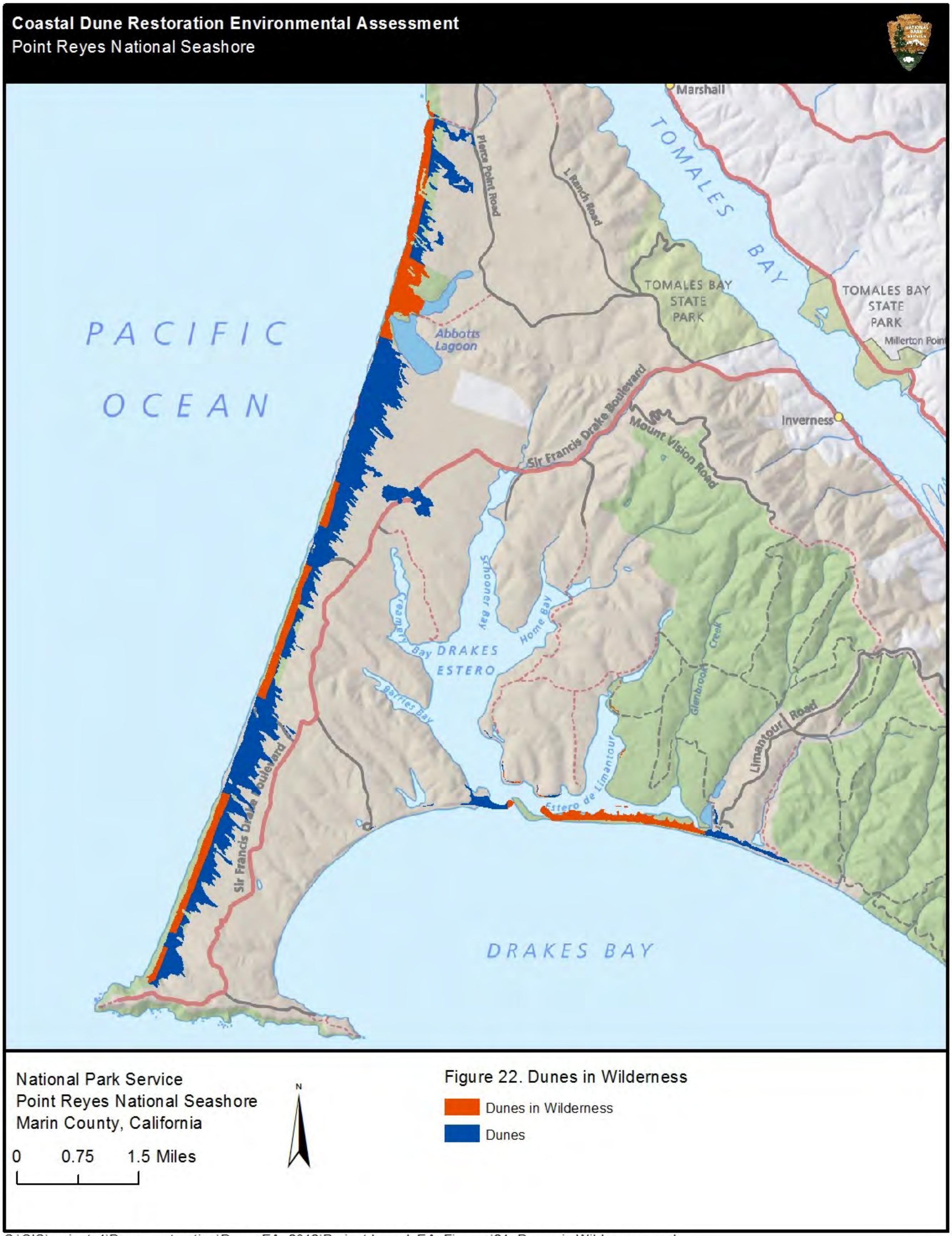
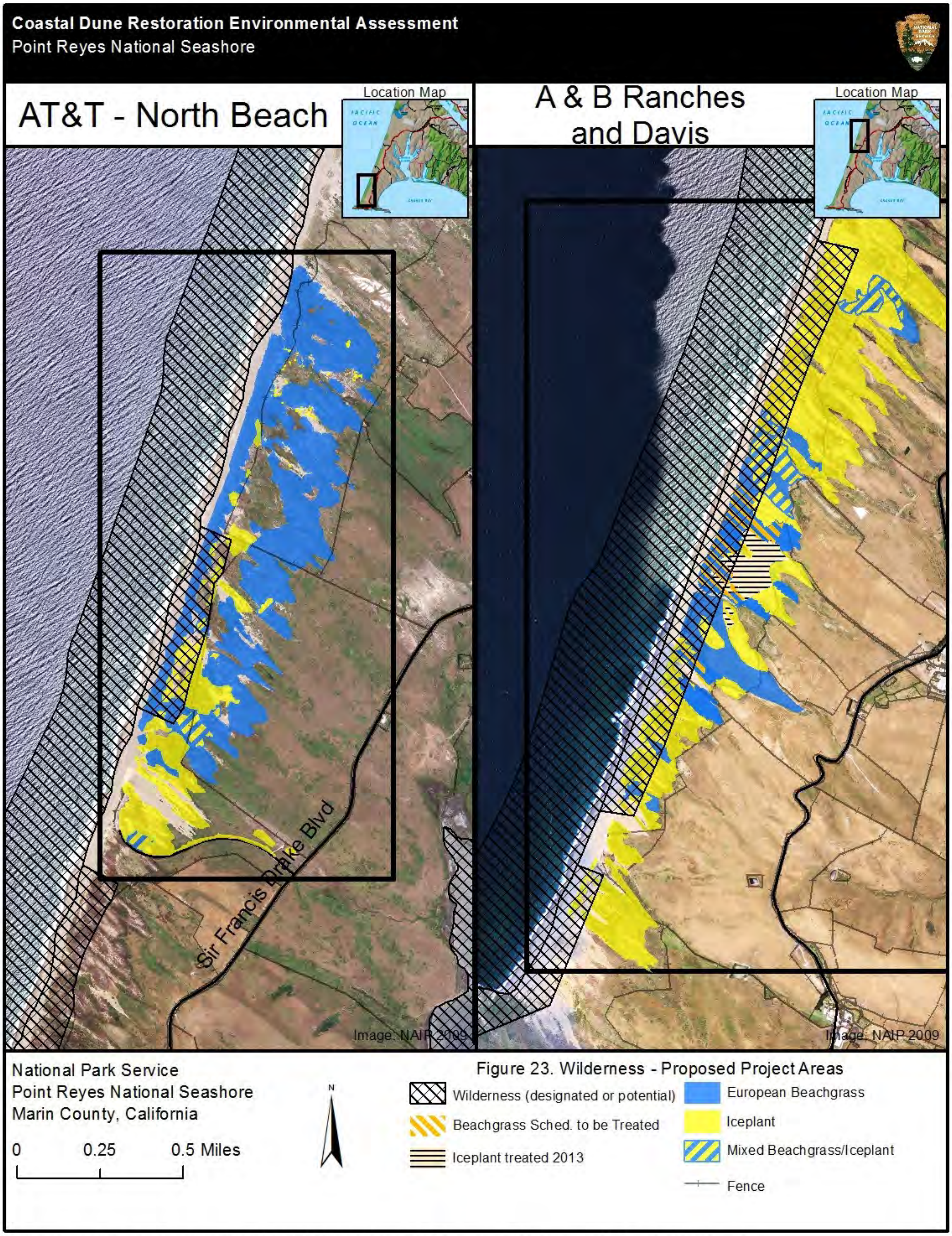


Figure 22. Dunes in Wilderness

S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\21_Dunes in Wilderness.mxd



S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\22_Wilderness - AT&T and B Ranch.mxd

Figure 24. Wilderness - Limantour

S:\GIS\projects1\Dune_restoration\Dune_EA_2012\Project-based_EA_Figures\23_Wilderness - Limantour.mxd airplanes, individual businesses, agricultural ranch activities, and individual construction projects. Background sound levels vary depending on the level of development. Urban areas have the highest background sound levels, with daytime levels approximating 60 to 65 dBA (USEPA 1978). Suburban or residential areas have background levels around 45 to 50 dBA (USEPA 1978), while rural areas are the quietest with sound levels of 35 to 40 dBA (USEPA 1978). In a more recent study, Cavanaugh and Tocci (1998) identify typical urban residential background sound at around 65 dBA and high-density urban areas at 78 dBA.

The U.S. Department of Transportation's Federal Aviation Administration prepared a study on ambient noise levels within the Seashore in 2011 (FAA 2011). This study characterized a range of summer and winter daytime noise levels in varying development and/or habitat types, including Bear Valley Visitor Center (36.7-38.8 dBA-LD50), mixed forest (31.8 – 38.1 dBA-LD50), scrub grassland (35.3 – 37.6 dBA-LD50), and wetlands (33.8 – 35.8 dBA-LD50; FAA 2011). While noise levels did not vary greatly between sites, the predominant source of noise did vary. Human-related sound and, to a lesser degree, aircraft noise represented the most common source of sound at Bear Valley Visitor Center, while natural sounds accounted for the most "noise" in the mixed forest, scrub grassland, and wetlands (FAA 2011). Aircraft noise also factored into the ambient soundscape, albeit to a lesser degree, for the mixed forest site (FAA 2011).

In areas of the Seashore near the dunes, the predominant human-related source of noise is car and truck traffic on Sir Francis Drake Boulevard or other arterial roads, traffic in parking lots, and car, truck, farm equipment, and motorized all-terrain vehicle (e.g., ATV) activity on ranches. There may also be noise generated on occasion by park road or facility maintenance activities such as roadwork. Typical natural sources of sound include the sound of waves crashing on the beach, wind, and the call of birds and elephant seals. The FAA study estimated ambient levels along the Great Beach and adjacent coastal dunes, scrub, and grasslands as ranging between 30 to <40 dBA-LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011).

Cultural Resources

Coastal areas, including dunes, often end up being areas of cultural or archaeological significance due to the abundance of natural resources present in these areas for use for indigenous or non-indigenous peoples.

The cultural resource *Management Policies* for the Park Service recognizes five categories of resources that the Park Service is responsible for managing; archaeological resources, cultural landscapes, ethnographic resources, historic and prehistoric structures, and museum collections. Several cultural resources falling under these categories are known to be present within the coastal dune environments of Point Reyes, and there are likely more that have yet to be identified. The coastal areas of Point Reyes, including dunes, provided a multitude of natural advantages that influenced the human use of this area from prehistory up to the present.


Historic radio communication facility

Several prehistoric archaeological resources, mainly shell middens, are located within the dune environment. These sites are mainly focused on the coast and the procurement and processing of the marine resources it provided. The maritime focus of the landscape continued into the historic-era. As the Point Reyes Peninsula juts approximately 10 miles out into the Pacific Ocean, ships often foundered along the coast, and coastal areas became the unfortunate location of several shipwrecks. Some of the material remains of these wrecks come to rest along the beaches and become buried by the active tidal and dune environment. Additionally, several historic-era operations concerned with maritime safety and communications were established along the coastal dune environment of Point Reyes including the Point Reyes Life Saving Station, the Navy Radio Direction Finder Station, and the RCA Point Reyes Receiving Station. These activities and others occurring within the coastal dune environments of the Seashore have left a legacy of potentially important cultural resources that the Park Service is responsible for managing.

Background and Regulatory and Policy Setting

Since the early 1900s, a number of laws and policies have been enacted to protect cultural resources such as these for the enjoyment of future generations of park visitors. The Antiquities Act of 1906 (16 USC §432) mandated protection of historic or prehistoric remains "or any antiquity" on federal lands, including historic monuments and ruins. It was superseded by the Archeological Resources Protection Act of 1979 (16 USC §470aa et seq.) as an alternative federal tool for prosecution of antiquities violations on public lands. In addition to protecting resources, the Archeological Resources Protection Act regulates excavation and collection on public and Indian lands and requires notification of Indian tribes that may consider a site of religious or cultural importance prior to issuing a permit. The importance of consulting with Native American tribes was bolstered by passage of the American Indian Religious Freedom Act (42 USC §1996), which stresses that religious concerns should be accommodated or addressed under NEPA or other appropriate statutes. The Archeological Resources Protection Act was amended in 1988 to require the development of plans for surveying public lands for archeological resources and systems for reporting incidents of suspected violations.

The National Historic Preservation Act of 1966, as amended (16 USC §470 et seq.) requires agencies to take into account the effects of their actions on properties listed in or eligible for listing in the National Register of Historic Places. The Advisory Council on Historic Preservation has developed implementing regulations (36 CFR 800), which allow agencies to develop agreements for consideration of these historic properties. The Park Service, in consultation with the Advisory Council, the California State Historic Preservation Officer (SHPO), Native American tribes, and the public, has developed a Programmatic Agreement for operations and maintenance activities on historic structures. This 2008 Programmatic Agreement provides a process for compliance with the National Historic Preservation Act.

In addition to federal and state laws governing protection of cultural resources, Executive Order 11593 instructs all federal agencies to support the preservation of cultural properties. It directs them to identify and nominate cultural properties under their jurisdiction to the National Register of Historic Places and to "exercise caution… to assure that any federally owned property that might qualify for nomination is not inadvertently transferred, sold, demolished, or substantially altered." The Park Service incorporated direction from law and federal policy into development of the Cultural Resources Management Guidelines (NPS 1998), which recognizes five types of cultural resources: archeological resources, historic structures, ethnographic resources, cultural landscapes, and museum objects.

In California, authority for NHPA has been transferred to California's Office of Historic Preservation. The Office of Historic Preservation also is responsible for oversight of California Pubic Resources Codes Section 21083.2-21084.1, which requires state and local agencies to evaluate impacts of proposed projects to archaeological and historic structure resources. Federal and federally-sponsored programs and projects are reviewed pursuant to Sections 106 and 110 of the NHPA. Section 106 of the NHPA requires federal agencies to consider the effects of proposed federal undertakings on historic properties. NHPA requires federal agencies to initiate consultation with the SHPO as part of the Section 106 review process. The State Office of Historic Preservation maintains the California Register of Historic Places. The California Register includes resources listed in or formally determined eligible for listing in the National Register of Historic Places, as well as some California State Landmarks and Points of Historical Interest. Properties of local significance that have been designated under a local preservation ordinance (local landmarks or landmark districts) or that have been identified in a local historical resources inventory may be eligible for listing in the California Register and are presumed to be significant resources for purposes of CEQA unless a preponderance of evidence indicates otherwise (PRC Section 5024.1, 14 CCR § 4850).

Point Reyes Cultural Affiliation

The Point Reyes National Seashore Cultural Affiliation report (Emberson et. al. 1999) examining Native American affiliation at Point Reyes concluded that the Federated Coast Miwok people have a clear, exclusive affiliation with the lands managed by the Seashore extending back more than 2,000 years. The Federated Coast Miwok are politically recognized by the federal government as the Federated Indians of Graton Rancheria.

Archeological Resources

Archeological resources are "the remains of past human activity and records documenting the scientific analysis of these remains" (NPS 1998). These include artifacts, ecofacts, and features. Over 100 Native American archeological sites exist within the Seashore, primarily on the coastal lowlands. These known prehistoric sites are primarily shell middens, voluminous deposits of rich organic soil with a relatively high content of local shell, created by human habitation of the site. The Seashore also has approximately 90 historic terrestrial archeological sites. These sites typically reflect historic occupation and use of the peninsula, first by homesteaders and dairy ranch communities, and later by government lighthouse and lifesaving personnel and private radio telecommunication companies. They include discrete refuse deposits containing household and work related artifacts and foundation remains and road remnants from former ranching operations and radio communication facilities. Approximately 92% of the Seashore's lands have not yet been surveyed for archaeological resources.

Prehistoric Background (Meyer and Dalldorf 2006)

Early visitors to the Point Reyes Peninsula recorded descriptions of Coastal Miwok culture. Much of what is known of the prehistoric use of the peninsula prior to that time is based on archaeological investigations conducted on multiple sites in the 1940s.

These investigations led to the development of a cultural sequence for the Marin coast by Richard Beardsley consisting of three primary facies or aspects. These are as follows:

– ***McClure aspect*** – an undifferentiated Middle horizon (aka Middle period, or Upper Archaic period), ca. 500 B.C. to A.D. 1000

- ***Mendoza aspect*** **–** equivalent to some portion of Phase 1 of the Late horizon (aka Late period, or Lower Emergent period), ca. A.D. 1000 to 1500
- ***Estero aspect*** **–** equivalent to Phase 2 of the Late horizon (aka Late period, or Upper Emergent period), ca. A.D. 1500 to Historic Period

Based on the GIS information, there are 20 prehistoric archaeological sites that occur within the coastal dunes of Point Reyes. Concentrations of sites occur along the southern stretch of Ten Mile beach, the Kehoe Beach drainage, Abbotts Lagoon, and Limantour Spit. These sites were recorded by Robert Edwards of San Francisco State College in 1967 and 1968, who conducted reconnaissance surveys for large portion of the park to relocate and identify previously recorded sites. More recent site record updates have been completed for most of these sites.

Much of this portion of the project area has been covered by two previously conducted archaeological surveys. As part of the archaeological surveys conducted for the 2011 dune restoration project at Abbotts Lagoon, the northern portions of this portion of the project area were investigated. This included an intensive level archaeological surface survey, as well as a geoarchaeological (backhoe trench) investigation. No cultural resources were identified as a result of this study. The geoarchaeological field investigations (subsurface exploration trenches) identified a sequence of Aeolian deposits spanning from the late Pleistocene to the historic period. Though no archaeological soils were located, two deposits of buried soils dating to the late Holocene were identified. These soils could potentially contain archaeological deposits. In addition, the dynamic nature of the dune field could have also redeposited archaeological materials within the upper dune sands. Consequently, it was recommended that these buried soils areas be monitored during dune restoration activities (excavations, earth moving). At least one of these areas occurs on the very northwestern perimeter of this portion of the project area (Meyer and Dalldorf 2006). Another archaeological surface survey was conducted in 2013 to cover the northern portions of this portion of the project area not covered by the study for the Abbotts Lagoon restoration. Approximately 184 acres were surveyed, but no cultural resources were identified by the survey effort.

At B Ranch/A Ranch/Davis Property, one previously conducted archaeological survey and several resource specific studies have been conducted within this portion of the project areas. The archaeological surface survey was conducted in 2012 to inform a habitat restoration project. The survey effort covered approximately 185 acres at the northern edge of A Ranch and southern portions of B Ranch. The survey effort identified two historic-era archaeological sites consisting of a concentration of household type artifacts. Additionally, an extensive concentration of prehistoric artifacts consisting primarily of chert and obsidian lithics and cobble tools were identified. Since these materials were within close vicinity of site CA-MRN-238, they were recorded as a new locus of that site.

The B Ranch/A Ranch/Davis Property dune system areas also fall within the Point Reyes Peninsula Indigenous Archaeological District. The Point Reyes Peninsula Indigenous Archaeological District consists of 72 recorded archaeological sites distributed among seven (7) non-contiguous clusters within the boundaries of the Seashore. This portion of the project area intersects the Headlands Cluster of the Point Reyes Peninsula Indigenous Archaeological District, which is comprised of eight (8) sites that contain dark, ashy midden soils with artifacts such as obsidian and chert tools, debris from tool manufacture, fire-cracked rocks, ground-stone tools, marine shells, and faunal remains (Engel 2013).

Besides previously documented cultural resources, unrecorded cultural resources may also be present within the project areas. Based on an evaluation of the environmental setting and features associated with known sites within the Seashore compared to that of this portion of the project areas, the potential for unrecorded Native American cultural resources to exist was estimated to be high within the B Ranch/A Ranch/Davis Property project areas and moderate at the AT&T/North Beach project areas. Sites within the Seashore tend to be located in sheltered and relatively flat areas with good access to marine and estuarine resources, as well as fresh water. There are fewer freshwater drainages in the northern project areas than the southern ones, and the dunes in northern portions of the Great Beach are more wind-exposed (P. Engel, *pers. comm*.).

Additionally, the active dune environment makes this area also sensitive for buried Native American cultural resources, which might have otherwise been identified by previous studies. At B Ranch/A Ranch/Davis Property, native American cultural resources that have the potential to occur within the project area include similar site types to those expressed in the Headlands Cluster of the Point Reyes Peninsula Indigenous Archaeological District that include constituents such as; chert or obsidian lithics, debitage from tool manufacture, milling features, and midden soils with artifact constituents such as shell, lithics, fire cracked rock, and faunal remains. At AT&T/North Beach, native American cultural resources that have the potential to occur within this portion of the project are those site types expressed in the North Coast Cluster of the Point Reyes Peninsula Indigenous Archaeological District that include constituents such as; chert or obsidian lithics, debitage from tool manufacture, milling features, and midden soils with artifact constituents such as shell, lithics, fire cracked rock, and faunal remains.

Historic Background (Meyer and Dalldorf 2006)

Historically, the Point Reyes Peninsula is associated with the 16th-century voyages of Sir Francis Drake in 1579 and Sebastian Rodrigues Cermeño in 1595. Known outside contact with the Miwok was limited until the late 18th and early 19th centuries, with the founding of missions in San Francisco (1776), San Rafael (1817), and Sonoma (1823).

The advent of cattle grazing resulted in most of the native inhabitants leaving the area by the 1820s. Others remained as converts and supplied labor for the missions. In the 1830s, the peninsula was being divided into land grants, and, around 1850, the cattle grazing pattern that continues today began. Many of the historic ranches are still being leased.

Prior to 1875 and the construction of the railroad, transportation to the area was primarily by boat. Shipwrecks were always a risk with ocean transport. There have been numerous known shipwrecks in the vicinity of Abbotts Lagoon and elsewhere and numerous wrecks of unknown location from which debris may have been scattered onto the beach and dunes. Due to prevailing currents, wrecks tend to deposit debris further south along the shoreline than where the actual incident occurred.

There are nine (9) known shipwrecks dating prior to 1940 between the mouth of Tomales Bay and Abbotts Lagoon and an additional 20 shipwrecks of unknown location along the Point Reyes peninsula that may have contributed flotsam that washed up on the beach near Abbotts Lagoon. The nature of this material's deposition makes its location within the dunes difficult to predict.

A large timber – presumably from a shipwreck – was found during 2004 mechanical dune restoration efforts near the mouth of Abbotts Lagoon. The timber likely belonged to a ship that was constructed either on the east coast of the United States or in Europe during the mid-19th century. Several associated bottles found dated from approximately 1933.

As part of surveys conducted for the 2011 dune restoration project at Abbotts, some pieces of early- to mid-20th century refuse were identified, but most of these materials were located in open dunes, not within areas of proposed restoration and excavation (Meyer and Dalldorf 2006). A large scatter of historic debris (milled lumber, wire nails, bottle fragments, a cartridge casing, etc.) located in the project area may have been associated with a shack or other shelter (Meyer and Dalldorf 2006). It was not recorded as a cultural resource site. A large iron ship's line chock covered in beachgrass was also found in this area (Meyer and Dalldorf 2006).

During the seven-month Abbotts Lagoon Phase I project, no significant resource finds were uncovered during the extensive excavation efforts, although the foredune area was littered with bottles, many of which appeared to date back to the 1900s or possibly even earlier. These finds were left in place. Isolated prehistoric artifacts, a mortar and pestle, were also identified. These artifacts were determined to be isolates and were collected by the Park Service Cultural Resource Staff for accessioning into the park museum collection.

A review of the literature covering historic uses of the B Ranch/A Ranch/Davis Property and AT&T/North Beach (F Ranch) area suggests a moderate likelihood that unrecorded historic-era resources may exist in these areas (Engel 2013, P. Engel, *pers. comm*.). Because of its long grazing history, the type of historic-era resources with potential to occur include: historic-era refuse deposits, agricultural related machinery and equipment, historic-era fence lines, foundational remains, landscaping features, and water conveyance systems (Engel 2013). During recent survey efforts, three previously unknown historic-era artifact scatters consisting primarily of domestic type artifacts were observed, all of which were surface scatters without any apparent depth (Engel 2013). The Seashore is treating these new resources as eligible under Section 106 (Engel 2013). The AT&T/North Beach (F Ranch) was utilized primarily for grazing livestock throughout the historic period. With this in mind, the type of historic-era resources with potential to occur within this dune system area includes: historic-era refuse deposits, agricultural related machinery and equipment, historic-era fence lines, foundational remains, landscaping features, and water conveyance systems.

Cultural Landscapes and Features

Cultural landscapes "are settings we have created in the natural world" (NPS 1998). In 1998, the Seashore started developing a cultural landscape inventory database. To date, the database has identified 12 historic cultural landscapes, with the dairy and cattle ranches on the Point Reyes Peninsula comprising the single largest landscape (NPS 2001). The smallest is located at the 19th century lime kilns located in the Olema Valley (NPS 2001). Landscapes can range in scale from historic sites to substantial districts (NPS 2001). They may express a high level of design, as seen in the two former RCA / Marconi Wireless Stations on Point Reyes and Bolinas, or, conversely, they may be landscapes that have arisen from need or desire over time, rather than arising from measured designs (NPS 2001). The ranches along Lagunitas Creek and the Olema Valley fall in this category (NPS 2001).

In total, the Seashore manages 39 cultural landscapes: 23 are within the boundaries of the Seashore, and 16 are within the North District of the GGNRA. The landscape and landscape features primarily reflect the maritime, ranching, communications, and military history of the park. Two of these landscapes are considered historic districts. The Point Reyes Ranches Historic District is the largest and encompasses over 22,000 acres on the Point Reyes Peninsula with the oldest dairy operations (1857-1939) known as the "alphabet ranches." The Seashore has rehabilitated the NHRP-listed Pierce Point Ranch in this district. Home Ranch is listed as a landscape feature integral to the Point Reyes Ranches Historic District Cultural Landscape. Home Ranch is one of the oldest and best preserved ranches on the Point Reyes

Peninsula (Livingston 1994). The Olema Valley Ranches Historic District, including the Lagunitas Creek ranches, is a smaller, but comparable district with a broader range of architectural styles and site development influenced by a higher diversity of ownership and lack of standardization (NPS 2001).

Several other landscape features have national significance. The 1927 Point Reyes Lifesaving Station is a National Historic Landmark, and the Marconi/RCA Wireless Stations sites are in the process of being nominated as a multiple property National Historic Landmark. The Point Reyes Light Station, which was built in 1870, is listed on the NRHP. The Olema Lime Kilns are listed as a California State Historical Landmark and also as a National Register of Historic Places property.

Within the coastal dunes of Point Reyes that may be affected by this project are four cultural landscapes that are recorded as either historic sites or historic districts. These sites include: the Point Reyes Lighthouse Station historic site, the United States Coast Guard Point Reyes Lifeboat Station Historic District, the Naval Radio Compass Station/Point Reyes Life-Saving Station site, the Shafter/Howard Tenant Ranches Historic District, and the RCA Point Reyes Receiving Station Historic District. These historic properties consist of a complex linkage of buildings and structures and natural landscape features that together support the properties' aspects of integrity that communicate their significance.

The Shafter/Howard Tenant Ranches Historic District encompasses approximately 18,000 acres of historic ranch lands in the northern portion of the Point Reyes Peninsula. The district includes 16 ranches historically associated with the system of tenant ranches established between 1857 and the 1890s. A Ranch and B Ranch, component ranches of the historic district, occur within this portion of the project area and consist of a collection of residences, outbuildings, windbreaks, corrals, fences, and grazing pastures that contribute to the properties eligibility for listing in the National Register of Historic Places. However, the grazing pastures of A and B Ranches are the only contributing resources of the historic district that extend into the coastal dune environment.

AT&T/North Beach also occurs within the extent of the Shafter/ Howard Tenant Ranches Historic District. However, it occurs within the F Ranch portion of the historic district, which is not one of the component ranches because it lacks sufficient integrity to be individually eligible for listing in the National Register of Historic Places. The grazing pastures associated with F Ranch to occur within the project area and contribute to the significance of the overall historic district.

Historic Naval Compass Station and Lifesaving Station, c. 1927

The Naval Radio Compass Station/ Point Reyes Life-Saving Station Site covers an extensive area of approximately 10 acres within the B Ranch/A Ranch/Davis property dune system area that contains historic-era artifacts and features associated with the operation of the Point Reyes Life-Saving Station and the Naval Radio Compass Station. The site consists primarily of refuse disposal features and foundation remains. The site was found to be eligible for the National Register of Historic Places for its information potential.

Historic Structures

Historic structures are "material assemblies that extend the limits of human capacity" and comprise such diverse objects as "buildings, bridges, vehicles, monuments, vessels, fences, and canals" (NPS 1998). More than 300 historic structures are found on land managed by the Seashore. The structures range from simple timber-framed barns to the cast-iron Point Reyes Lighthouse to the concrete Mission Revival Marconi transmitting station. Historic structures are found throughout most of the park, except for the wilderness area, and mark the built history of the Seashore. Approximately two-thirds of the Seashore's listed structures are ranch structures managed under leases and permits. The remaining structures reflect the park's maritime and radio communication history.

Four sites are listed in the National Register, including the Point Reyes Lifeboat Station, a National Historic Landmark. Three additional properties have been determined to be eligible for the National Register of Historic Places, and several additional properties are in review. Within the Seashore, 297 historic structures are on the List of Classified Structures, the Park Service inventory of historic and prehistoric structures.

Most of the historic buildings and structures that occur within the extent of Point Reyes coastal dune areas are associated with the four cultural landscapes discussed above. However, there are a number of buildings and structures that occur within these environments that have not been evaluated for their eligibility for listing on the National Register of Historic Places.

VISITOR EXPERIENCE


Birdwatchers

National parks are valued for the recreational and aesthetic resources they provide to the public, both visitors and nearby residents. Park visitors expect national parks to provide beauty, a sense of quiet, and opportunities for hiking, bird-watching, and other recreational pursuits. Perhaps, some of the most valued natural resources within parks in terms of sheer visitor numbers are beach and water-related ones such as beaches, covers, rivers, lakes, oceans, and waterfalls, and even geysers. Beaches, wetlands, and water bodies offer opportunities for hiking, birdwatching, fishing, kayaking and canoeing, boating, and swimming.

With more than 50 percent of its lands in public ownership or conservation easement, Marin County is one of the leaders in the San Francisco Bay region in terms of providing access to both residents and visitors. Some of the largest tracts of undeveloped land within the county are its national parks, including the Seashore and north district of GGNRA. While many parks primarily serve visitors who come from outside the park's region, the majority of the 2.25 million visitors who come to the Seashore each year live in the San Francisco Bay area. In 2012, more than 400,000 visitors visited the three Seashore visitor centers, and more than 50,000 visitors had extended contacts with park interpretative staff through ranger-led programs (J. Dell'Osso, NPS, *pers. comm*.). The main visitor center is at Bear Valley near the park's administrative headquarters, which serves 250,000 people annually (J. Dell'Osso, *pers. comm.*). The nearby trail, the Bear Valley Trail, is the most heavily used trail, with 70 percent of visitor centers users believed to use the trail (J. Dell'Osso, *pers. comm.*).

The Seashore provides backcountry campgrounds, numerous beaches, and 147 miles of hiking trails. Activities include hiking, water sports, horseback riding, fishing, camping, wildlife viewing, and other interpretive opportunities. Hiking is primarily a day-use activity. There are approximately 50 trails throughout the Seashore, and they are found in a range of habitat types, ranging from wooded mountains to sandy beaches. Overnight stays are possible in four backcountry campgrounds: the Stewart Horse Camp, the Point Reyes Hostel, a private campground, and local hotels and inns. Visitors bring horses daily to ride on designated trails, and hundreds rent horses every week from commercial stables.

Though Stinson Beach and Bolinas attract more surfers, North Beach is known as a challenging surfing area. Nature study and wildlife viewing are important activities at Point Reyes. Visitors make special trips to the Seashore to see migrating whales, shorebirds, breeding elephant seals, tule elk, and spring wildflowers. Information received from visitor surveys conducted by Sonoma State University (NPS 1997; 1998b) found that most park visitors spend 2-6 hours at the Seashore in a variety of activities dependent upon the season, ranging from whale watching and kayaking to hiking and bird watching.

The attractiveness of the Point Reyes area to visitors and residents is enhanced by the fact that the western portion of Marin County remains largely undeveloped, even those portions not owned by the Park Service. The pastoral setting of the largely agricultural community draws many visitors, who enjoy both viewing the working farms and purchasing some of the locally produced products in stores within local towns. The beauty of the area has also led to an active artist community that caters to visitors. Tomales Bay and Drake's Bay attracts people interested in the abundant water-based recreational opportunities such as boating, kayaking, and swimming, as well as in purchasing oysters. The "open space" opportunities offered by the Seashore and GGNRA have been greatly enhanced through creation of numerous other open space areas and parks in western Marin County by local and state agencies, including Marin Municipal Water District lands, County Open Space lands, Mt. Tamalpais State Park, Tomales Bay State Park, and several small County Parks at White House Pool, Green Bridge, and Chicken Ranch Beach.

Regulatory and Policy Setting

The Park Service 2006 Management Policies emphasizes that "providing opportunities for appropriate public enjoyment is an important part of the Service's mission" (NPS 2006, Section 8.1). In fact, public education and enjoyment could be considered an integral component of the wetland restoration process. "When practicable, the Service will not simply protect, but will seek to enhance, natural wetland values by using them for educational, recreational, scientific, and similar purposes that do not disrupt wetland functions" (NPS 2006, Section 4.6.5).

Both the Architectural Barriers Act of 1968 (PL90-480) and the Americans with Disabilities Act (ADA) of 1990 (PL 101-336) help to ensure that buildings and other facilities meet set standards to make them accessible to all visitors, including those with disabilities. The Park Service complies with ADA standards and follows the stricter of either the Americans with Disabilities Act Accessibility Guidelines (ADAAG; 36 CFR part 1191) developed in 1991 or the Uniform Federal Accessibility Standards (UFAS) established in 1984. Standards for outdoor recreational facilities are often guided by recommendations from a report issued in September 1999 by a Regulatory Negotiation Committee convened by the Architectural and Transportation Barriers Compliance Board (Access Board) to help guide development of guidelines for facilities such as trails, boating and fishing facilities, parks, and sports facilities.

Based on these guidance documents, the Park Service requires that walks or paths that connect to accessible features need to be made accessible and that key features in the park need to be made accessible. However, paths need to be kept consistent with preserving the natural and cultural resources of the park, if the same experience can be provided on some portion of the alignment or a different trail. California has also developed handicap access standards through California Building Code, Title 24 regulations, although the Title 24 standards are intended for urban facilities and not necessarily rural and park-type trails.

Public Access Opportunities Within the Seashore's Dunes

Very few formal trails exist in or near most of the Seashore's dunes. A single, two-mile public trail leads to the beaches north of Abbotts Lagoon, and, from there, people can walk along the beaches and into the dunes. Trail use is highest on weekends and holidays, with weekdays relegated to joggers, bird watchers, walkers, etc. Bikes and dogs are not allowed on the Abbotts Lagoon trail. People can also access the the beach and dunes at North Beach from a parking lot with limited visitor facilities. Another trail leads from the Limantour parking lot across Limantour Pond out to Limantour Beach, where, again, people can walk up and down the beach and into the thin fringe of dunes behind the beach. Dogs-on-leash and horses are allowed on limited portions of this beach.

The Seashore's beaches and dunes are open to visitors for recreating. Activities include hiking, birdwatching, beachcombing, swimming, and horseback riding, dog-walking, and fishing, where permissible. In general, beaches are much more highly visited than the dunes, perhaps because the invaded dunes tend to discourage visitation due to the thick aboveground cover of both European beachgrass and iceplant that makes traversing through these areas very difficult and limits scenic opportunities.

Noise-free Intervals (NFI) are currently high along the Great Beach of Point Reyes National Seashore, particularly in the vicinity of Abbotts Lagoon. NFI is affected primarily by noise generated from anthropogenic sources. The only routine anthropogenic noise in this area comes from both high and low altitude aircraft, U.S. Coast Guard helicopters, occasional noise from adjacent ranching operations, and occasional use of Utility Terrain Vehicles (UTV) for law enforcement or resource management purposes. At North Beach and Limantour Beach, vehicle noise also occurs, because the parking lot is close, and park vehicles must service public facilities. In general, however, the loud, crashing noise of the ocean waves typically mask out this sound and provide for extended periods of NFI. Sound within and adjacent to most of the Seashore's dune systems are typically associated with wave action, birdlife, cattle, weather, and, to a much lesser extent, visitors.

ADJACENT LAND USE

As discussed earlier under *Natural Physical Processes and Soils*, centuries of grassland establishment and subsequent organic matter deposition in the former dune soils that occur inland of the Seashore's dunes have transformed these once granular, relatively nutrient-poor, well-drained soils into fertile pasture. During the 1800s and much of the 1900s, these former dunelands were turned into dairy ranching operations. With the establishment of the Seashore, almost all of these ranches were acquired by the Park Service, although they were typically leased back to the former owners or former lessees for beef and dairy cattle ranching. Of the park's approximately 70,000 acres, approximately 18,900 acres are currently ranched.

A few properties adjacent to or in the vicinity of dunes were not sold to the Park Service, including the U.S. Coast Guard facility near Abbotts Lagoon, and a number of areas along the western edge of Tomales Bay and in Olema Valley. Ownership of the AT&T property adjacent to the AT&T dunes just recently converted to the park. Near Limantour, all of the land neighboring the dunes is in Park Service ownership and management, with ranch boundaries occurring much further north. These lands include mostly natural areas with a parking lot, public facilities, trails, and some park residential units.

Cows on a portion of dune that is leased as pasture

In the past, most of the leased ranches have operated on agricultural lease/permits that specify the types of agricultural uses authorized, define the number of animal units and animal unit months (AUM) permitted, and address maintenance responsibilities of the rancher, etc.

During the lease renewal process, carrying capacity of the pastures may be re-evaluated. Carrying capacity is evaluated using a number of factors, including soil information, existing herd sizes, "grazeability" of lands as determined from aerial imagery analysis, and on-the-ground knowledge of the ranch. The primary factor used for evaluation is forage production data from the National Resource Conservation Service (NRCS) Soil Survey. The Soil Survey estimates the amount of forage in pounds per acre that each soil type is likely to produce during dry, average, and above-average rainfall years. The park uses average rainfall years to determine forage production for AUM calculation purposes. Certain soil types may be considered to be largely "ungrazeable:" For example, dunes are typically mapped as "Dune land," and NRCS consider these soils to not support vegetation suitable for grazing, so forage production value is essentially zero (SCS 1985). Most of the adjacent soils fall into the Sirdrak series, which has a production rate in normal rainfall years of 2,500 lbs/acre dry weight (SCS 1985). Forage production values for soils in Marin County during normal rainfall years range from as low as 600 lbs/acre (Henneke mapping unit) to as high as 3,500 lbs/acre (Kehoe Variant; SCS 1985).

The soil map for Marin County is considered a small (or coarse) scale map that shows broad mapping unit areas that incorporate one or more major soil types and some minor soil types (SCS 1985). This scale is considered not suitable for ranch or farm planning (SCS 1985). For this reason, the Seashore developed an additional resource to evaluate grazing value of leased lands. A grazeable rangeland GIS data layer was created in 2008 by the Seashore's GIS manager, with direction from the Range Management Specialist. The layer was created by hand digitizing polygons on aerial photos to exclude areas that were dominated by dense brush, trees, sand, rock, etc. which were delineated as "ungrazeable". The Seashore's fence layer was also used to determine "ungrazeable" areas, including those that have been excluded by fencing for various purposes. In addition, this layer includes the developed ranch compounds. Within the layer, much of the dune habitat within grazing SUPs is included as "ungrazeable" area, as these areas are dominated by European beachgrass or other low forage value species such as iceplant, bush lupine, low-growing coyotebrush, and other scrub and dune species. Other factors that may affect carrying capacity are loss of land due to erosion, weed invasion, succession to shrubland, fencing off of riparian habitat or other areas, and dune migration.

The USFWS BO is also used for guidance. As summarized in this regulatory compliance document, "cattle stocking on grazing lands within (the Seashore) is 6.7 acres (2.7 ha) per animal unit (AU) whereas grazing on (GGNRA) lands is 7.5 acres (3.03 ha) per AU. One AU is equivalent to one cow or a cow-calf pair together. The standard residual dry matter at Point Reyes National Seashore is 544 kg (1,200 pounds) per acre (1,344 kg/ha (2,964 lb/ha))." These numbers refer to beef cattle operations only.

Sand Movement

As discussed under *Natural Physical Processes and Soils*, most of the ranchlands adjacent to dunes are marine terraces formed from Aeolian deposition of sands during the Pliocene and Holocene periods (Knudsen and Wentworth 2000; Baye 2008). Grasslands developed on these sandy terraces. Some leases include active dune features such as foredunes and backdunes in the permit; for other leases, dunes are excluded or only partially included. In addition to these so-called active dunes, during certain climatic conditions, even more stable dunes can actively migrate into grasslands (Baye 2008). This migration is apparent as "fingers" of dune habitat within pasture -- at C Ranch, one dune finger extends almost a mile from the beach -- or even isolated dune "islands" some distance from the beach as observed at F Ranch.

Dune burying fence

Dune represents varying percentages of the total leased lands for different ranches, ranging from as low as 2% at G Ranch – most of the dune system is currently outside the lease boundary at this ranch – to 24% at AT&T, with B Ranch estimated at 22% (Johnson 2013a). Prior to establishment of the park, many landowners reportedly planted European beachgrass or iceplant to stabilize dunes and minimize encroachment into the pastures. However, these species may not have curtailed dune movement entirely, as some dune "fingers" continue to extend even without removal of invasive species. Based on analysis of historic aerial imagery using GIS, the dunes have continued to migrate inland over the past 60- 70 years despite rapid spread of these species within the dunes. The rates of inland dune growth between 1943 and 2007 have varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual growth rates during this period of 0.25% to 0.91% (Johnson 2013a). At A Ranch, sand movement has buried boundary fencing in several locations, even though dune areas are stabilized by iceplant, and restoration has not been performed directly near or adjacent to these areas.

Based on analysis of historical aerial imagery, the proportion of ungrazeable pasture within G Ranch lease boundaries due to the presence of barren, sandy areas actually appears lower in 2013 – even with sand remobilization – than in 1963 (Johnson 2013a). In general, sand movement since 2011 has tended to follow established historical sand deposition paths as evidenced by the fact that most of the ungrazeable areas buried were pre-existing dune "fingers" that extended into the pasture, which were already very sandy and dominated by dune and scrub type species. In the 1960s, two decades after European beachgrass was planted at Abbotts, these fingers are very distinguishable on aerial imagery as barren, sandy areas (Johnson 2013a). Over the next 30- to 40 years, these fingers remained within the pasture, but became sparsely vegetated by dune and dune scrub plant species, as can be seen in 2010 aerial imagery (Johnson 2013a). In essence, while there has been an inland creep from the perimeter of the mechanical removal area, this creep has largely been burying areas that had already been repeatedly buried by sand in the past, with some very minor (<1.0 acre) exceptions.

Agricultural uses can be affected by sand movement from restoration activities. Sand movement can bury pastures and decrease the amount of "grazeable" lands and bury fences and increase the amount of maintenance required. In general, ranchers are required by SUP to maintain this fencing in good condition. In addition, sand movement has the potential to bury artificial water sources such as troughs and stock ponds or natural water sources such as creeks or drainages used by cows. The FONSI for the Abbotts Lagoon Coastal Dune Restoration Project acknowledged the potential for loss of grazing land from sand movement and stipulated that the lease should be re-evaluated accordingly if such burial occurred.

Following extensive excavation as part of mechanical removal of European beachgrass at Abbotts Lagoon in 2011, sands that had accumulated from decades of artificial stabilization by European beachgrass were remobilized, with remobilization potentially exacerbated by lack of vegetation establishment during the successive dry winters that were also accompanied by high spring winds. By spring 2013, approximately 10.1 acres of grassland, scrub, and wetland had been buried by newly remobilized sand (Johnson 2013a), which is equivalent to about 3% of the entire 300-acre restoration project area. Of the 10.1 acres, 7.3 acres involved inland "creep" of dunes, with the remainder being internal to the dune system (Johnson 2013a). Of those 7.3 acres, approximately 2 acres occurred in portions of the lease SUP mapped as being on Sirdrak Variant soils and therefore considered "grazeable;" 2 acres represents approximately 0.2% of the 952-acre leased pasture (Johnson 2013a). Of these 2 acres, only 0.8 acre is currently being grazed due to the current fence alignment (Johnson 2013a). Another 3.5 acres of pasture characterized as "ungrazeable" due to its Dune land soil mapping designation were also buried (Johnson 2013a). Of these 5.5 acres, 4.1 acres or 75% occurred within areas previously buried by sand through dune migration (Johnson 2013a).

In contrast to mechanical removal efforts, adjacent backdune areas that were treated with herbicide have not shown any tendency for sand to remobilize. No inland creep has occurred following either the 2011 Phase II or the 2012 Phase III treatment efforts (Johnson 2013a).

Sections of fence were buried by sand movement following both the Phase I and 2009 pilot project at Abbotts Lagoon, although many of these areas were re-fenced by the park after discussions with the rancher about new alignments as part of the restoration project. Sand also migrated into a natural creek that has historically directly abutted the backdunes: In addition to serving as a water source, this drainage supports federally endangered Sonoma alopecurus and federally threatened California red-legged frog. The Seashore has initiated a project to help mitigate for these impacts by creating a new drainage swale nearby that is outside the primary sand migration "paths."

Organic Operations

All dairy operations within the park are certified organic. In addition, a handful of beef operations are either certified organic or are managed as if they are organic. Typically, both the pasture and the animal are certified as organic. In some rare cases, either the pasture or the animal will be certified. For example, non-certified animals can graze on certified organic pasture. In order for beef cattle to be considered organic, the mother must be treated as organic for at least the last one-third of its gestation period, and the calf must then be raised as organic.

A Ranch is a certified organic Grade A dairy that has both year-around and seasonal grazing in its associated pastures. The average annual stocking rate for the year-round dairy operation is 496 animals. This number includes the milking string of approximately 400 animals (50 of which are dry cows at 50 Animal Units), 90 heifers (72 Animal Units) and up to 6 bulls (8 Animal Units). The maximum number of dry cows and heifers allowed to graze at any one time is 135 Animal Units. Seasonal grazing of a smaller number of cows can occur over a six-month period in the headlands area of A Ranch.

B Ranch is a certified organic grade A dairy. There are a total of 466 animals. This includes 240 milking cows and dry cows, 176 heifers on pasture, 30 heifers on dry lots, roughly 20 calves in the calf hutches, and four (4) bulls on the ranch for approximately six (6) months.

The Evans lease-permit on ATT Ranch authorizes 420 Animal Unit Months (AUMs), which would be 35 AU for 12 months. However, AT&T is managed jointly with Rogers Ranch and is not grazed year-round by the current operator. The AT&T lease authorizes up to 90 AU at one time. This is a stocker and some cow/calf operation and is managed using organic principles, although it is not currently certified organic. However, the rancher is planning to seek organic certification.

F Ranch is not an organic operation. The lease currently stipulates grazing of 175 Animal Units (2,100 AUM's annually) of beef cattle. The maximum number of animal units allowed to graze at any one time is 193 Animal Units.

There are certain requirements for organic operations that are not required for conventional operations. For example, fencing posts installed cannot contain any coatings such as creosote or other treatment finishing: Posts must be untreated. New fencing often uses juniper or redwood material for posts.

One of the other restrictions involves herbicide use. Herbicides are not allowed to be used in areas designated as organic. No prohibited substances may be applied to the land for 36 months prior to the harvest of any product that will be labeled or otherwise represented as organic (National Center for Appropriate Technology/NCAT 2004). If herbicides are used in areas adjacent to organic certified or managed pastures, buffers must be established. The Organic Crop Workbook published by NCAT stated that no standardized buffer widths for spraying of herbicide and adjacent areas certified as Organic Crop or Organic Livestock have been developed, but 25-feet is the most common buffer width applied (NCAT 2004). During the design phase of the Abbotts project, park staff communicated with the Marin County Department of Agriculture – Weights and Measures, which recommended a 25-foot buffer, as well (Anita Sauber, Marin County Department of Agriculture, *pers. comm.*). For this reason, the park has standardly employed this 25-foot buffer in addition to a large number of other measures to prevent drift, including weather restrictions and use only of spot spraying with backpacks.

In order to effectively regulate pesticides, the USEPA conducts regular assessments and reviews existing pesticides' potential to impact the environment. By conducting field studies on raw agricultural commodities and processed products derived from crops and livestock, and by analyzing mechanisms of toxicity, the USEPA designates tolerable levels of pesticides in food (USEPA 1999; EPA Residue Chemistry Test Guidelines).

After risk and exposure assessments have been performed, the USEPA sets maximum amounts of pesticide residue that may lawfully remain on a food commodity that has been treated, either intentionally or not, with pesticide. These are known as "tolerances". Tolerances are used on all food and grain crops and also on cattle forage. Residue testing is specified under 7 CFR §205.670 of the National Organic Program, and only certifying agents who review the tests and agricultural products are authorized to perform the tests (USDA Agricultural Marketing Service NOP 5028 Draft). Tolerances also exist for pesticide in livestock, poultry or other meat products as well. Often, the USEPA establishes tolerances for a pesticide and any significant metabolites such that the tolerance is a sum of the "parent" compound and its metabolites.

The National Organic Program defines residues as "too high" when they are greater than 5 percent of the USEPA's tolerance for the pesticide. If the USEPA has not established a tolerance for a pesticide on the product, then "too high" is defined as residues greater than 5 percent of unavoidable residual environmental contamination. This means that samples of the organic product would have to be analyzed for the pesticide, and the resulting value would need to be compared to the federally established standards (Purdue Fact Sheet 2012). In determining whether a product is above or below 5% of the USEPA tolerance, certifying agents must use the results of testing from the raw agricultural product as specified in USEPA guidance or an appropriate processed product, animal tissue or animal product for which a tolerance is established (EPA Residue Chemistry Test Guidelines).

All tolerance values for a wide array of pesticides (including glyphosate and imazapyr, as well as their derivatives or parent chemicals) are published as part of the Code of Federal Regulations (CFR) Title 40, Part 180. The two herbicides being used for dune restoration are glyphosate and imazapyr. The USEPA tolerance limit for glyphosate is 300 ppm for "grass, forage, fodder and hay, group 17," so the 5% tolerance residue would be 15 ppm. For imazapyr, the USEPA tolerance is 100 ppm for "grass forage," which is equivalent to a 5% tolerance residue of 5 ppm.

In the event that residues are detected above and between 5% of the tolerance, the certifying agent is required to immediately notify the National Organic Program (NOP), Food and Drug Administration (FDA), state food safety programs or foreign health agency (if outside of the U.S.), restrict the product from being sold as "organic;" issue notice of noncompliance; and investigate why residues are present. If intentional or direct application of prohibited substances is found, it may lead to suspension or revocation of certification. If residue presence is determined to be due to inadequate buffer zones or inadequate management practices to prevent commingling or contact with prohibited substances, then a notice of non-compliance could be issued by the certifying agent to implement corrective actions to remove contaminant source (from USDA Agricultural Market Service, NOP 5028 Draft).

If residues are detected below 5% of USEPA tolerance level, but are above trace levels, then the certifying agent will notify the operator and the NOP (or State Organic Program (SOP), if applicable) of test results. The product may be sold as organic unless residues are due to intentional or direct application.

Public Health and Safety

Enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks (NPS 2006, Section 8.2). Some of this enjoyment may ultimately depend on health and safety of park visitors. While recognizing that there are limitations on its capability to totally eliminate all hazards, the Park Service – and its concessionaires, contractors, and cooperators – are directed to provide a safe and healthful environment for visitors and employees (NPS 2006, Section 8.2).

For most people visiting dune and beach areas in the park, threats to safety primarily involve hiking on highly uneven, deep sand and sometimes heavily vegetated terrain; exposure to the elements (sun, wind) and potential dehydration; exposure to ticks and poison oak; and ocean-related threats from sneaker waves and unsafe surf conditions.

Additional threats to health and safety can be present during dune restoration projects. In some instances, visitors act as volunteers and assist the park directly with operations such as manual removal of invasives. Manual removal can cause physical injuries to both volunteers and employees such as back, arm, wrist, or hand strains, or ankle sprains. While volunteers would not participate in other types of restoration, improperly supervised chemical control efforts could expose visitors to drift. Mechanical removal poses risks due to use of heavy equipment such as bulldozers and excavators that can cause severe injury or even death if proper safety measures are not employed.

As part of project development, park managers develop or adopt Best Management Practices (BMPs) to limit risk to staff, contractors, and visitors. These BMPs often are drawn directly from regulations and recommendations issued by Occupational Safety and Health Administration (OSHA), USEPA, California Department of Pesticide Regulation (CalDPR), and other agencies regulating fire safety. The Seashore develops Standard Operating Procedure (SOP) guidance for many hazards or potential issues within the park: These SOP typically rely on federal regulations regarding worker and public safety as issued by agencies such as OSHA, USEPA, and CalDPR. Park employees are regularly provided training regarding general safety issues, and job safety is further promoted by use of Job Hazard Analysis (JHA) and Green-Amber-Red (GAR) risk management tools. A JHA is a second tier risk assessment that attempts to prevent personal injury by identifying job-related hazards before they occur and steps that can be taken to eliminate or reduce hazards to an acceptable risk level. Task- or project-specific risks are assessed through use of a GAR to identify and either eliminate risks of associated activities or greatly reduce them. In addition to general safety measures, employees who manage herbicide application are certified as Qualified Applicators by the CalDPR and meet safety training requirements necessary to maintain accreditation.

To ensure that restoration projects do not negatively impact the health and safety of park visitors, managers of maintenance and construction projects within the park take measures to notify and\or temporarily re-route public access and to ensure that the public does not come too close to construction equipment and areas, herbicide spraying, mowing, or prescribed burn operations. Most of these measures involve posting notices at trailheads and work area entrances regarding the activity being undertaken and any precautionary measures. Information may be posted on the web-site: If work areas are to be closed, advance notice will be provided at the trailhead and possibly on the website, and a press release may be issued.

In addition to direct threats to public safety from dune restoration, some indirect threats exist, as well. These include the potential for dune restoration to remobilize sands, which can deposit on adjacent roadways and cause issues with traction for vehicles, motorcycles, and bicycles. The park does not maintain specific records on the number of accidents related to slippage due to sand, but accidents have occurred, particularly in the southernmost portion of the Point Reyes Headlands: Most of these accidents have involved motorcycles (R. Feickert, NPS, *pers. comm*.). To increase public safety, this section of road has been posted with signs, cautioning drivers and others about sand drifts.

During restoration of dunes conducted several years ago at A Ranch, a "buffer" of unremoved iceplant was retained adjacent to Sir Francis Drake Boulevard to trap sands mobilized from adjacent restoration areas where iceplant was removed and to minimize "sand drift" onto adjacent roads. While no formal analyses have been performed, park records document that maintenance staff has removed sand from this section of road a number of times over the years, however, sand removal pre-dates restoration at A Ranch, suggesting that sand drift occurs with and without restoration.

Other indirect threats include smoke from prescribed burning. Implementation of a prescribed burn must comply with the Seashore's Fire Management Plan and Park Service policy. Additionally, a burn plan must be prepared, and required permits must be obtained. The burn would be conducted by the Seashore's Fire Management staff in collaboration with cooperators from local fire departments and resource management agencies.

Prescribed burns typically occur in the fall between August 15 and December 15. The Seashore notifies Bay Air Quality Management District (BAAQMD) 24 hours prior to burning and on each burn day to obtain a meteorological forecast, determine whether it is an approved burn day, and request an acreage allocation before burning. Burning does not occur 1) on holidays or weekends, 2) on "no burn days" as determined by BAAQMD unless a variance is requested and granted or 3) if the National or Regional Preparedness Levels preclude new prescribed fires.

One week prior to burning, burn notification flyers are delivered to residents and businesses near the location of the burn. Flyers are posted on bulletin boards and in post offices, and a press release is typically sent to local media. As noted above, on burn days, prescribed fire warning signs are placed at trailheads, parking lots, and other public access locations.

Wind flow and direction is monitored by the crew prior to and during ignition, and smoke emission and behavior is continually monitored and documented. If hazardous or unhealthful smoke conditions are observed in Smoke Sensitive Areas, the Fire Management Officer advises the Chief Ranger and the Fire Information Officer, who would coordinate notification about smoke conditions and potential health impacts. Hazardous conditions can be defined as chronic smoke that reduces visibility to less than 3 miles in Smoke Sensitive Areas: Short-term reduced visibility in the immediate fire vicinity should not cause hazardous conditions. Unhealthful conditions can be defined as chronic smoke that exceeds federal ambient air standards in a Smoke Sensitive Area.

PARK OPERATIONS AND MANAGEMENT

In fiscal year 2014 (FY2014), the Seashore employed approximately 80 permanent staff, 15 term employees, and 35 temporary staff working on a variety of projects and programs, including Natural Resources, Cultural Resources, Science, Maintenance, Interpretation and Education, Roads and Trails, Fire, Law Enforcement, Administration and the Pacific Coast Learning Center. During the peak summer months, the park staff increases to about 130

Visitor facility

staff members. This work force is supplemented by 40,000 hours of Volunteers-in-Parks service.

The Seashore maintains the necessary infrastructure to support an annual park visitation of 2.25 million people and to provide offices, support structures and limited housing for the permanent and seasonal park staff. The Seashore also administers approximately 19,000 acres of the north district of GGNRA. Slightly less than half of the Seashore – the 32,373-acre Philip Burton Wilderness Area – must be managed in conformance with the 1964 Wilderness Act, Park Service Management Policies (NPS 2006, Chapter 6), and the Director's Order and Reference Manual 41 for Wilderness Preservation and Management. The Wilderness Act requires that, except as necessary to meet the minimum requirements for the administration of a wilderness area, "there shall be no temporary roads, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, or no other form of mechanical transport, and no structure or installation" within the wilderness (16 U.S.C. 1131 et seq., Section 4 (c)).

Permanent park structures outside the wilderness area include:

- 3 visitor centers
- 2 environmental education centers
- 30 restroom complexes
- 4 backcountry campgrounds
- 17 water systems
- 147 miles of trails
- Over 100 miles of roads
- Over 100 public and administrative structures, and
- 27 sewage treatment systems

The Seashore also manages and protects park cultural resources including:

- 297 historic structures
- 127 recorded archaeological sites
- 11 identified cultural landscapes
- 498,000 museum objects

Financial resources available to achieve the park's annual goals include a base-operating budget of approximately $7.5 million. In addition, the park receives supplemental support for fire operations, cyclic maintenance, special natural resource projects, and repair and rehabilitation of structures.

Projects within the park are often funded separately from park operations, with funding coming from Park Service, federal, or other sources. Park projects typically require time from a number of staff within the park, including those in Contracting, Budget, Administration, Interpretation, Cultural Resources, Human Resources, Facilities (including Roads and Trails), Natural Resources, and possibly Law Enforcement and Fire.

Apart from the Park Service program, there are numerous leases within the Seashore, including businesses, service agencies, farms, and ranches. Leases include:

– 6 dairies

– 9 beef cattle ranches

– Silage production on approximately 1,000 acres of land, and

– Water supply to Bolinas Community

Park Operations Within the Seashore's Dunes

Park operations near coastal dunes are minimal. Visitor facilities such as restrooms, parking lots, roads, and trails have been constructed near beach access points at Abbotts Lagoon, Limantour, North Beach, and South Beach. Also, Sir Francis Drake Boulevard is adjacent to some dune and beach habitat as it nears the Lighthouse. These facilities require consistent maintenance, such as cleaning and servicing of restrooms, repair and maintenance of trails, repair and removal of sand from roadways and parking lots. However, in general, there are few or no facilities to maintain within the dunes themselves. One exception is fencing, which has been erected in many dune systems adjacent to ranches to keep cattle out of sensitive habitat for threatened and endangered species. In general, ranchers are required to maintain this fencing in good condition. Restoration projects have the potential to affect the intensity and frequency of maintenance for both park staff and leases by increasing sand transport that can blow sand onto roadways and bury fences.

In addition to maintenance, park staff also monitors many of the threatened and endangered species in conformance with conditions of the park's Recovery Permit, which covers western snowy plover, as well as all of the endangered plants, two of which occur in the dunes. Staff time is also needed to manage or implement maintenance or re-treatment in restored dune systems to ensure that invasive, non-native species do not return.

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ENVIRONMENTAL CONSEQUENCES

The role of impact analysis is to "fairly, objectively, and candidly display the projected impacts of each alternative" (NPS 2004 *in* NPS 2009). The potential impacts of each alternative on the environment are analyzed for each of the impact topics or subtopics discussed in Chapter 3. For each of the impact topics, an indicator or a suite of indicators is chosen for analysis based on U.S. Department of Interior (DOI) NEPA-related guidance, laws, regulations, and policies. In using indicators, the Council on Environmental Quality (CEQ) requests that impacts be quantified as much as possible and described in terms of their context, duration, and intensity, which are described more below (NPS 2001a). In addition, impacts must include not only direct impacts from project implementation, but indirect and cumulative impacts: these are impacts that are either indirectly associated with implementation of the proposed project or that result from actions taken outside the proposed project that affect the same resources as the proposed project.

In addition to presenting the analysis of impacts, Chapter 4 describes the methodology used to evaluate potential impacts from not taking the proposed actions (No Action) and three action alternatives that involve different approaches to taking the proposed actions. Generally, impacts of the action alternatives are analyzed *relative* to the No Action alternative — that is, they are compared to the impacts of no change from the current approach. It is the *incremental* change in the condition of a resource that would likely occur if an alternative is implemented that is analyzed and reported in the impact analysis section.

This chapter first outlines a general methodology common to all impact topics. Impacts will be evaluated using standard definitions of context, intensity, duration, and type of impact unless indicated otherwise. The discussion of impacts may be preceded by any additional discussion of regulations, laws, policies, or ordinances needed to understand the framework for evaluation. An introduction to the relevant regulations, laws, policies, and ordinances often used to frame the description of the Affected Environment impact topics can be found in Chapter 3 for most of the impact topics. The impact topic methodology section may also incorporate the assumptions used in evaluating impacts and the specific thresholds used to assess intensity, if they are different from the standard ones outlined in the beginning of this chapter.

The impact analysis section then assesses the potential impact of No Action or not taking the proposed actions (Alternative A) and three action alternatives on each resource, characterizing the intensity, duration, and context of the impacts, as well as indicating whether they are direct or indirect. If measures, such as standard best management practices (BMPs) for example, are mandatory or are certain to be implemented, impacts are analyzed assuming the measures are in place. These mitigation measures are described in Chapter 2. However, if mitigation depends on funding, permits or other decisions that are not absolute, impacts are analyzed both with and without mitigation in place.

These impacts are then assessed relevant to other ongoing or reasonably foreseeable future projects within the park and local region or other appropriate frame of context to determine cumulative impacts to the resource or impact topic. The information for each impact topic is then summarized in a conclusions section.

General Methodology for Assessing Impacts

National parks are directed to assess the extent of impacts on resources and services as defined by the context, duration, and intensity of the effect. For the purposes of this document, potential impacts are generally described in terms of the nature of the impact (*Are the effects beneficial or adverse*?), duration (*Are the effects restricted to the implementation period? Are they short term? Are they long-term?*), intensity (*Are there no effects or would effects be negligible, minor, moderate, major?*), type of impact (*Are the effects direct, indirect, and/or cumulative?*), and context (*Are the effects localized to the project area?, park?, or region?*). A more detailed description of these categories and the general methodology for impact analysis can be found below.

Nature of Impacts

Impacts from the proposed project can either be ***Beneficial*** by enhancing or improving resource values or ***Adverse*** by degrading or lessening resource values. Some actions can have both adverse and beneficial impacts. In addition, in some cases, the change would be considered neutral or not really beneficial or adverse. These neutral impacts are not evaluated in Chapter 4.

Intensity of Impacts

The evaluation of impact intensity represents one of the most important parts of Chapter 4. It describes the degree to which an impact would affect a given resource. For analysis purposes of this document, impacts are generally described as: ***No impact*** (causing no change); ***Negligible*** (causing no measurable change or change that is barely detectable and often within the natural range of variability); ***Minor*** (causing small, but detectable or measurable change); ***Moderate*** (causing apparent or appreciable change); or ***Major or Substantial*** (causing striking, highly-noticeable change).

Duration of Impacts

Duration describes the length of time that an impact would affect a given resource. Many impacts can occur over multiple timeframes or duration periods. Duration is generally described as: ***Implementation*** (restricted to the implementation period only); ***Short-Term*** (restricted to the first two years or so after restoration); or ***Long-Term*** (occurring after the first two years or continuing beyond the first two years).

Type of Impacts

Type describes the type of relationship between the proposed actions and the impact. Type is generally described as: ***Direct*** (actions would directly effect this change); or ***Indirect*** (actions would not effect this change, but would enable change to occur, or change would occur later in time, or farther in distance than the actions); and/or ***Cumulative*** (actions would have an additive effect with the actions of other past, ongoing, or reasonably foreseeable future projects).

CEQ regulations implementing NEPA defines a cumulative impact as "…the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (CEQ Section 1508.7). In other words, cumulative impacts are the impacts of actions independent of those in this proposal. They are impacts that are already occurring or expected to occur in the reasonable future on the same resources as would be affected by the proposed dune restoration.

Context of Impacts

Context describes the geographic setting within which an impact is analyzed. A ***Localized*** impact is one that occurs within the restoration project area or in its immediate vicinity. A ***Park-Wide*** impact would apply to those impacts that occur within the Seashore and immediately adjacent non-park lands. A ***Regional*** impact is one that takes place on a scale larger than the park – mostly likely at a county-wide scale or the scale of the San Francisco Bay area or central California.

VEGETATION RESOURCES

Policies and Regulations

Park Service Management Policies (2006) regarding the eradication of non-native plant species and the restoration of native plant and animal species to return the dune ecosystem to a more natural state are part of the motivation for taking action as noted in Chapters 1 and 3 of this EA. Because policies are fully discussed as part of those chapters, they are summarized here: if exotic species can be eliminated and control is "prudent and feasible," the National Park Service (Park Service) is required to manage up to the level of eradication if the exotic species interferes with natural processes or native species (NPS 2006; Sections 4.1.5, 4.4.4.2). In addition, the Park Service is required to maintain all plants (and animals) native to park ecosystems by preserving habitat, restoring populations, and minimizing human impacts (Section 4.4.1).

Wetlands are addressed separately in impact analysis from other vegetation types as part of the *Water Resources* section as they are protected by a specific set of laws and regulations under the Clean Water Act. Special wetland communities are addressed here.

Assessment Methodology

Vegetative communities in the park have been mapped using either GIS or field mapping. The assessment of impacts of treatment assumed the mandatory mitigation described in the *Alternatives* section of this EA and projected the effect that treating European beachgrass and iceplant with different methods or approaches might have on neighboring native vegetation communities.

Impact Thresholds

Negligible**:** There would be no measurable or detectable adverse or beneficial changes in the geographic or areal extent of any native vegetative plant community and its integrity, species richness, or species diversity, or any changes would be within the range of natural variability. No measurable detectable changes to sensitive plant communities would occur. Key environmental conditions influencing plant communities (such as soils and water quality) would not be measurably affected, or change would be within the natural range of variability. There would be no measurable or detectable change in the number or abundance of non-native plant species.

***Minor**:* Measurable adverse or beneficial changes in the geographic extent of a native vegetative plant community and its integrity, species richness, or species diversity may occur, but its viability would be unaffected. Slight or small changes to sensitive plant communities may occur. Changes in environmental conditions influencing plant communities (such as soils and water quality) would be at the lower levels of detection. The potential for beneficial or adverse changes in the number or abundance of non-native plant species would be detectable, but small.

Moderate**:** Noticeable adverse or beneficial changes in the geographic extent of a native vegetative plant community and its integrity, species richness, or species diversity may occur within the park, but even if changes are adverse, the viability of this community on park lands would remain. Detectable changes to sensitive plant communities, including wetlands, may occur, but effects are likely to be localized, not park-wide or regional. Changes in environmental conditions influencing plant communities (such as soils and water quality) would be measurable. The potential for changes in the number and abundance of non-native species would be noticeable on a park-wide basis.

Major**:** Striking changes in the geographic extent of a native vegetative plant community and its integrity, species richness, or species diversity may occur on a par-wide or even regional scale. Although the communities would remain viable regionally, communities on a park-wide scale may be eradicated if the impact is adverse. Beneficial impacts to native vegetation communities, including wetland communities, may include substantially increasing acreage of a native vegetation community within the park, its range, or on a regional scale. Changes in environmental conditions influencing plant communities (such as soils and water quality) would be striking and highly noticeable. The potential for changes in the number and abundance of non-native plant species within the park would be striking and highly noticeable.

Impact of Alternative A

Analysis

Under this alternative, there would be no near-term restoration efforts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although already permitted projects would still move forward.

Long-Term Effects

Over the long-term, Alternative A would likely result in negligible to minor adverse impacts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour for certain native vegetation communities such as Dune Mat and Dune Scrub, but perhaps only minor beneficial impacts on a park-wide basis. Certain communities such as Native American Dunegrass and bog-like Dune Swale Wetlands are restricted enough currently within the park and regionally that the No Action is likely to have either no effect or no more than negligible adverse effects.

These adverse effects would result from continued, unchecked expansion of European beachgrass (*Ammophila arenaria*) and iceplant (*Carpobrotus* spp.) into remaining native vegetation communities. These three general dune system areas – AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour -- already support considerable acreage of invasive, non-native species, and these invasive species would be expected to continue to expand at an accelerated rate. At one dune system in northern California (Lanphere-

Christensen Dune Preserve in Humboldt County), European beachgrass increased – and bare sand decreased – in cover nearly 600% over a four-year period (Buell 1992, Buell et al. 1995). During a 19-year span, from 1986 to 2005, iceplant vegetative cover in MacKerricher State Park increased by 300%, not including the multitude of seedlings and individual plants too small to map (Warner 2006 *in* CDPR 2012). Another study found that European beachgrass and bush lupine (*Lupinus arboreus*) associations had displaced a pre-existing native vegetative dune community 20 years after these species had been found (Parker 1974; LaBanca 1993 *in* Pickart and Sawyer 1998). Between 1943 and 1994, vegetated dunes appeared to increase in the Seashore by 33% relative to unvegetated dunes based on analysis of historic aerial imagery (Forrestel et al., *in prep*.): most of this increase is likely due to European beachgrass and iceplant.

As discussed extensively in Affected Environment, European beachgrass and iceplant not only directly displace native and sensitive vegetation communities, but beachgrass also indirectly affects remaining communities by decreasing native species richness (Boyd 1988) and native species diversity (Barbour et al. 1976). Iceplant and bush lupine also negatively affect dune soils and water availability (D'Antonio and Mahall 1991, D'Antonio and Mahall 1991, Vilà et al. 2006, Conser and Connor 2009, de la Peña et al. 2010, Santoro et al. 2011), which renders these dune areas less hospitable to native dune species, particularly primary successional ones. Iceplant areas often have reduced pH and different levels of organic matter, carbon, and nitrogen than areas without iceplant (D'Antonio and Mahall 1991, Vilà et al. 2006, Conser and Connor 2009, de la Peña et al. 2010, Santoro et al. 2011, Winsemius 2013). As a nitrogen fixer, bush lupine has also been associated with higher nitrogen or organic matter levels (Gadgil 1971, Palaniappan et al. 1979, Skeffington and Bradshaw 1980, Maron and Jeffries, unpub. data *in* Maron and Connors 1996). Both species appear to outcompete adjacent shrubs, herbs, and grasses for water.

Implementation-Related and Short-Term Effects

There would be no impact at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, as restoration would not be conducted in these areas in the near-term, except for previously permitted projects.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Primary projects with the potential to have cumulative effects with this alternative on native dune vegetation communities would be restoration of coastal dunes at Bodega Marine Laboratory in Sonoma County, continued restoration of coastal dunes at Tom's Point in Marin County, possible dune restoration that might be conducted at Lawson's Landing, and small-scale dune restoration efforts being conducted as part of the Muir Beach Restoration Project at Golden Gate National Recreation Area (GGNRA). The Wildlife Protection and Habitat Improvement Plan proposed by Marin Municipal Water District (MMWD) would principally affect vegetation communities such as oak woodland and grassland habitats, so it would be unlikely to have a cumulative effect with this project on the same types of coastal native vegetation communities. From a regional perspective, based on the scale of projects proposed outside the park, the No Action Alternative would likely have only negligible beneficial effects on native dune vegetation communities due to the fact that no near-term restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these external dune restoration efforts end up being conducted concurrently. Projects conducted outside the park would be unlikely to adversely impact coastal grasslands or prairie as at least two of these projects would not require access or staging to be located in these types of vegetation communities, therefore, cumulative impacts to these communities would be negligible on a regional scale.

Conclusions

There would be no implementation-related impacts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, as restoration would not be conducted in these areas in the near-term, except for previously permitted projects. European beachgrass and iceplant would continue to expand at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour into native Dune Mat and Dune Scrub vegetation communities, causing at least at least negligible to minor adverse impacts to remaining native plant communities.

From a cumulative perspective, the No Action Alternative would offset benefits provided by dune restoration projects conducted outside the Seashore, resulting in negligible beneficial effects on the extent of native Dune Mat and Dune Scrub in the region, with a potential for negligible adverse impacts should external dune restoration efforts be conducted concurrently.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Both initial treatment and re-treatment would be conducted using manual methods.

Long-Term Effects

Restoration has proven successful in restoring dune communities, including some restoration projects in which manual removal was the primary treatment approach. A 1988-1989 manual removal project successfully eliminated beachgrass, had relatively low re-treatment needs in the second year, and increased native plant cover from 2.7% to 38% (Pickart and Sawyer 1998). In the Point Reyes Headlands, native species cover in plots manually treated rose from 16% pre-treatment to 31% in 2010 (Hamingson and Voeller 2011). A study at Fort Funston in GGNRA found that areas where iceplant had been removed had higher native plant species richness and total percent cover than unrestored areas or areas where visitor access was restricted (Russell et al. 2009).

However, manual removal projects tend to be very labor intensive. The Humboldt projects were estimated to require at least eight (8) visits during the first year and seven (7) visits the second year, followed by additional treatment during a third year (Pickart and Sawyer 1998). Labor was estimated at 2,951 person hours per acre for all three years (Pickart and Sawyer 1998).

Further south, in Mendocino County, another hand removal project was conducted from 2000-2004 using California Conservation Corps (CCC) crews and California Department of

Forestry and Fire Protection (CalFire) crews varying from 3 to 13 people (CDPR 2012). After approximately 3 years, 5.5 acres had been pulled 5-8 times to a point where re-treatment was reduced to several days work a few times a year for a crew of three (CDPR 2012). An additional 10.4 acres were pulled; however, project funding only allowed for 2-3 total pull-efforts, and much of the European beachgrass grew back (CDPR 2012).

From a long-term perspective, manual removal of European beachgrass is more time-consuming and intensive in terms of re-treatment needs than other removal techniques: there is not a dramatic decrease in the amount of re-treatment required after each re-treatment event. There are less logistical constraints in terms of weather with manual removal than herbicide treatment, but seasonal restrictions associated with special status species would apply, which would limit when and where manual removal could be performed, particularly during the spring and summer. In addition, with successful treatment costs ranging approximately from $35,000 to $55,000/acre, fewer acres of dunes could be potentially restored at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour if only manual removal techniques were used.

In addition to being more time-consuming, hand removal of European beachgrass is also ultimately less effective in eradicating this species due to the deep depth of its rhizomes, which can extend from 3 to as deep as 15 feet below the ground surface (Salisbury 1952; Buchenau 1889). Even small rhizome fragments (<2 inches) can sprout roots, so, if digging and disposal efforts are not carefully conducted, this localized extent of this species can be inadvertently increased. Manual removal may lead to invasion by other non-native invasive species such as iceplant (Russo et al. 1988 *in* IUCN AMAR Management info).

Some of the initial restoration at Abbotts Lagoon also was conducted using primarily manual removal, although the park switched approaches, because results were poor. Even with at least 15 to 20 repeat treatments (Peterson 2004), the area directly south of the Abbotts Lagoon mouth had been completely recolonized by European beachgrass by 2011. Some additional manual removal of European beachgrass was performed subsequently at the Point Reyes Headlands: initial removal only was estimated to require 303.3 hours/acre, and re-treatment is still continuing.

From a European beachgrass perspective, this alternative would have at most only a negligible to very minor beneficial effect on native vegetation communities at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. The acreage that could be restored would be lower than under the other action alternatives. Also, the continued encroachment by European beachgrass into native Dune Mat, Dune Scrub, and even wetland communities in unrestored areas would be more severe than under the other action alternatives.

In terms of manual removal of iceplant, these projects are typically less intensive, require less re-treatment, and are more successful long-term. Iceplant roots less deeply than European beachgrass, with excavation of only the top 6 inches typically sufficient to remove most of the root mass. Removal of iceplant by hand from dunes in Spain, where iceplant is also considered an invasive, resulted in approximately 52% of the plots having no reestablishment following treatment (Andreu et al. 2010). Most of the resprouts came from smaller iceplant individual, which likely established through seed from the seedbank (Andreu et al. 2010). Re-treatment would be expected to require two treatments per year over two years, with total treatment costs considerably less per acre than European beachgrass - $13,000 to $19,000/acre. However, hand removal is more difficult and time-consuming when iceplant patches are very dense.

Not all iceplant hand removal projects have successfully restored native dune vegetation communities. In Spain, removal of iceplant caused a significant increase in species richness, particularly of annual plants, but not necessarily native species cover or diversity (Andreu et al. 2010).

Also, even if iceplant is removed, native dune vegetation communities may not be able to be fully restored. Iceplant not only alters soil properties over the long term, but appears to have allelopathic effects on adjacent plant species (D'Antonio and Mahall 1991, de la Peña et al. 2010, Santoro 2011, Vilà et al. 2006, Novoa et al. 2012), and can either outcompete other species for water (D'Antonio and Haubensak 1998) or establish in drier conditions (Novoa et al. 2012). Iceplant leaves have high contents of tannin and antibacterial compounds that may reduce litter decomposition rates (Van der Watt & Pretorius 2001 in Vila et al. 2006) and leach into the soils, and this leachate may acidify dune soils (D'Antonio and Haubensak 1998, D'Antonio and Mahall, unpub. *in* Conser and Connor 2009). Soil acidification occurs naturally with dune succession, but iceplant invasion speeds up this process (D'Antonio and Mahall, unpub. *in* Conser and Connor 2009).

These soil changes may preclude re-establishment of certain types of native dune vegetation communities, such as primary or mid-successional ones, and ultimately favor later successional ones or even Dune Scrub. In areas where native dune exists with iceplant, the presence of iceplant appears to drive the successional status of native dune "pockets" towards a more mature, late successional community supporting species such as dune buckwheat (*Eriogonum latifolium*), dune sagebrush (*Artemesia pycnocephala*), sea thrift (*Armeria maritima*), gumplant (*Grindelia stricta*), sand mat (*Cardionema ramosissimum*), and woolly lotus (*Lotus heermanii*). Even if the duff layer is removed during manual removal of iceplant, soils may still remain highly altered relative to native dune soils and preclude establishment of certain species or types of communities. Studies conducted in Spain suggested that success of iceplant removal efforts could be compromised by lingering allelopathic effects (Novoa et al. 2012). Therefore, even if duff could be raked up -- which increases the level of effort, time, and cost per acre – this action may or may not increase the likelihood of establishing more primary successional dune species.

It may be that only mechanical removal could effect changes in soil properties, at least on an immediate and short-term basis, such that establishment of more primary successional communities could occur in iceplant-invaded areas. A recent greenhouse study showed higher germination for both the federally endangered beach layia (*Layia carnosa*) and the rare curlyleaf monardella (*Monardella sinuata ssp. nigrescens*; California Native Plant Society (CNPS) List 1B.2) in native and, to a lesser extent, mechanically restored "flipped" soils than in soils from iceplant area where duff or surface organic matter was or was not removed (Winsemius 2013). Growth of at least beach layia also responded to soil factors, with aboveground biomass actually highest in the native and no-duff iceplant soils (Winsemius 2013).

From an iceplant perspective, this alternative could have a minor beneficial effect on native vegetation communities at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. The acreage that could be restored would be lower than under the other action alternatives, however, because large, dense patches are difficult to remove manually.

Due to the fact that excavation for invasives removal does not typically extend below 1.5 feet under this alternative, manual removal would not be expected to have more than a negligible adverse impact to adjacent vegetation communities such as Coastal Grasslands and Coastal Prairie due to sand movement into these areas. These impacts would be mediated by active revegetation of backdune areas to rapidly establish native shrub species that can stabilize sands in lieu of European beachgrass and iceplant.

Overall, this alternative would have at most only a negligible to minor beneficial effects on native vegetation communities at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour where near-term restoration would be conducted, with slightly higher level of benefits realized at B Ranch, A Ranch, and Davis Property due to the fact that iceplant can be removed more successfully than European beachgrass by hand, and the southern portion of the Great Beach is more heavily dominated by iceplant. As less restoration could probably be effected using manual removal, the level of benefit to native vegetation communities in these systems is reduced relative to Alternatives C and D. Use of manual removal as the primary control method, as well as active revegetation in backdunes, would help to minimize movement of sand into adjacent Coastal Grasslands and Coastal Prairie.

Implementation-Related and Short-Term Effects

Access and Staging: Most of the potential for effect in Dune Scrub and Coastal Grasslands and Prairies would be due to the need to access sites and stage restoration efforts adjacent to coastal dunes. Proposed impact avoidance and minimization measures include using existing ranch roads to the maximum extent practicable; siting staging areas outside of sensitive vegetation communities to the maximum extent practicable; and locating any new access routes such that they avoid sensitive vegetation communities, including wetlands, and special status or important plant species such as the only larval plant for the federally endangered Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*) –western dog violet (*Viola adunca*). There is a potential for construction equipment or equipment used during implementation to introduce new non-native species within access routes or staging areas. The Seashore requires that all construction or other equipment be cleaned before being deployed and may require that tires of vehicles be cleaned prior to exit to limit spread of established non-native invasive species elsewhere in the park.

Based on these measures, staging and access may have a negligible to possibly minor localized adverse impact on Dune Scrub and adjacent grasslands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with more negligible impacts at Limantour and possibly North Beach and Davis Property due to the fact that primary access and staging would largely occur in already developed areas such as parking lots and maintenance access roads. At AT&T/North Beach and B Ranch/A Ranch Dunes, potential impacts to grassland vegetation communities would remain negligible. Both of these general dune system areas would be accessed either partially or primarily by existing ranch roads at AT&T, B Ranch, and A Ranch. Any new access route requires would be coordinated with the ranchers and would be carefully sited to avoid wetlands, rare plants, and western dog violet. Staging areas would be located on the oceanward side of the fences separating pastures from dunes to minimize the impacts of staging on ranching operations. Contractors would be required to maintain the condition of roads, fences, and gates and to ensure that operations have the most minimal impact impossible on ranching operations.

Under Alternative B, adverse impacts associated with access and staging would be more negligible than under Alternative D and potentially Alternative C due to the fact that heavy equipment would not need to access or be staged in these adjacent grassland or dune transition areas. There would still be access required for crews, trucks, and potential all-terrain vehicles (e.g., UTVs).

Manual Removal: The primary implementation-related impacts associated with manual removal are trampling of native vegetation by contractor crews, volunteers, and/or park staff; trampling of native vegetation by use of all-terrain vehicles such as UTVs; and possible impacts to adjacent native vegetation from digging out either European beachgrass or iceplant. Digging can disrupt the root systems of adjacent native plant species. Manual removal is currently used for sparse areas of iceplant and for European beachgrass directly adjacent to rare or native plants or in wetlands.

Some impacts may occur, as well, from on-site disposal of biomass. This would only occur for iceplant and certain other species such as bush lupine if flowers are removed before disposal. Disposal areas would be sited to the maximum extent practicable outside of larger native dune vegetation areas. If possible, biomass would be disposed of in stands of European beachgrass and iceplant not designated for treatment. European beachgrass would only be disposed of on-site if an area could be found where material could be placed without the potential for it to get blown around by high winds: siting of disposal areas is much more sensitive for this species due to its propensity to resprout easily from even the smallest rhizome.

Based on the factors discussed, including proposed impact avoidance and minimization measures, impacts to native vegetation communities would be characterized as negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, because most of the expanded manual removal acreage would occur in dense European beachgrass or iceplant stands, where only a few native species typically occur intermixed within the stands.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Project with the potential to have a cumulative impact with those under this alternative on Vegetation Resources would be the same as those discussed under Alternative A. From a regional perspective, dune restoration projects conducted within and outside of the park would likely have negligible cumulative beneficial effects on native dune and wetland vegetation communities, with the potential for negligible adverse impacts during implementation should some of these efforts be conducted concurrently. Projects conducted outside the park would be unlikely to adversely impact coastal grasslands or prairie as at least two of these projects would not require access or staging to be located in these types of vegetation communities. Therefore, combined with potential negligible adverse impacts of projects at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, cumulative impacts to coastal grassland or prairie communities should remain very negligible on a regional scale.

Conclusions

Dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would result in negligible to minor beneficial effects on native vegetation communities such as Dune Mat and Dune Scrub, with minor benefits expected for iceplant removal efforts at B Ranch, A Ranch, and Davis Property. Additional benefits to native vegetation communities, particularly Dune Scrub, would also occur from conducting active revegetation in the backdunes, which would jumpstart native species establishment. Revegetation efforts would also help to stabilize sands in the backdunes and, thereby, minimize impacts to adjacent Coastal Grasslands and Coastal Prairie from sand movement.

It is likely that European beachgrass and iceplant could continue to spread in areas within AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour where restoration is not conducted due to higher costs of manual removal and funding constraints and possibly in areas where European beachgrass is manually removed, thereby countering some of the benefits from restoration. In addition, restoration efforts may be hampered by changes to soils brought about by iceplant and other species.

Adverse implementation-related impacts to native vegetation communities and native plant species would likely be negligible to possibly minor at AT&T/North Beach, B Ranch/A Ranch/ Davis Property, and Limantour. Potential impacts to Dune Scrub, Coastal Grassland, and Coastal Prairie associated with access and staging would be reduced relative to Alternative D and, potentially, Alternative C due to the fact that no heavy equipment would be required to access or be staged in these areas and would also be negligible.

From a cumulative perspective, because the amount of restoration that could be implemented may be reduced relative to Alternatives C and D, this alternative would have no more than negligible beneficial effects on native dune vegetation communities within the region, given the scale of other dune restoration efforts proposed outside the park.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Long-Term Effects

The primary method proposed under this alternative – herbicide control – has been found to be very effective at controlling European beachgrass and iceplant (Hyland and Holloran 2005, CDPR 2012, Pickart and Sawyer 1998). In the Point Reyes Headlands, native species cover in plots treated chemically rose from 30% pre-treatment to 48% in 2010 (Hamingson and Voeller 2011).

The mixture of glyphosate with imazapyr has apparently been particularly successful in treating almost 80- to 90% of the European beachgrass with as little as one to six treatments, and the extent of re-treatment drops dramatically after each re-treatment event (Hyland and Holloran 2005, CDPR 2012). Herbicide has also been shown to be very effective in treating iceplant, with very little re-treatment required. The decrease in effort required for re-treatment would mean that resources could be reallocated to expanding the extent of area restored. Costs of this technique also appear to be lower, ranging currently from $1,200 to $3,000/acre depending on species, site conditions, and amount of re-treatment. Lowered costs could result in more acres being restored than under Alternative B or Alternative D, where primary treatment methods would be manual or mechanical removal, respectively.

Not only does this treatment method control European beachgrass and iceplant, but spot-spraying appears to be effective at limiting impacts on non-target species. Monitoring conducted after herbicide treatment of European beachgrass at Abbotts showed that much of the non-target perennial species such as coyotebrush (*Baccharis pilularis*) and mock heather (*Ericameria ericoides*) intermixed within stands remained alive (Johnson 2013b). In addition, a high number of species established after treatment, including miner's lettuce (*Claytonia perfoliata*), wild cucumber (*Marah fabaceus*), yarrow (*Achillea milleflora*), woodland groundsel (*Senecio vulgaris*), coast cryptantha (*Cryptantha leiocarpa*), seaside fiddleneck (*Amsinckia* sp.), as well as dune species such as sand mat mat (*Cardionema ramosissimum*), beach morning-glory (*Calystegia soldanella*), and beach primrose (*Camissonia cheiranthifolia*; Johnson 2013b). Some individuals of beach layia, Tidestrom's lupine (*Lupinus tidestromii*; FE) and another CNPS-listed annual species, curlyleaf monardella, were also observed. These results are somewhat similar to what Hyland and Holloran (2005) found after treatment of Monterey dunes, with initial colonization by native annual plant species, early successional woody shrubs such as bush lupine, and European sea-rocket.

Many of the species that established at Abbotts and Monterey following chemical treatment are either weedy or late successional dune species. As with other disturbance events, restoration using herbicide may initially favor establishment of weedy species, followed over time by later successional or even Dune Scrub communities. As surface soils would not be turned over during herbicide treatment, any changes in soil nutrient and biota properties that occurred as a result of European beachgrass or iceplant establishment would persist. Soil nutrient pools may be further altered by decomposition of dead European beachgrass and iceplant or establishment by bush lupine, which increases nitrogen pools in soils. Higher nutrients could tip the balance towards annual, weedy species, both native and non-native. More primary successional dune communities might be able to establish in buffers or areas adjacent to wetlands or organic pastures where mechanical removal is used to eliminate invasive species, as that method "turns over" the soils and reduces nutrient levels in surface soil horizons.

While restoration would benefit Dune Mat and Dune Scrub, it is likely that European beachgrass and iceplant could continue to spread within areas of AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour where restoration is not conducted, thereby countering at least some of the benefits from restoration at a localized scale. However, these adverse impacts would be potentially reduced relative to Alternative D and certainly Alternative B. Continued spread of other invasive plant species such as bush lupine would have at negligible impacts on dune vegetation, as it is already highly pervasive, but does not appear to spread as quickly or establish dense monocultures within most dune systems.

As with Alternative B, then, the communities that would most benefit from this expanded restoration effort would be Dune Mat and Dune Scrub. Certain communities such as Native American Dunegrass and bog-like Dune Swale Wetlands are restricted enough currently within the park and regionally that restoration at this scale is unlikely to have more than negligible beneficial effects.

Potential adverse to impacts to adjacent vegetation communities such as Coastal Grasslands and Coastal Prairie from movement of sand following invasives removal would be expected to be negligible. Once treated, the rhizomes of even the dead European beachgrass plants appear to persist over the short-term, thereby "holding" the sands in place. Following herbicide treatment in Phases II and III at Abbotts Lagoon, no appreciable inland movement of dune sands could be detected during monitoring (Johnson 2013a). This transitional phase enables native plants such as shrubs to establish that can then help to stabilize these sands over the long term. In addition, adjacent to ranchlands, active revegetation of backdune areas could occur that would speed up colonization by native plants and decrease the amount of bare or open sand that would be susceptible to movement during high wind conditions. Some inland movement may occur from buffer areas treated mechanically, because the extent of this type of treatment conducted under Alternative C relative to chemical control would be quite low.

In summary, near-term restoration efforts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would result in minor to moderate beneficial effects on native vegetation communities such as Dune Mat and Dune Scrub. Use of herbicide treatment as the primary control method, as well as active revegetation in backdunes, would help to minimize movement of sand into adjacent Coastal Grasslands and Coastal Prairie and would maintain a negligible level of impact

Implementation-Related and Short-Term Effects

Access and Staging: In general, impacts to Dune Scrub, Coastal Grasslands, and Coastal Prairie associated with access and staging would be similar to that discussed under Alternative B, but of greater intensity because heavy equipment may be used to mechanically treat wetland or organic pasture buffers. At AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, potential impacts to Dune Scrub and grassland vegetation communities would be negligible to minor, depending on whether heavy equipment is brought in and the number of equipment pieces.

Manual Removal: Implementation-related and short-term effects of manual removal would be similar to that described under Alternative B. Potential adverse impacts would be negligible.

Mechanical Removal: The primary implementation-related impacts associated with mechanical removal involve destruction of native plant species that are intermixed within dense European beachgrass or iceplant stands. Larger native vegetation communities such as Dune Mat, Dune Scrub, and Dune Swale Wetlands would be typically either flagged or fenced to ensure avoidance by heavy construction equipment, all-terrain vehicles such as UTVs, and construction crews. When access through native vegetation communities may be required due to the location of some of the invasive plant stands, these areas would be surveyed, and an access route would be chosen that would have the least impact on either rare plants or native dune vegetation. No access would be allowed through wetlands, including sensitive wetland communities.

Due to the factors discussed, including proposed impact avoidance and minimization measures, mechanical removal would be likely to have negligible to possibly minor adverse effects at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: The primary implementation-related impacts associated with chemical control involve accidental spraying or drift even with direct foliar application using a backpack sprayer onto non-target species, particularly native plant species that are intermixed within dense European beachgrass or iceplant stands. Larger native vegetation communities are unlikely to be directly impacted, because these areas would be off-limits to spray crews.

As discussed in the *Alternatives* chapter, several herbicides are proposed for use: glyphosate, imazapyr, a non-ionic surfactant, and a dye. Both imazapyr and glyphosate are broad-spectrum products that would be lethal to both target vegetation (European beachgrass or iceplant) and non-target vegetation (native or non-native species intermixed within European beachgrass or iceplant stands). These herbicides would be used with a non-ionic surfactant (likely Competitor®) and a dye compound. Very little information exists on the environmental fate and impacts of either of surfactant and dye compounds (PRI 2008), particularly in relation to vegetation, so the discussion below focuses on potential impacts associated with the herbicides.

Foliar exposures to glyphosate, assayed as vegetative vigor studies, are much more toxic than soil exposures, as assayed by seedling emergence (SERA 2011a). The lesser toxicity of glyphosate in soil exposures is probably attributable at least in part to the tight binding of glyphosate to some types of soils (e.g., Accinelli et al. 2005; Borggaard and Gimsing 2008; Caceres-Jensen et al. 2009; Glass 1987; Mamy and Barriuso 2005 *in* SERA 2011a). Seedling emergence studies involving three different glyphosate formulations indicate that application rates in the range of 4-5 lb a.e./acre (pounds acid-equivalent/acre) are relatively nontoxic to seedlings emerging after spraying is complete (Bohn 1987; Everett et al. 1996a; Willard 1996 *in* SERA 2011a). For glyphosate treatment of European beachgrass and iceplant, application would result in approximately 4.0 lbs a.e./acre. However, if non-target plants are hit during spraying, the effects are much more toxic, with the no-observed-effect-concentration (NOEC) levels varying from 0.035 to 0.7 lbs a.e./acre depending largely on type of species (monocot, dicot; Chetram and Lucash 1994 *in* SERA 2011a). During restoration efforts in Monterey in 2004, shrubs such as coyotebrush and mock heather that were intermixed in European beachgrass stands were "significantly damaged" by pre-treatment prescribed burning and herbicide application (Hyland and Holloran 2005).

Imazapyr differs from glyphosate in that it can exert effects on non-target vegetation both aboveground and belowground. If directly sprayed with imazapyr at an application rate of 1 lb a.e./acre, even less susceptible species of plants may be damaged (SERA 2011b). Application rate for treatment of European beachgrass in the park would not exceed 1.5 lbs a.e./acre (1.5% concentration) and would typically be a 1% concentration. Sensitive species often show non-target effects at application rates as low as 0.000064 lbs a.e./acre, while resistant species may be able to tolerate up to 0.4 lbs a.e./acre (SERA 2011b). Some weed species have become very resistant to imazapyr, including perennial ryegrass (*Festuca perenne*) and sowthistle (*Sonchus oleraceus*; Cox 1996 *in* ImazapyrFactSheet.pdf n.d.).

Where imazapyr differs from glyphosate markedly is in its potential belowground effects, which appear to vary depending on the environment in which it is used. Within estuaries or strongly tidal systems, imazapyr does not appear to have strong non-target plant effects (Patten 2003). Following treatment of Atlantic cordgrass (*Spartina alterniflora*) in Willapa Bay, Washington, treatment sites were recolonized by another non-native species, Japanese eelgrass (*Zostera japonica*) and a native species, pickleweed (*Sarcocornia virginica*), within 12 to 20 months after treatment (Patten 2003). However, treatment in more terrestrial environments has sometimes led to issues with long-term adverse impacts on non-target plant species. Treatment of perennial pepperweed (*Lepidium latifolium*) in seasonal wetlands in the upper margins of San Francisco Bay resulted in "severe" and "persistent" non-target effects, with species richness and percent cover of non-target plant species significantly reduced even two years after treatment (Whitcraft and Grewell 2011). There are no clear-cut studies on potential non-target effects on dune systems, but, in Mendocino County, no evident lasting effects were observed either with respect to germination or establishment of native dune plants, including rare plants (CDPR 2012).

Non-target effects appear to be mediated strongly by rates of chemical breakdown and soil adsorption that differ depending on the environment (discussed more under *Soils and Sand Movement*) and exudation or leaching of imazapyr from the roots of target species into the surrounding soils (Tu et al. 2004). Legumes, in particular, appear to leach this chemical into adjacent soils (Tu et al. 2004). Also, adverse effects may also result if root systems of target and non-target species are intertwined (Tu et al. 2004). A recent study found that treatment of saltcedar in Colorado resulted in non-target impacts to several native species, including fourwing saltbush (*Atriplex canescens*), Canada wildrye (*Elymus canadensis*), and alkali saccaton (*Sporobolus airoides*; Douglass 2013). In another study, treatment with the Arsenal formulation of imazapyr appeared to decrease biomass of test species by 75% (Kaeser and Kirkman 2010 *in* Douglass 2013). Range of effect may extend to twice the "dripline" or the outer canopy perimeter of any non-target plant species (Tu et al. 2004).

The park has not conducted any formal study of effects of glyphosate/imazapyr treatment on adjacent non-target species, but vegetation monitoring conducted in plots one year after herbicide treatment of European beachgrass during Phase II of the Abbotts project showed that much of the non-target perennial species such as coyotebrush and mock heather intermixed within stands remained alive (Johnson 2013b). As discussed earlier, a number of species established after treatment, including miner's lettuce, wild cucumber, woodland groundsel, galium (*Galium trifidum*), fairy mist (*Pterostegia drymarioides*), coast cryptantha, bitter-cress (*Cardamine oligosperma*), tarweed (*Hemizonia* sp.), seaside fiddleneck (*Amsinckia spectabilis*), fescue (*Festuca bromoides*), sheep sorrel (*Rumex acetosella*), and California poppy (*Eschscholzia californica*; Johnson 2013b). Additional species included sand mat, beach morning-glory, beach primrose (*Camissonia cheiranthifolia*), and yarrow. Some individuals of beach layia, Tidestrom's lupine, and another CNPS-listed annual species, curlyleaf monardella, were also observed. These results are somewhat similar to what Hyland and Holloran (2005) found after treatment of Monterey dunes, with initial colonization by native annual plant species, early successional woody shrubs such as bush lupine, and European sea-rocket.

In addition to these issues, drift can also impact non-target species that are more distant from the actual treatment area. Drift can result when herbicide application extends beyond the intended area of application and can be influenced by many factors, including the method of application (e.g., aerial or broadcast versus ground), topography, wind speed, humidity, type of herbicide, and droplet size. The park employs a number of impact avoidance and minimization measures during herbicide treatment, including avoidance of broadcast application methods; use of backpack sprayers with calibrated nozzles; and discontinuation of spraying when wind speeds reach an average or consistent gusts of 10 mph at plant level or when conditions are very foggy. Labels for both AquaMaster® (currently marketed as Round-Up Custom®) and Habitat® recommend spraying between 2 or 3 to 10 mph to minimize drift. In addition, wicking of herbicide onto vegetation or drift shields may also be used to minimize the potential for herbicide drift.

Most studies on herbicide drift are focused on either aerial application or boom sprayer-type application methods used in agricultural operations (Salyani and Cromwell 1992, Holterman et al. 1997 *in* SERA 2011a). An earlier U.S. Forest Service (USFS) risk assessment showed that, for a boom sprayer than a backpack unit, a wind velocity of no more than 5 mph with a wind direction perpendicular to the line of application could cause drift of herbicide as far as 23 feet (USFS 2003 *in* NPS 2009). Herbicide emitted from a boom sprayer could drift twice as far with winds at 10 miles per hour (USFS 2003). No more than 0.58% (e.g., 0.0058) of the application rate would be expected to drift 100 meters offsite during low boom ground applications (USFS 2003 *in* NPS 2009).

However, these studies greatly overestimate the potential for drift for more focused backpack-specific application methods (SERA 2011a). Drift associated with backpack applications (directed foliar applications) are likely to be much less than drift from ground broadcast applications such as boom sprayers (SERA 2011a). Few studies, however, are available for quantitatively assessing drift after backpack applications (SERA 2011a). For the 2011 update of the USFS risk assessment, which uses the EPA's AgDRIFT model, estimates of drift from backpack applications were based on adjusting the droplet size typically used in low boom ground application to Fine to Medium/Coarse drop size distributions (rather than very fine to fine) and on assumptions of 50th percentile estimates of drift (rather than the 90th percentile used for ground broadcast applications; SERA 2011a). Based on USFS risk assessment worksheets developed by SERA, use of the proposed 4.0 pounds a.e./acre of glyphosate as Round-Up® would result in drift of 0.8% (0.033 lbs a.e./acre) of the applied solution within 25 feet of the application area, 0.4% (0.017 lbs a.e./acre) within 50 feet, and 0.03% (0.001 lbs a.e./acre) within 900 feet. As noted earlier, the no observed effect concentration (NOEC) levels for glyphosate for non-target plant species varied from 0.035 to 0.7 lbs a.e./acre depending largely on type of species (monocot, dicot; Chetram and Lucash 1994 *in* SERA 2011a).

Based on USFS risk assessment worksheets developed by SERA for imazapyr, the relationship between the proportion of imazapyr subject to drift shows the same relationship with distance from application area as glyphosate, however, the volume of herbicide delivered downstream with drift would differ. Use of an application rate of 1.0 pounds a.e./acre of imazapyr would result in drift of 0.008 lbs a.e./acre of the applied solution within 25 feet of the application area, 0.004 lbs a.e./acre within 50 feet, and 0.0006 lbs a.e./acre within 900 feet. As noted earlier, certain species are more tolerant to imazapyr than others, and this would affect susceptibility to drift, as well, with rates varying as little as 0.000064 lbs a.e./acre to 0.4 lbs a.e./acre (SERA 2011b).

One other form of drift that may affect non-target vegetation is wind erosion (SERA 2011a). Wind erosion leading to off-site movement of pesticides is likely to be highly site-specific and depends on several factors, including application rate, depth of incorporation into the soil, persistence in the soil, wind speed, and topographical and surface conditions of the soil (SERA 2011a). The earlier USFS risk assessment (2003 *in* NPS 2009) calculated that for a reasonable worst case scenario – a sandy surface with high wind speeds and arid conditions – approximately 0.54% of the glyphosate applied to an application area would be lost due to wind erosion.

In addition to drift and erosion, herbicides can also exert effects on non-target vegetation through surface water run-off or percolation into groundwater tables. The proportion of run-off as a fraction of application rate varies with soils, as well as climate, specifically temperature and rainfall. For the 2011 USFS risk assessment, a number of 0.089 lbs a.e./acre of glyphosate was calculated as the maximum run-off herbicide proportion in 100 individual simulations for an area with predominantly clay soils, cool temperatures, and high rainfall (SERA 2011a). The lower value of 0.0000001 lbs a.e./acre of the glyphosate application rate would be expected in arid areas with predominantly loam or sandy soils (SERA 2011a). Based on climate and soils, coastal dunes within the Seashore would tend towards the lower value due to the very sandy soils, and moderate rainfall. One recent study conducted for MMWD found that glyphosate and its breakdown product, aminomethylphosphonic acid (AMPA), were not found either in dissolved or particulate phases of stormwater run-off collected from an application area, probably due to strong soil and litter adsorption (Hwang and Young 2011).

The same is true for imazapyr: "In areas with predominantly sandy soils, the runoff of imazapyr following foliar applications should be negligible, and risks to non-target plants should also be negligible" (SERA 2011b). The potential for impact would be further reduced by impact avoidance and mitigation measures such as spraying only during dry periods, not spraying 24 hours before a rainfall event with a 20% probability of occurrence, or 24 hours after a rainfall event. In addition, herbicide application methods emphasize avoidance of any drip of herbicide from foliage onto the ground.

Percolation represents the amount of the herbicide that is transported below the root zone: it can be transported off-site through movement of groundwater. Groundwater infiltration rates depend on soil adsorption rates, depth to groundwater, and fate of chemicals once in soils or in groundwater. In general, glyphosate strongly adsorbs to soils (SERA 2011a). Penetration of glyphosate into clay or loam soils is an estimated 4-12 inches, with the depth of penetration increasing as rainfall rates increase (SERA 2011a). In predominantly sand soils, glyphosate may penetrate to a depth of about 8-18 inches, depending on rainfall rates (SERA 2011a). Once adsorbed, it breaks down through microbial degradation, hydrolysis, and photolysis (Hwang and Young 2011). Soil adsorption characteristics of imazapyr are more complex, with sorption strongly dependent on pH and texture: imazapyr adsorption in sandy soils is reportedly very weak (Borjesson et al. 2004 *in* Douglass 2012). However, some field studies have indicated that imazapyr remains typically within the top 20 inches of the soil surface (USFS 2007). Based on this information, imazapyr would be more likely to percolate downwards towards the groundwater table than glyphosate, but the depth of percolation is considerably shallower than the groundwater table in treatment areas, which is probably typically deeper than 2- to 3 feet. Also, the groundwater table within dunes typically flows in an oceanward direction rather than an inland direction, which would minimize potential for impacts to adjacent grassland, wetland, or coastal scrub communities.

One measure that has been used in at least one instance to improve native vegetation establishment after herbicide treatment of European beachgrass has been mowing or shallow dozing. If areas are mowed, intermixed shrubs such as coyotebrush and mock heather that may have been successfully avoided during directed foliar application could still be ultimately killed or harmed. However, breakdown of aboveground biomass of European beachgrass – which appears to degrade very slowly naturally – has appeared to hasten rates of native plant establishment in treated areas, at least based on preliminary results from 2012. Coyotebrush and California blackberry can readily resprout after mechanical disturbance via basal sprouting, layering, or root and stem "suckers" (Hobbs and Mooney 1987, GPFA 1986). As mowing would not impact intact sands of Dune Mat or Dune Scrub, but only intermixed plants, adverse impacts from use of this post-treatment measure would remain no more than negligible.

Mowing, as well as prescribed burning, can also be used as a pre-treatment measure to reduce the amount of aboveground biomass that would need to be treated. Prescribed burning would take place exclusively in European beachgrass-dominated areas, where beachgrass is often intermixed with coastal or dune scrub and grassland species. Coastal scrub is somewhat fire-adapted: many of the dominant species have the ability to resprout following fire. In the absence of disturbance, such as fire or grazing, grasslands may convert to coastal scrub.

Coyotebrush – one of the dominant species in both Coastal and Dune Scrub – is moderately fire tolerant (USDA 2002) and regenerates primarily through basal sprouting following fire (McBride and Heady 1968, Hobbs and Mooney 1987). In coastal scrub, fire creates canopy gaps with exposed mineral soil that allow coyotebrush and other coastal scrub species (most of which also have small, light seeds) to establish from seed and outcompete other herbaceous vegetation (Kirkpatrick and Hutchinson 1980). While fire can cause regeneration of coyotebrush, frequent fires (< 5 year intervals) suppress coyotebrush establishment, which is why prescribed burning has been used both in historic and modern times to reduce invasion of coyotebrush and other shrubs and maintain grasslands (Stephenson and Calcarone 1999, Keeley 2002). In terms of other Dune Scrub species, high rates of germination were also observed for mock heather after an experimental surface burn treatment (Holl et al. 2000), and California blackberry (*Rubus ursinus*) can also reproduce very well both vegetatively and from seed after fire (Tirmenstein 1989).

Prescribed burning of intermixed stands of Dune Scrub and European beachgrass would probably have only very temporary adverse impacts on these intermixed species, most of the dominants are adapted to fire. Regeneration of these scrub species – and European beachgrass – following fire could possibly result in slightly elevated impacts to native species from herbicide treatment due to regeneration, but adverse impacts would still be no more than negligible, as burning would not take place in wetlands or intact Dune Mat or Dune Scrub stands. A fire break or line adjacent to European beachgrass would help to ensure that these habitats are avoided, however, the lines or break themselves may impact native plant species, including rare plant species. Every effort would be made to site the fire break or line in already impacted areas so as to avoid these adverse impacts. The size of the fire line needed would be determined in a burn plan before the fire is set.

Based on the factors discussed, including the proposed impact avoidance and minimization measures, no more than negligible or minor impacts to native vegetation communities, including unique wetland communities, are generally expected at AT&T, B Ranch, and Limantour. Where native plants (e.g. unlisted, non-wetland species) are strongly intermixed with European beachgrass and iceplant, non-target vegetation may be killed either through accidental foliar spraying, localized soil residue effects (imazapyr), or short-distance herbicide drift. However, these factors are unlikely to affect native vegetation communities such as intact Dune Mat or Dune Scrub, because these areas would be avoided during spray operations. Avoidance and minimization measures such as discontinuation of spraying during moderate wind or foggy conditions would reduce indirect impacts from excessive drip or drift.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with those proposed under this alternative on Vegetation Resources would be the same as those discussed under Alternative A. From a regional perspective, dune restoration projects conducted both within and outside of the park would likely have minor beneficial effects on native dune and wetland vegetation communities, with the potential for negligible adverse impacts during implementation should some of these efforts be conducted concurrently. Potential cumulative effects on grasslands and prairie would be the same as described under Alternative B.

Conclusions

Potential benefits to native vegetation communities at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour such as Dune Mat and Dune Scrub would range from minor to moderate. Relative to Alternative B and, to a lesser extent, Alternative D, Alternative C would provide the highest potential benefits to native vegetation communities, because it is more cost-effective and efficacious than either manual removal or mechanical removal. Additional benefits to native vegetation communities, particularly Dune Scrub, would also occur from phasing restoration efforts in the backdunes and incorporating a revegetation component, which would jumpstart native species establishment.

It is likely that European beachgrass and iceplant could continue to spread in areas within AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour where restoration is not conducted and possibly in buffer or wetland areas where European beachgrass is manually removed, thereby countering some of the benefits from restoration at a park-wide scale. However, relative to Alternative B and, to a lesser extent, Alternative D, these adverse impacts would be reduced under Alternative C. Also, restoration efforts may be hampered in some areas by changes to soils brought about by iceplant and certain other plant species such as bush lupine. In iceplant removal or chemical control areas, restoration efforts may not be able to restore primary successional communities, only later successional or even Dune Scrub communities.

Potential adverse to impacts to adjacent vegetation communities such as Coastal Grasslands and Coastal Prairie from movement of sand following invasives removal would be expected to be negligible due to the persistence of rhizomes of dead European beachgrass, which would continue to hold the sands in place. Inland sand movement immediately after restoration would be limited to mechanical removal areas in wetland or organic pasture buffers, which would represent a small percentage of the total acreage restored under this alternative. In addition, adjacent to ranchlands, active revegetation of backdune areas would speed up colonization by native plants and decrease the amount of bare or open sand that would be susceptible to movement during high wind conditions.

Adverse implementation-related impacts to native vegetation communities and native plant species would range from negligible to minor. Potential impacts to Dune Scrub, Coastal Grassland, and Coastal Prairie associated with access and staging would be reduced relative to Alternative D due to the fact that heavy equipment needs would be reduced.

From a cumulative perspective, this alternative could have a minor beneficial effect on native dune vegetation communities within the region, given the scale of other dune restoration efforts proposed outside the park.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Long-Term Effects

Long-term effects would generally be similar to those described for Alternative C, although the intensity of these effects may be different. The primary method proposed under this alternative – mechanical removal – has been found to be effective in some situations at controlling European beachgrass (Peterson 2004, Transou et al. 2007), although there have been other instances where it has been less successful or required frequent re-treatment (Pickart and Sawyer 1998, USFS 2010).

As with the other action alternatives, the communities that would most benefit from this expanded restoration effort would be Dune Mat and Dune Scrub. Certain communities such as Native American Dunegrass are restricted enough within the park that restoration in these project areas is unlikely to have more than negligible beneficial effects. Relative to

Alternatives B and C, this alternative would be more likely to restore primary successional dune communities due to the fact that mechanical removal results in "turn over" of soil horizons, thereby greatly reducing residual pools of nitrogen and organic matter built up after decades of beachgrass and iceplant establishment. This turnover would also offset some of the other changes to soils caused by species such as iceplant and bush lupine, which was discussed in more detail under Alternative A.

Some of the benefit to native vegetation communities would depend on how quickly vegetation would establish within the mechanical removal areas. Six months following restoration of dunes near the mouth of Abbotts Lagoon, nine species of native dune plants appeared within the area restored by heavy equipment (Peterson 2004, Rodgers 2006). However, in Oregon, the intentional periodic "scalping" of European beachgrass from foredunes to benefit western snowy plover nesting success has not surprisingly led to decreases in richness and cover of native plant species, as well as a reduction in abundance of Oregon endemics, native dune plants, and non-native plants (Zarnetske et al. 2010).

Even without periodic "re-treatment," dunes restored through mechanical means can remain largely unvegetated, with reduced cover and species richness of native plant species. Following Phase I of the Abbotts Lagoon was completed, cover and species richness of non-native plant species such as European beachgrass dropped considerably, although so did cover and species richness of native dune plant species (Minnick and Parsons, *in prep*.). Immediately after restoration, vegetation cover – largely of non-native species including European beachgrass – dropped from 87% cover prior to restoration to 0% cover after sands were flipped with use of excavators and bulldozers (Minnick and Parsons, *in prep*.). The number of species per plot also not surprisingly dropped immediately after dune-flipping from an average of 5.4 species pre-restoration to an average of 0 species post-restoration (Minnick and Parsons, *in prep*.).

Over the following fall, some species did colonize the mechanically restored foredunes, including prolific numbers of the federally endangered Tidestrom's lupine, as well as much lower numbers of beach pea (*Lathyrus littoralis*), European sea rocket (*Cakile maritima*), yellow sand verbena (*Abronia latifolia*), beach bursage (*Ambrosia chamissonis*), and beach morning-glory. In the backdunes, bush lupine was fairly common, with approximately 250 shrubs having established in the northern backdunes (Johnson 2012). Further establishment of new species was hindered during the first year by strong spring winds that scoured out many germinants and caused considerable movement of sand. Vegetation establishment following these projects can be strongly dependent on weather: drier years are often accompanied by strong spring winds, which can preclude native plant recruitment (Baye 2008).

Sand movement can not only affect the potential for re-establishment of Dune Mat and Dune Scrub within restoration areas, but vegetation communities adjacent to treatment such as Dune Mat, wetlands, and Coastal Grasslands and Prairie. Following Phase I, many small dune swale wetlands in the interior of the dune system were buried by sand, although quite a few, particularly some of the larger dune slack wetlands remained, and appeared to be only marginally impacted. One freshwater marsh swale wetland on the inland perimeter of the dunes has also been adversely impacted by dune movement, even though a sand fence was built to help minimize impacts on this feature. Sands have also migrated into the existing Dune Mat vegetation community located in the interior of the Phase I restoration area, although many of the native dune plant species appeared to have tolerated this sand burial to some degree. Approximately 10.1 acres of grassland, scrub, and wetland within and adjacent to Abbotts have been impacted by sand movement (Johnson 2013a), which represents about 3% of the 300-acre project area.

In addition to internal movement of sands within the dune system, sands have also migrated inlands in response to the strong spring winds after completion of Phase I of the Abbotts Lagoon project. As of spring 2013, approximately 7.3 acres directly adjacent to the dunes had been subject to sand movement, with 5.5 acres of this being within the lease boundary (Johnson 2013a). Only 2.0 acres of this occurred in pastures characterized as grazeable based on soil type (Johnson 2013a). Another 3.5 acres of pasture designated as "ungrazeable" had been impacted: areas characterized as ungrazeable typically occur on soil types considered marginal for forage production such as Dune land, which typically has a sandy substrate and a moderate number of characteristic dune plant species (Johnson 2013). Of these 5.8 acres, 4.1 acres or 75% actually occurred within areas already buried previously by sand through dune migration (Johnson 2013a). While European beachgrass and iceplant were planted to stop movement of the dunes, the dunes have continued to migrate inland over the past 60- 70 years despite rapid expansion of these invasive plant species. Dune growth rates between 1943 and 2007 have varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual growth rates during this period of 0.25% to 0.91% (Johnson 2013a).

At Little River State Beach in Mendocino County, mechanical removal resulted in sand movement rates of approximately 3.9 cubic feet for every 10 square feet per year (Transou et al. 2007). During restoration, dunes moved, on average, 2.5 feet per month in a southeast or inland-trending direction, although the rate of inland dune movement may have been retarded by sand moving over existing European beachgrass stands (Vaughan and Fiori 2007).

Some of these potential impacts to adjacent grasslands or wetlands within grasslands would be avoided or minimized by actively revegetating backdune areas and possibly phasing backdune restoration efforts, which would reduce impacts of mechanical removal relative to that of past projects. However, this approach would not necessarily eliminate potential impacts to "interior" or dune swale wetlands or Dune Mat communities.

In terms of re-treatment, mechanical removal appears to result in lower re-treatment needs than certainly manual removal. In Phase I of Abbotts Lagoon, where mechanical was used to remove approximately 80 acres European beachgrass, re-treatment needs have not been substantial, except in wetland buffers or areas where "dirty" material was not fully capped with 3 feet of clean sand. Most of the re-treatment can be done easily by hand, because the resprouting European beachgrass has not developed deep rhizomes. However, if re-treatment is not performed in mechanical removal areas, European beachgrass can quickly re-establish, as was evident in earlier restoration efforts at the Seashore near the mouth of Abbotts Lagoon.

As pointed out with Alternative C, the decrease in effort required for re-treatment with mechanical removal would potentially mean that resources could be reallocated to expanding the extent of area restored. However, costs of this technique are much higher than Alternative C, ranging currently from $25,000/acre to $30,000/acre for the Abbotts project depending on the type of dune habitat (e.g., foredune, backdune). These costs approximate those for manual removal of European beachgrass. However, due to the fact that re-treatment needs are lower and that initial treatment may be accomplished more quickly, more acres could probably be restored under Alternative D than under Alternative B. With mechanical removal, 1 acre would require approximately two (2) to three (3) days or 48 to 72 person-hours to complete based on performance rates under Abbotts Lagoon Phase I, while, with manual removal and a crew of 12, initial treatment of 1 acre in the Point Reyes Headlands'required more than three (3) days and 303 person-hours.

While restoration efforts under Alternative D would benefit native vegetation communities, it is likely that European beachgrass and iceplant could continue to spread in areas within AT&T, B Ranch, and Limantour where restoration is not conducted, thereby countering some of the benefits from restoration. However, under this alternative, these adverse impacts would be potentially reduced relative to Alternative B. Continued spread of other invasive plant species such as bush lupine would have at most negligible impacts on dune vegetation, as it is already highly pervasive, but does not appear to spread as quickly or establish as dense monocultures within most dune systems as European beachgrass or iceplant.

Therefore, for these and the other reasons discussed above, the potential for beneficial effects to native vegetation communities within dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour may be reduced relative to Alternative C, resulting in minor to possibly moderate beneficial effects on Dune Mat and Dune Scrub communities. Under this alternative, benefits to Dune Scrub may be greater than Dune Mat due to the active revegetation component. The active revegetation approach in backdunes would also help to minimize movement of sand into adjacent Coastal Grasslands and Prairie and keep adverse impacts negligible to minor.

Implementation-Related and Short-Term Effects

Access and Staging: In general, impacts to Dune Scrub, Coastal Grasslands, and Coastal Prairie associated with access and staging would be similar to that discussed under Alternatives B and C. However, there may be slightly higher adverse impacts associated with more pieces of heavy equipment needing access or to be staged in adjacent grassland or dune transition areas. Therefore, potential adverse impacts to grassland vegetation communities would be negligible to minor, depending on the number of heavy equipment pieces used for restoration.

Manual Removal: Implementation-related and short-term effects of manual removal would be similar to that described under Alternative C. Potential adverse impacts would be negligible.

Mechanical Removal: Implementation-related and short-term effects of mechanical removal would be similar to that described under Alternative C, however, the intensity of impacts would increase relative to that alternative, as mechanical removal would be the primary removal method. Based on factors discussed under Alternative C, including proposed impact avoidance and minimization measures, impacts of mechanical removal on native dune vegetation communities would likely be negligible to at most minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

There is potential under this alternative to incorporate mowing as a pre-treatment measure to reduce biomass prior to mechanical treatment. Pre-treatment mowing would also cause short-term adverse impacts to Dune Scrub species intermixed with European beachgrass stands. Coyotebrush and California blackberry can readily resprout after mechanical disturbance via basal sprouting, layering, or root and stem "suckers" (Hobbs and Mooney 1987, GPFA 1986). Therefore, potential adverse impacts to intermixed Dune Scrub species would not be expected to increase due to this pre-treatment measure.

Chemical Control: Implementation-related and short-term effects of chemical control at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would be similar to that described under Alternative C, although the intensity of impacts would be reduced to negligible, because herbicide treatment would be only used for very focused spot-spraying of re-sprouts in mechanical removal areas.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative on Vegetation Resources would be the same as those discussed under Alternative A. From a regional perspective, dune restoration projects conducted within and outside the park would likely have negligible to at most minor beneficial effects on native dune and wetland vegetation communities, with the potential for negligible adverse impacts during implementation should some of these efforts be conducted concurrently. Potential cumulative effects on grasslands and prairie would be the same as described under Alternative C.

Conclusions

Potential benefits to native vegetation communities such as Dune Mat and Dune Scrub at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would be minor to possibly moderate. Some of this would be mitigated for Dune Scrub vegetation communities by actively revegetating backdune areas. However, benefits to native Dune Mat would be reduced under this alternative relative to Alternative C due to the fact that less acreage could be restored, even though mechanical removal is more likely to re-set the successional clock and encourage development of primary successional dune communities. Success of restoration efforts must take into consideration that climatic factors can affect the speed with which native dune plant species colonize newly "flipped" soils.

Mechanical removal can also impact existing Dune Mat, Dune Scrub, wetland, and Coastal Grassland and Prairie communities through sand movement: for adjacent grassland and wetland communities, this impact would be mitigated by the revegetation component for backdune areas, but Dune Mat and "interior" or Dune Swale wetlands may still be impacted, with the level of potential impact ranging between negligible and minor adverse on a localized scale and negligible on a park-wide scale.

It is likely that European beachgrass and iceplant could continue to spread in areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour where restoration is not conducted and possibly in areas where European beachgrass is manually removed, thereby countering some of the benefits from restoration. However, relative to Alternative B, these adverse impacts would be reduced. In addition, as discussed under Alternative B, restoration efforts may be hampered by changes to soils brought about by iceplant and other species.

Adverse implementation-related impacts to native vegetation communities and native plant species would range from negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. This includes potential pre-treatment mowing to reduce biomass. Potential impacts to Dune Scrub, Coastal Grassland, and Coastal Prairie associated with access and staging would range from negligible to minor depending on the amount of heavy equipment that needed to access or be staged in these adjacent areas.

From a cumulative perspective, because the amount of restoration that could be implemented may be reduced relative to Alternative A, this alternative would have minor beneficial effects on native dune vegetation communities within the region, given the scale of other dune restoration efforts proposed outside the park.

Species of Special Concern

As noted in *Affected Environment*, this section includes both species listed as threatened or endangered on the federal or state list and those that are not officially listed, but are considered rare or unique by the park or other monitoring entities (such as CNPS).

Policies and Regulations

The federal Endangered Species Act (ESA) of 1973, as amended, requires federal agencies to consult with the USFWS before taking actions that (1) could jeopardize the continued existence of any federally listed plant or animal species or species proposed for listing, or (2) could result in the destruction or adverse modification of critical or proposed critical habitat for federally listed species. The USFWS website was consulted to find the list of species that must be considered for this EA. If actions would adversely affect a species, but would not jeopardize its continued existence, the USFWS may issue an incidental "take" permit. One key difference between listed plants and wildlife is that there is no incidental take prohibition. Section 7(b)(4) and 7(o)(2) of ESA generally do not apply to listed plant species. However, protection of listed plant species is provided to the extent that ESA prohibits the removal and reduction to possession of federally listed plants or the malicious damage of such plants on areas under federal jurisdiction.

In addition, Park Service *Management Policies 2006* state that state and locally listed species are to be managed in a manner similar to the treatment of federally listed species to the greatest extent possible. Species that are rare, unique, or declining, but not listed, are to be inventoried and managed to maintain their natural distribution and abundance (Section 4.4.2.3).

Assessment Methodology

The Seashore has varying levels of geographic and database information for federally listed endangered and threatened species, as well as for some of the state-listed species or species classified as rare by the CNPS. In some instances, the park has conducted censuses of total numbers each year or for a number of years, or sampling is conducted, which allows for some annual estimation of numbers and trends within certain areas. For some species, the only sources of information available are one-time surveys. When a species' presence in an area is uncertain, it is typically presumed to be present if appropriate breeding or non-breeding habitat exists. These information sources, combined with knowledge of the natural history and habitat requirements of special status species, were the primary resources used to determine the intensity and duration of impacts. Impacts were assessed on several potential scales when appropriate, including at the project area or local population scale, at a park-wide population level, and/or at larger scales such as regional or range-wide. Impact analysis takes into account implementation of standard and proposed impact avoidance and minimization measures. Restoration timing was compared to important life cycle phases for both animals and plants. Best professional judgment was used to evaluate how each of these factors would figure into an overall impact determination for each species.

Context and Duration

Implementation-Related: Implementation-related are those that occur only during the implementation phase of the project.

Short-term: Short-term impacts are those that extend beyond implementation, but that last no more than one year or one reproductive season.

Long-term: Long-term impacts would extend beyond a single year or reproductive season.

Impact Thresholds

Negligible: There would be no measurable change, or change would be barely detectable and often within the natural range of variability.

Minor**:** There would be small, but detectable or measurable changes. During implementation, actions would not adversely affect critical periods (e.g., breeding/nesting/denning, pupation, flowering, or seed set) or important habitat for listed species, but could have detectable or measurable effects on use of or feeding within project areas. For example, individual animals may temporarily avoid areas. On a localized scale, during implementation, a few individuals of non federally listed special status wildlife species or a listed or rare plant species would be inadvertently killed or injured, but no individuals of any listed wildlife species would be killed or injured, resulting in incidental take. Over the long-term, as a result of the action or actions, there would be small, but detectable or measurable change, in viability of either individual park populations, distribution of the species within the park as a whole, or on a regional or range-wide scale or in habitats important for these species.

Moderate**:** There would be apparent or appreciable change. During implementation, individuals may be impacted during critical periods (e.g., breeding/nesting/denning, pupation, flowering, or seed set), or there may be apparent or appreciable change in important habitat; however, the level of impact would not result in physical injury or mortality to more than an incidental number of individuals of a listed wildlife species. No extirpation of any local population or species of rare plants or animals from the park would occur, however, more than a few individuals of a listed plant species may be incidentally injured or killed. These actions would not jeopardize the species' continued existence either within or outside the park. Over the long-term, as a result of action or actions, there would be apparent or appreciable change in viability of either individual park populations, distribution of the species within the park as a whole, or on a regional or range-wide scale or in habitats important for these species.

Major**:** There would be striking or highly noticeable change. During implementation, more than an incidental number of listed animals may suffer physical injury or mortality, or local populations of rare plants or non- federally listed special status animals may be extirpated from project areas or even the park. These actions would not jeopardize the species' continued existence either within or outside the park. Over the long-term, as a result of action or actions, there would be striking or highly noticeable change in viability of the species or in habitats important for these species within the park or on a regional or range-wide scale.

Impact of Alternative A

Analysis

Under this alternative, there would be no near-term restoration efforts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although already permitted projects would still move forward.

Listed Plant Species

In the long term, Sonoma spineflower would not likely be affected, as it does not occur in or near (> 0.5 mile) any of the Seashore's dune systems.

Beach layia

Long-Term Effects

Twelve of the 14 occurrences in the park have been characterized as threatened by the presence of the non-native European beachgrass and iceplant nearby, as the monotypic stands of either species crowd out less competitive native species (Benson 2004; USFWS 1998). Iceplant, in particular, forms "dense, smothering mats" that take over prime beach layia habitat (Benson 2004). "Continued efforts to manage non-native weeds will be essential for the protection of this species" (USFWS 1998).

On average, since 2004, plant numbers have dropped by 48% in most of the beach layia census plots, with decreases ranging from a low of 17% to a high of 99% (NPS, unpub. data). Only one census plot located north of North Beach showed an increase (NPS, unpub. data). Many of these areas are ones where beach layia is being encroached upon by either European beachgrass or iceplant.

Over the long-term, populations of beach layia at AT&T, North Beach, Davis Property, and B Ranch would be expected to continue to decline, because there would be no near-term restoration conducted except for already permitted projects, although declines may be greater at B Ranch and Davis Property than at AT&T. Declines in plant numbers between 2004 and 2012 were estimated to average 17%,61%, and 75% at AT&T, B Ranch, and Davis Property, respectively (NPS, unpub. data). These adverse impacts could range from negligible to minor adverse. There would be no impact at Limantour and A Ranch, as beach layia has not been documented in these areas.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Tidestrom's lupine

Long-Term Effects

Ten (10) of the 19 populations remaining as of 2013 occur at the Seashore; the rest are on private, municipal, or State Park beach properties. The major threats to this species range-wide include invasion by non-native plants such as iceplant and European beachgrass, development, and trampling by hikers, equestrians and, to a lesser extent, trampling and grazing by cows (USFWS 1998). At the Seashore, threats include habitat loss due to the encroachment of European beachgrass and iceplant: "Most of the populations at PRNS exist within islands of native dune communities surrounded by beachgrass and/or iceplant" (Rodgers 2006). In fact, encroachment by iceplant may have already eliminated one population (Population #5; Rodgers 2006).

As discussed in Affected Environment, Tidestrom's lupine is affected by these non-native invasive species both through direct displacement from dune habitat – European beachgrass typically accounts for more than 90% of the plant cover in invaded areas – as well as through indirect factors. European beachgrass typically provides habitat for native deer mice that have been documented to eat up to 82% of the seeds of lupine both from the plant and off the ground, effectively reducing the potential for successful reproduction of this species (Dangremond et al. 2010). Population viability analyses conducted earlier found that, under these reproduction conditions, at least four populations were projected to decline in numbers to the point that they could go extinct (Dangremond et al. 2010, WU, unpub. data). These populations included North Beach, Abbotts Lagoon, B Ranch North, and B Ranch South (Dangremond et al. 2010, WU, unpub. data). The AT&T population appeared barely stable (Dangremond et al. 2010). In populations with European beachgrass where consumption is substantial (e.g. B Ranch South, AT&T, B Ranch North, Abbotts Lagoon), the model showed that removing seed consumption improved the projected population growth (WU, unpub. data). More recent viability modeling suggested that B Ranch North, B Ranch South, and Davis Property were the populations at the highest risk of extinction (Pardini and Knight 2013).

This species would continue to be impacted by expansion of European beachgrass under this alternative. Based on censuses conducted between 2000/2001 and 2011, numbers of Tidestrom's lupine had declined over the decade by roughly 36% at North Beach and 54% at B Ranch South, with the most dramatic decline recorded at B Ranch North (Parsons and Minnick 2012). In recent years, the B Ranch North population has crashed dramatically, with estimated numbers dropping from an estimate of 11,000 to 12,000 individuals between 2001 and 2007 to 1,835 individuals in 2011 and 1,685 individuals in 2012, an approximately 83% decrease in population size (Parsons and Minnick 2012; Johnson et al. 2012b).

Over the long-term, populations of Tidestrom's lupine at B Ranch North, B Ranch South, Davis Property, and possibly even North Beach would be expected to continue to decline substantially, because there would be no near-term restoration conducted, except for already permitted projects. Declines would be less dramatic at AT&T, although the AT&T population was also hovering on the brink in terms of reduced reproduction causing loss of population viability. Adverse impacts could potentially range from possibly moderate (B Ranch, Davis Property) to minor (AT&T, North Beach). There would be no impact at Limantour and A Ranch, because Tidestrom's lupine does not currently occur in these areas.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Sonoma Alopecurus

Long-Term Effects

Unlike beach layia and Tidestrom's lupine, Sonoma alopecurus does not occur in dunes, but in freshwater systems that are sometimes either within or adjacent to dunes. As of 2013, the Seashore supported eight out of only nine known extant populations of this plant (Ryan and Parsons 2012a). Of these eight populations, only three have the potential to be directly or indirectly impacted by coastal dune restoration: this includes the dune swale population at AT&T and the freshwater marsh populations within the grasslands adjacent to dunes at

Abbotts Lagoon and North Beach. Plants have not been found at the latter population during the past few years, however.

Based on annual monitoring, viability of these populations appears to be threatened. Numbers within five of the eight populations appear to be declining in recent years (Ryan and Parsons 2012a): the other three populations have not been consistently monitored, because they were just discovered or rediscovered. Inflorescence numbers within one of the larger populations at AT&T has dropped by an order of magnitude (10X) since comprehensive monitoring was initiated, even though rainfall has been roughly normal or slightly above normal (Ryan and Parsons 2012a). The cause of the Sonoma alopecurus decline is unknown, although grazing regime, including intensity and seasonality, may play an important role (Ryan and Parsons 2012a). The grazing regime at the AT&T population has been more sporadic in recent years, which may have led to the reduction in numbers (Ryan and Parsons 2012a). In at least once instance (Abbotts Lagoon), numbers have been adversely affected by sand burial of the drainage swale adjacent to the restored dunes, as restoration has remobilized sands accumulated during decades of stabilization by non-native, invasive plant species. The park is attempting to help mitigate this loss through construction in fall 2013 of a new drainage swale nearby: Sonoma alopecurus transplants grown from genetic material from the impacted population would be planted in this newly constructed swale in winter 2014. The park plans to expand the swale in fall 2015.

Sonoma alopecurus does not occur at B Ranch, A Ranch, Davis Property, or Limantour. Under this alternative, there would be no near-term restoration at AT&T, where it does occur. There may be some very negligible adverse effects from continued invasion of European beachgrass and iceplant into the periphery of wetlands where these species occurs, but Sonoma alopecurus tends to establish in the wettest portion of dune swales, where presence of this species is very unlikely. Therefore, Alternative A would be likely to have no effect on this species.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Listed Animal Species

Myrtle's silverspot butterfly

Long-Term Effects

One of the critical life history stages for this butterfly is the larval stage: its only known larval host, western dog violet, is a perennial herb that occurs principally in adjacent grasslands, some of which fall adjacent to coastal dunes. Once the butterfly has pupated, it feeds on nectar from a number of plant species that occur both in coastal dunes and grasslands. One of its favorite nectar plants is curlyleaf monardella (Adams 2004), a rare, CNPS-listed annual plant species that occurs in considerable numbers within the Seashore's dunes. Other native nectar sources in dunes include yarrow, beach evening primrose, and mock heather, although butterflies will also use non-native species such bullthistle (*Cirsium vulgare*) and Italian thistle (*Carduus pynocephalus;* Launer et al. 1992, Adams 2004), both of which are more prevalent in grasslands. As a grass species, European beachgrass cannot provide nectar, and iceplant is not a documented nectar source for Myrtle's silverspot butterfly, either (Launer et al. 1992).

Without restoration, expansion of European beachgrass and iceplant would continue to displace native plant species such as curlyleaf monardella, beach evening primrose, and mock heather that provide nectar at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and possibly Limantour dunes. European beachgrass and iceplant are both considered "unambiguously bad" for butterfly habitat (USFWS 1998) and have, in fact, been named as "one of the most serious present-day threats" to this species.

For this reason, there would be negligible to possibly minor adverse long-term impacts on butterfly habitat at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and possibly Limantour. These adverse impacts would range from negligible adverse (B Ranch, A Ranch, Davis Property, and Limantour) to possibly minor adverse (AT&T/North Beach), as the latter is known to support a sizeable population. Ultimately, recovery of the butterfly depends on the health of both the dune and grassland systems.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/, and Limantour.

California Red-legged Frog

Long-Term Effects

California red-legged frogs occur in many different types of wetland habitat within the park, including Dune Swale wetlands and, more commonly, in freshwater marshes and other types of wetlands in adjacent grasslands. Because of the importance of the Point Reyes area to this species, the USFWS has designated Critical Habitat within at least two large portions of the park. At least one of these Critical Habitat units encompasses dune systems along the Great Beach from the Lighthouse to AT&T. Dunes north of AT&T along the Great Beach do not fall within USFWS-designated Critical Habitat.

Primary constituent elements that may be present in the action area include aquatic breeding habitat, aquatic non-breeding habitat, upland habitat, and dispersal habitat. Many of the more seasonally flooded or saturated Dune Swale wetlands do not represent breeding habitat, although those few that sustain ponding through the summer can provide breeding opportunities. In addition, Dune Swale wetlands may provide more breeding opportunities during wet years. Other Dune Swale wetlands and the vegetated uplands that surround them can also provide shelter, foraging, predator avoidance, and dispersal areas for juvenile and adult frogs. Sparsely-vegetated and/or unvegetated dunes provide little to no shelter (boulders, rocks, large woody debris, small mammal burrows or moist leaf litter), foraging, or predator avoidance and are thus less-likely to serve as upland or dispersal habitat; these areas, though they may be within one mile of breeding or non-breeding aquatic habitat, are also unlikely to affect the hydrologic regime or quality of the aquatic habitat.

In general, should restoration of coastal dunes not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, there may be no long-term impacts on red-legged frogs, although encroachment of European beachgrass and iceplant into the peripheral areas of dune swale wetlands may decrease the quality of aquatic habitat. Upland and dispersal habitat could also be negatively affected by expansion of beachgrass and iceplant. Together, these impacts may possibly result in negligible adverse effects on the red-legged frogs and its Critical Habitat even if restoration is not conducted.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Western Snowy Plover

Long-Term Effects

As with many migratory species, many different factors affect success of western snowy plover nesting and fledging efforts.

Most snowy plover nesting occurs along the beach just oceanward of the foredunes: adults and chicks will use foredune areas and areas behind the foredunes for feeding and roosting, particularly if blow-outs or breaks in the foredune ridge exist. European beachgrass alters foredune topography, eliminating blow-outs and creating steep ridges that often begin encroaching oceanward (USFWS 2007; Zarnetske et al. 2010). These topographic changes effectively restrict breeding snowy plovers to a much narrower strip of habitat between the high tide line and the lower edge of the dunes – the same narrow area of the beach used by visitors and dogs (Wiedemann 1987, USFWS 2007).

Under this alternative, other current park management actions would also continue, including installation of nest exclosures and reduction of feed sources for corvid predators on adjacent ranchlands. Public education efforts may or may not continue, depending on whether funds are available to continue the docent program during the breeding season.

Without near-term restoration at AT&T and North Beach and, to a lesser degree, B Ranch/A Ranch/Davis Property and Limantour, invasive plants could continue to spread from the foredunes towards the shoreline, thereby impacting nesting and foraging habitat for plovers and resulting in at least negligible adverse long-term impacts. Currently, plovers do not actively use B Ranch, A Ranch, or Davis Property, and plovers only winter at Limantour, although they have nested there in the past. While the lack of restoration may not adversely impact the number of nest attempts and fledging success currently at these two project areas, it could reduce chances that plovers would return to these areas to nest in the future.

In addition, it would reduce quality of Critical Habitat designated along the Great Beach and at Limantour Spit. Critical Habitat along the Great Beach stretches roughly from Point Reyes to Tomales Points and includes most of the west-facing dune-backed beaches (USFWS 2007). This subunit supports both nesting and wintering Pacific Coast WSPs and has the potential to support 50 breeding birds with proper management (USFWS 2007). The Critical Habitat subunit at Limantour includes the end of the spit and narrows to include only the south-facing beach towards the base of the spit. While nesting does not occur currently, the USFWS expects that this area could contribute significantly to plover conservation in the region by providing habitat capable of supporting 10 nesting birds (USFWS 2007). However, USFWS acknowledges that non-native vegetation and human use may be decreasing suitability of the area for nesting and foraging.

No restoration of dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour could have adverse effects on several of the primary constituent elements of Critical Habitat, including areas that are 1) below heavily vegetated areas or developed areas and above the daily high tides; 2) shoreline habitats for feeding with no or very sparse vegetation that are between annual low tide and annual high tide, that support essential food sources; and/or 3) surf- or water-deposited organic debris such as seaweed or driftwood that provides substrates for food and cover or shelter from predators and weather. Expansion of beachgrass oceanward from the foredunes would continue to compress potential nesting areas above the daily high tides along the Great Beach and along Limantour Spit.

Based on these factors, Alternative A would potentially have minor adverse effects on the current number of nest attempts at fledging success at AT&T and North Beach, where nesting occurs currently, but potentially no impact on these parameters at B Ranch/A Ranch/ Davis Property and Limantour, where nesting currently does not occur. However, negligible adverse long-term effects would be expected on Critical Habitat at all three project areas, if restoration was not conducted in the near-term.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

California brown pelican

The California brown pelican was recently delisted by the USFWS. Brown pelicans may occupy open water habitats near some dunes where restoration could occur, but do not occur within the dunes themselves. Therefore, the lack of dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour is unlikely to have any long-term effect on this species.

California least tern

The California least tern is an extremely rare fall migrant that is unlikely to occur within any of the potential restoration areas. In the long term, lack of restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would be unlikely to have any beneficial or adverse effect on least terns.

Willow flycatcher

This is a rare migrant to certain areas of the park, including near Abbotts Lagoon, and is present primarily in August, if at all. The willow flycatcher is a riparian scrub species and could rest in vegetation that surrounds dune hollows and other permanent and semi-permanent wetlands within restoration areas. In the long term, lack of restoration at AT&T/ North Beach, B Ranch/A Ranch/Davis Property, and Limantour would be unlikely to have any beneficial or adverse effect on willow flycatchers.

Plant Species of Concern

The plant species of concern within the Seashore's Dune systems occur in Dune Mat, Dune Scrub, Coastal Grasslands, Coastal Scrub, and wetland communities. Some species can be found in several different types of habitat. Species that are commonly found in Dune Mat or Dune Scrub include curlyleaf monardella (CNPS List 4.2), blue coast gilia (*Gilia capitata spp. chamissonis;* CNPS List 1B.1), dark-eyed gilia or yarrowleaf gilia (*Gilia millefoliata;* CNPS List 1B.2), and pink sand verbena (*Abronia umbellata* ssp. *breviflora*; CNPS List 1B.1). The gilia species also occur in the ecotone between dunes and grasslands, along with several other species such as Blasdale's bent grass (*Agrostis blasdalei;* CNPS List 1B.2), rose leptosiphon (*Leptosiphon rosaceus*; CNPS List 1B.1), and two species of *Chorizanthe cuspidata* – San Francisco spineflower (var. *cuspidata*; CNPS List 1B.2) and woolly headed spineflower (var. *villosa*; CNPS List 1B.2). Many of these species are also prevalent in the sandy soils of adjacent grasslands in addition to several other species such as Point Reyes horkelia (*Horkelia marinensis*; CNPS List 1B.2), short-leaved evax (*Hesperevax sparsiflora* var. *brevifolia*; CNPS List 1B.2), and Gairdner's yampah (*Perideridia gairdneri* ssp. *gairdneri;* CNPS List 4.2). Others occur in wetlands within adjacent grasslands, some of which are directly adjacent to the dunes: these include Point Reyes meadowfoam (*Limnanthes douglasii* var. *sulphurea; SE;* CNPS List 1B.2), Point Reyes checkerbloom (*Sidalcea calycosa* ssp. *rhizomata*; CNPS List 1B.2), Point Reyes blennosperma (*Blennosperma nanum* ssp. *robustum*; CNPS List 1B.2), and beach starwort (*Stellaria littoralis*; CNPS List 4.2).

Potential impacts to these species from not conducting dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour largely relate to the primary habitat in which they occur. For those species primarily located in the dunes, such as curlyleaf monardella, Alternative A would likely result in negligible adverse impacts to these species. Continued spread of European beachgrass and iceplant in unrestored areas threatens many of the native dune plant species, common and rare. However, lack of near-term restoration would have no effect on other species. As gilias are less prevalent within many of the dune interiors than curlyleaf monardella, impacts of not conducting dune restoration on gilia and species such as the spineflowers, rose leptosiphon, and Blasdale's bent grass may range from no effect to only very negligible adverse effects. For species primarily occurring in adjacent grasslands and wetlands within dunes and grasslands, the lack of near-term dune restoration should have no effect on these species.

There would be no implementation-related or short-term effects, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Animal Species of Concern

Other than California red-legged frog (discussed earlier), no fish, amphibian, or reptile species of concern are found commonly within the Seashore's dunes. There would be no impacts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, because restoration would not be conducted in these areas in the near-term, except for already permitted projects.

Terrestrial Invertebrates

In general, sand-burrowing arthropod communities are lower in abundance and diversity within dense European beachgrass stands (Stenzel et al. 1981, Slobodchikoff and Doyen 1977 *in* USFWS 2007), therefore, it is likely that many of the special status beetle species do not occur within these stands, but rather on beaches or open areas within beachgrass or iceplant stands. Continued spread of European beachgrass and iceplant at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour could have negligible adverse effects on some terrestrial invertebrate species, while it may have no effect on others and even beneficial effects on species that forage on European beachgrass. Overall, Alternative A would be expected to have negligible adverse effects on terrestrial invertebrate special status species over the long-term.

There would be no implementation-related or short-term effects, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Birds

The majority of bird species of concern occupy habitat around open water bodies such as Abbotts Lagoon or Estero de Limantour (see Table 4 in *Affected Environment*). Exceptions to this generalization include white-tailed kite, Northern harrier, short eared owl, burrowing owl, and Allen's hummingbird.

Raptors

Northern harriers nest in open areas, including dune hollows and wetter grasslands or shrublands. The harrier breeds from late March through mid June and is known to nest in wetlands within dunes at Abbotts Lagoon. The Northern Harrier forages by slowly flying above the ground surface looking for small rodents. Short eared owls have similar nesting behavior and habitat and nest where they find a high density of small rodents, their preferred prey. If they do nest in the vicinity of dunes, chicks would typically be fledged by mid -June. The burrowing owl does not nest in or near the Seashore's dunes, but does winter in the park. It prefers to roost and forage in the dunes and eats crickets, beetles and other insects.

In general, Alternative A would be expected to have no long-term effects on special status raptor species. Continued expansion of beachgrass may even benefit some species, as beachgrass stands support higher abundances of species such as deer mice than native Dune Mat communities (Pitts and Barbour 1979, Fellers and Pratt 2002).

There would be no implementation-related or short-term, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Allen's Hummingbird

Allen's hummingbird occupies undergrowth in Dune Swales and other wetlands, such as blackberry patches. This species may nest in these patches as well, with fledging occurring no later than the end of June. The Allen's Hummingbird drinks nectar from flowers, as well as eating any small insects it finds crawling around the flower blossom, which provides it with needed protein. A potential nectar source within dunes could be bush lupine, along with paintbrush (*Castilleja*) species in adjacent grasslands (J. Evens, ARA, *pers. comm*.).

Over the long term, continued expansion of European beachgrass and iceplant could decrease the number of species from which this species could obtain nectar, as there are far more nectar-bearing plants in Dune Mat vegetation than in monotypic beachgrass and iceplant stands or in wetlands. For this reason, Alternative A would likely have no effect on Allen's hummingbird occurrences at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although continued loss of nectar species in adjacent Dune Mat areas could result potentially in negligible adverse effects on this species.

There would be no implementation-related or short-term effects, as restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mammals

The Point Reyes jumping mouse is the southernmost population and smallest subspecies of the Pacific jumping mouse (Gannon 1988 *in* Bolster 1998). Survey efforts in the 1990s failed to find any mice in Point Reyes or GGNRA (G. Fellers, USGS, *pers. comm*. *in* Bolster 1998), but this mouse is "probably distributed throughout the swales of the outer peninsula" (Evens 1988 *in* Bolster 1998). Therefore, the Point Reyes jumping mouse may inhabit moist meadow or riparian habitat within swales in dune systems or in adjacent grasslands or coastal scrub.

There should be no potential for long-term, implementation-related, or short-term effects at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, as near-term restoration would not be conducted, except for previously permitted projects.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Primary projects with the potential to have cumulative effects with this alternative on special status species would be restoration of coastal dunes at Bodega Marine Laboratory in Sonoma County, continued restoration of coastal dunes at Tom's Point in Marin County, possible dune restoration conducted at Lawson's Landing, and small-scale dune restoration efforts being conducted as part of the Muir Beach Restoration Project at GGNRA. The Wildlife Protection and Habitat Improvement Plan proposed by MMWD would principally affect vegetation communities such as oak woodland and grassland habitats, so it would be unlikely to have a cumulative effect with this project on the same types of special status species as discussed here.

Beach layia. Based on the scale of projects proposed outside the park, Alternative A would likely have negligible adverse effects on beach layia distribution and numbers within the region. Beach layia is not currently listed as occurring at Bodega Dunes (BML 2012), nor at any of the other areas slated for restoration within the region (USFWS 1998). Expansion of beach layia into these newly restored non-park habitats could require reintroduction. Therefore, across this species' considerably large range from southern California to Humboldt County, the lack of restoration within at least two primary beach layia areas within the park (AT&T/North Beach, B Ranch/Davis Property) -- combined with the fact that non-park projects are unlikely to benefit this species -- would be expected to cumulatively have negligible adverse impacts on viability of this species.

Tidestrom's lupine. Based on the scale of projects proposed outside the park, Alternative A would have have negligible to minor adverse effects on Tidestrom's lupine distribution and numbers within the region. Tidestrom's lupine is not currently listed as occurring at Bodega Dunes (BML 2012). Within Marin County, Tidestrom's lupine has been documented at Lawson's Landing in Dillon Beach and at Ocean View Boulevard (USFWS 1998). There has been some discussion of dune restoration occurring at Lawson's Landing, but plans have not been finalized yet. On a range-wide scale, the lack of restoration within at four Tidestrom's lupine areas within the park (AT&T, North Beach, Davis Property B Ranch) -- combined with the fact that most of the non-park projects are unlikely to benefit this species -- would be expected to cumulatively have negligible to minor adverse impacts on viability of this species, whose distribution is largely centered in the park and in Monterey County, with a few occurrences in Sonoma County.

Sonoma alopecurus. There would be very little potential for cumulative impacts with Sonoma alopecurus, as Sonoma alopecurus is only current known to occur in one other location outside of the Seashore in a Sonoma County regional park located in Santa Rosa.

Sonoma spineflower. There would be no potential for cumulative impacts with Sonoma spineflower, as Sonoma spineflower currently does not exist outside the Seashore.

Myrtle's silverspot butterfly. Based on the scale of projects proposed outside the park, Alternative A could have cumulatively either no effect or, at most, negligible adverse effects on Myrtle's silverspot butterfly distribution and numbers within the region. While the main populations for this species occur in the Seashore, the Center for Conservation Biology did discover some butterflies east of the town of Bodega in the 1990s (USFWS 1998). Dune restoration at Bodega could benefit butterflies in this area. Potential benefits on a range-wide scale should be identical to the regional ones addressed above due to the fact that this species has been extirpated from other parts of its range, including south of San Francisco (USFWS 1998).

California red-legged frogs. Based on the scale of projects proposed outside the park, Alternative A could have cumulatively either no effect or very negligible adverse effects on distribution and numbers of California red-legged frog within the region. Dunes and Dune Swale wetlands are not the primary habitats for this species within the region, although they do occur within Dune Swale wetlands in the Seashore. Muir Beach and Tom's Point do not fall into Critical Habitat identified for this species in Marin County, however, frogs have been detected in certain drainages on the eastern side of Tomales Bay (i.e., as part of the Nick's Cove project) and in lower reaches of Redwood Creek and Muir Beach. Within Sonoma County, Critical Habitat for red-legged frogs is located in the interior portion of Sonoma County: frogs have been documented at Bodega Dunes, but no breeding sites have been recorded (J. Sones, BML, *pers. comm*.).

Western Snowy Plover. Based on the scale of projects proposed outside the park, Alternative A could have cumulatively either no effect or very negligible adverse effects on distribution and numbers of Western snowy plover within the region, as well as Critical Habitat. Along the California coast, Western snowy plovers have been extirpated from 33 of 53 nesting sites since 1970, and now number approximately 2,000 (Thomas et al. 2012). Although it is not one of the eight areas that support 78 percent of the California coastal breeding population, the Seashore is one of only 20 remaining plover breeding areas in coastal California (USFWS 2007). Snowy plovers do occur at Bodega Dunes, although not many plovers attempt to nest there (J. Sones, BML, *pers. comm*.). The viability of plovers throughout their range is affected by many factors, only some of which are related to the continued expansion of European beachgrass and iceplant in dune and beach areas.

Other Federally Listed Species: There would be no cumulative effect on other federally listed species.

Other Species of Special Concern: Potential long-term cumulative effects on other listed species, both plant and wildlife, would be no more than negligible adverse effects. Both gilia species occur at Bodega Dunes, as well as Blasdale's bent grass, woolly-headed spineflower, short-leaved evax, and beach starwort (BML 2012). Based on CNPS lists, blue coast gilia, woolly-headed spineflower, and beach starwort at least historically occurred in Tom's Point dunes and adjacent habitats (CNPS 1998).

There would be no potential for cumulative effects on either the Point Reyes jumping mouse or the Point Reyes blue butterfly, as these species are of very limited distribution and occur in the park only. For other species, the distribution is widespread enough that any cumulative effects would be very negligible.

Conclusions

For certain special status species, particularly those for whom dunes are the primary or at least secondary habitat, the lack of dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would, in general, adversely impact these plants and animals. The degree of impact varies depending on the project area. For other species, the lack of restoration may have no effect and could, in fact, over the short or long-term, be beneficial to these species.

In general, federally listed species such as beach layia, Tidestrom's lupine, Myrtle's silverspot, and western snowy plover would all be adversely affected under Alternative A, with the intensity of adverse impacts ranging from negligible to possibly moderate, with the highest level of impacts occurring for Tidestrom's lupine. Invasive plants are likely to continue to expand in these areas and negatively special status species, particularly Tidestrom's lupine at B Ranch, whose numbers have dropped dramatically in recent years due to habitat displacement by invasive species. In terms of project area, impacts from not restoring dunes would be highest at AT&T/North Beach, which supports all of these species, including nesting plovers. Impacts from the No Action Alternative would be next highest at B Ranch/A Ranch/Davis Property, which supports the federally endangered plant species, possibly Myrtle's silverspot, and historically snowy plover. Limantour does not support these federally listed rare plants, but it does occur within or directly adjacent to Myrtle's silverspot butterfly habitat and supports overwintering plovers and historically nesting plovers.

The lack of restoration would also degrade conditions for plant and animal species of special concern that primarily occur in Dune Mat or Dune Scrub. These species include curlyleaf monardella, pink sand verbena, gilias, some of the burrowing terrestrial invertebrates, and, to a lesser extent, non-federally listed spineflowers, rose leptosiphon, and Blasdale's bent grass that occur in more dune transitional habitats. With decreases in sand-burrowing arthropods and nectar-providing native dune plants, food sources for wintering owls, Point Reyes butterfly, and Allen's hummingbird could decrease, although continued expansion of European beachgrass could increase rodent populations, which are the primary prey items for raptors such as northern harriers and short-eared owls. For those species primarily located in the dunes or who may forage on dune plant species, Alternative A would result in negligible to potentially minor adverse effects on these species. For other non-dune species of special concern, the lack of restoration would either have no effect or negligible adverse effects.

For other federally listed species such as the threatened California red-legged frog, the lack of dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would either have no effect or, at very most, a negligible adverse effect on red-legged frog and its Critical Habitat from expansion of European beachgrass and iceplant into the periphery of Dune Swale wetlands and into upland and dispersal habitat. There would either be no effect on Sonoma alopecurus, as Sonoma alopecurus only occurs within dunes at AT&T and, in the past, near North Beach. AT&T would not be restored in the near-term under this alternative, and this species has never been documented at B Ranch, A Ranch, Davis Property, or Limantour. In addition to Sonoma alopecurus, this alternative should also have no effect on viability of plant species of special concern that primarily occur within adjacent grasslands or wetlands within dunes and grasslands.

In the long term, continued expansion of European beachgrass or iceplant stands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would be unlikely to have any beneficial or adverse effect on California brown pelicans, California least terns, willow flycatchers, or Point Reyes jumping mouse. There would be no effect on Sonoma spineflower, as it occurs within adjacent grasslands some distance (> 0.5 miles) from the dunes.

Based on the scale of dune restoration efforts proposed within the region, cumulative effects of these non-park projects with Alternative A would either have no impact on special status resources within the region or adverse impacts ranging from negligible to minor in intensity, with the only potential for detectable adverse cumulative effects possibly being for Tidestrom's lupine.

Impact of Alternative B

Analysis

Under this alternative, restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would primarily use manual methods to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such as European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Listed Plant Species

In the long term, Sonoma spineflower would not likely be affected, as it does not occur in or near (> 0.5 mile) any of the Seashore's dune systems.

Beach Layia

Long-Term Effects

Under Alternative B, European beachgrass and iceplant would be removed manually from relatively small areas at AT&T/North Beach and B Ranch/Davis Property that support beach layia. (Beach layia is not documented from A Ranch or Limantour.) Hand removal of iceplant may yield some long-term benefits for this species, as hand removal of particularly sparse iceplant patches is relatively successful in terms of eradicating this invasive. In general, however, European beachgrass areas restored through manual removal are typically less successful than iceplant ones, because they are more likely to be re-impacted in the future through re-growth of this deeply rooted non-native, invasive species. As was discussed under *Vegetation Resources*, very small fragments of this rhizomatous species can re-root or re-grow from buried rhizomes not completely removed by manual means. In addition, manual removal of European beachgrass is much more costly per acre than iceplant, which reduces the number of acres that can be potentially restored. A more complete description of the long-term impacts associated with continued expansion of European beachgrass and iceplant on beach layia can be found under Alternative A.

Under Alternative B, then, beach layia populations at AT&T, North Beach, Davis Property, and B Ranch could continue to decline in numbers or even be lost due to the reduced scale and efficacy of using strictly manual removal restoration methods. Benefits of restoration to beach layia would definitely be reduced relative to Alternatives C and D, although they would be possibly greater than under Alternative A.

Given these factors, over the long-term, impacts on beach layia under Alternative A would range from negligible adverse to negligible beneficial, with more beneficial effects expected where iceplant is the dominant invasive (B Ranch, Davis Property). There would be no impact at A Ranch or Limantour, as beach layia does not occur there.

Implementation-Related and Short-Term Effects

Access and Staging: Access and staging would have at most very negligible adverse impacts on beach layia at AT&T/North Beach and B Ranch/Davis. Most of the major access and staging would occur in areas adjacent to the dunes. There may be some secondary access routes created in dunes or in existing parking lots. These routes would be located to avoid rare plants such as beach layia to the maximum extent practicable. Occasionally, beach layia establishes within access routes: in these situations, the plant would be marked, and traffic would be re-routed to the maximum extent practicable around these individuals. There would be no impact at A Ranch and Limantour, as beach layia has not been documented there.

Manual Removal: Digging up of either European beachgrass or iceplant could adversely impact beach layia, principally because this plant is small enough that individuals can be located within the aboveground canopy of these species and would not be easily visible and, therefore, accidentally killed during manual removal activities. In general, most of the plants occur within open, sparsely vegetated areas and would, therefore, be more visible to crews, but this species, unlike Tidestrom's lupine, can occur within small pockets of open sand within dense European beachgrass stands. Some impact is likely to occur unless the project is conducted in the summer or fall, when this species has senesced. However, these impacts would not be expected to be measurable or detectable, given the inherent error in counting these types of plants. Based on these factors, adverse impacts would be no more than negligible to minor at AT&T/North Beach and B Ranch/Davis Property. There would be no impact at A Ranch or Limantour, as beach layia has not been documented there.

Tidestrom's Lupine

Long-Term Effects

Under Alternative B, Tidestrom's lupine populations could continue to decline in numbers or even be lost due to the reduced scale and efficacy of restoration using manual removal approaches. Ultimately, three populations that do not appear to be self-sustaining due to poor reproduction – B Ranch North, B Ranch South, and Davis Property –- could go extinct (Dangremond et al. 2010, Pardini and Knight 2013). The AT&T population is barely stable (Dangremond et al. 2010). This is particularly true in areas where poor reproduction due to seed consumption by deer mice is substantial (WU, unpub. data). Tidestrom's lupine has not been documented at A Ranch or Limantour.

While restoration would benefit Tidestrom's lupine, this species would continue to be impacted by expansion of European beachgrass within the AT&T, North Beach, and B Ranch North, and B Ranch South project areas. Based on censuses conducted between 2000/2001 and 2011, numbers of Tidestrom's lupine had declined over the decade by roughly 36% at North Beach and 54% at B Ranch South, with the most dramatic decline recorded at B Ranch (Parsons and Minnick 2012). In recent years, the B Ranch North population has crashed dramatically, with estimated numbers dropping from an estimate of 11,000 – 12,000 individuals between 2001 and 2007 to 1,835 individuals in 2011 and 1,685 individuals in 2012, an approximately 83% decrease in population size (Parsons and Minnick 2012; Johnson et al. 2012b).

Given these factors, even with restoration, populations of Tidestrom's lupine at AT&T, North Beach, and B Ranch may continue to decline, particularly at AT&T, because, even though near-term restoration would be conducted, the scale of restoration would be reduced relative to Alternatives C and D, and there would be, particularly at AT&T, a stronger potential for re-growth of European beachgrass in the future. Restoration under this alternative may have more benefits for Tidestrom's lupine at B Ranch and Davis Property, where iceplant is one of the major threats, because iceplant is easier and more economical to remove by hand than European beachgrass. Given these factors, benefits would range from very negligible to negligible at the AT&T/North Beach and B Ranch/Davis Property project areas, respectively.

Implementation-Related and Short-Term Effects

Access and Staging: Access and staging would have at most very negligible adverse impacts on Tidestrom's lupine at AT&T, North Beach, B Ranch, and Davis Property. Most of the major access and staging would occur in areas adjacent to the dunes or in existing parking lots. There may be some secondary access routes created in dunes. These routes would be located to avoid rare plants such as Tidestrom's lupine to the maximum extent practicable. Tidestrom's lupine, as with beach layia, sometimes establishes within access routes: in these situations, the plant would be marked, and traffic would be re-routed to the maximum extent practicable around these individuals.

Manual Removal: Digging up of either European beachgrass or iceplant could adversely impact Tidestrom's lupine, principally when these plants occur directly adjacent to Tidestrom's lupine, because digging can impact the adjacent root system of this perennial plant. In general, most of the plants don't occur within dense European beachgrass stands, but they do occasionally occur where European beachgrass is beginning to expand into native dune areas. Adverse impacts would be no more than negligible to perhaps minor at AT&T/North Beach and B Ranch/Davis Property.

Sonoma Alopecurus

Long-Term Effects

As of 2013, the Seashore supported eight out of only nine known extant populations of this plant (Ryan and Parsons 2012). Of these eight populations, only two have the potential to be directly or indirectly impacted by coastal dune restoration under this proposal: the dune swale population at AT&T and the freshwater marsh population within the grasslands adjacent to dunes at North Beach. Plants have not been observed at the latter population during the last few years. Sonoma alopecurus has not been documented at Davis Property, B Ranch, A Ranch, or Limantour.

Under this alternative, restoration would be conducted in the near-term at AT&T and North Beach. The AT&T population appears to be a highly imperiled population based on steadily declining numbers, as was discussed in greater detail under Alternative A. The cause of most of the Sonoma alopecurus populations' decline is unknown, although grazing regime, including intensity and seasonality, may play an important role (Ryan and Parsons 2012). The grazing regime at the AT&T population has been more sporadic in recent years, which may have led to the reduction in numbers (Ryan and Parsons 2012). In at least once instance (Abbotts Lagoon), numbers have been adversely affected by sand burial of the drainage swale adjacent to the restored dunes, as restoration has remobilized sands accumulated during decades of stabilization by non-native, invasive plant species. The park is attempting to mitigate this loss through construction in fall 2013 of a new drainage swale nearby.

Dune restoration would not necessarily appear to benefit this species: European beachgrass and iceplant may encroach into the periphery of dune swale wetlands, but the frequency of occurrence of these invasive species within the deepest part of these swales where Sonoma alopecurus is very low. Removal of invasives such as European beachgrass and iceplant from adjacent upland areas could destabilize the sand dunes surrounding the swale and increase the potential for wetland burial, although the potential for this is reduced under Alternative B relative to Alternative D and Alternative C due to the fact that excavation depths are shallower with manual removal. Under this alternative, there would be the potential for a negligible to possibly minor adverse effect long-term on Sonoma alopecurus at AT&T and North Beach.

Implementation-Related and Short-Term Effects

There would be no access or staging in wetlands within or outside of the dune systems. Some European beachgrass may be removed by digging in wetlands, which could impact root systems of adjacent Sonoma alopecurus plants, although beachgrass only sporadically occurs in dune swales, particularly in the wetter portion of these swales. Impacts from sand remobilization are addressed under Long-Term Effects. Implementation-related adverse effects on Sonoma alopecurus would be very negligible at AT&T and North Beach.

Listed Animal Species

Myrtle's Silverspot Butterfly

Long-Term Effects

In general, restoration of coastal dunes would benefit Myrtle's silverspot, because both European beachgrass and iceplant form monotypic stands that exclude native dune plant species that provide nectar. European beachgrass and iceplant are both considered "unambiguously bad" for butterfly habitat (USFWS 1998) and have, in fact, been named as "one of the most serious present-day threats" to this species.

Under this alternative, habitat for native dune plant species such as curlyleaf monardella, beach evening primrose, and mock heather would increase, although native Dune Mat and Dune vegetation communities would continue to be impacted in unrestored areas within AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour by further encroachment by European beachgrass and iceplant. The degree of benefit provided under Alternative B would be relative to Alternatives C and D due to the reduced scale of restoration. Also, relative to Alternatives C and D, areas restored through manual removal of European beachgrass are more likely to be re-impacted in the future through re-growth of this deeply rooted non-native, invasive species.

Overall, there would be negligible to perhaps minor long-term benefits for this species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Ultimately, recovery of the butterfly depends on the health of both the dune and grassland systems.

Implementation-Related and Short-Term Effects

Staging and Access: Most of the potential for effect in adjacent coastal grasslands and prairies would be due to the need to access sites and stage restoration efforts adjacent to coastal dunes. Proposed impact avoidance and minimization measures related to Myrtle's silverspot butterfly include using existing ranch roads to the maximum extent practicable and locating any new access routes such that they avoid the only known larval plant species for the butterfly -- western dog violet. Surveys would be conducted in the spring, and western dog violet would be mapped to enable careful siting of access routes to avoid patches of western dog violet. During the flight season, which is principally in the summer, all Park Service, contractor, or volunteer crews would be required to keep speed of vehicles below 10 mph within treatment areas and access roads to avoid striking by vehicles of adult butterflies. Based on these measures, staging and access would have at most a negligible adverse impact on Myrtle's silverspot at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour during implementation.

Manual Removal: The primary implementation-related impacts associated with manual removal are trampling of native vegetation by contractor crews, volunteers, and/or park staff; trampling of native vegetation by use of all-terrain vehicles such as UTVs; and possible impacts to adjacent native vegetation from digging out either European beachgrass or iceplant. Digging can disrupt the root systems of adjacent native plant species. These native vegetation species may be used by Myrtle's silverspot as nectar sources during the flight season. Manual removal is currently used for sparse iceplant areas and for European beachgrass directly adjacent to rare or native plants or in wetlands.

Some impacts may occur, as well, from on-site disposal of biomass. This would only occur for iceplant and certain other species such as bush lupine if flowers are removed before disposal. Disposal areas would be sited to the maximum extent practicable outside of larger native dune vegetation areas. Butterflies are more likely to frequent larger Dune Mat or Dune Scrub communities, where there is a higher concentration of nectar sources. If possible, biomass would be disposed of in stands of European beachgrass and iceplant not designated for treatment. European beachgrass would only be disposed of on-site if an area could be found where material could be placed without the potential for it to be redispersed by high winds: siting of disposal areas is much more sensitive for this species due to its propensity to resprout easily from even the smallest rhizome.

Impacts to adults from vehicular striking of adult butterflies by UTVs would be unlikely due to the fact that the rugged and, in many areas, highly vegetated terrain naturally limits speeds and would keep them below 10 mph, but the 10 mph speed limit would apply throughout the project area.

Based on these factors and the proposed impact avoidance and minimization measures, manual removal would have no more than a negligible adverse impact on Myrtle's silverspot at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour during implementation.

California Red-legged Frog

Long-Term Effects

Under Alternative B, restoration of coastal dunes using manual removal methods could have very negligible to possibly minor long-term adverse effects on red-legged frogs and its Critical Habitat at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Red-legged frogs occur in dune swale wetlands both at AT&T/North Beach and B Ranch/A Ranch/Davis Property. At Limantour, there are no dune swale wetlands within or directly adjacent to the dune system, but some freshwater wetlands that support frogs occur less than 0.25 mile away from the dunes.

Adverse impacts would be very negligible due to the fact that there would be less coastal dune restored under this alternative than under Alternatives C and D, and manual removal tends to result in less destabilization of dune sands than other control methods such as mechanical removal (see *Alternative D*). Therefore, breeding and non-breeding habitats within dunes and adjacent grasslands would be less directly impacted than they would be if mechanical removal or possibly chemical control were used.

Based on the factors discussed above, these restoration projects would have no more than very negligible to at most minor adverse impacts on this species at AT&T/North Beach and B Ranch/A Ranch/Davis Property, and Limantour over the long-term due to impacts on breeding and non-breeding habitat.

Implementation-Related and Short-Term Effects

Staging and Access: Most of the potential for effect on California red-legged frog from staging and access would result from the fact that some of the wetlands in grasslands adjacent to the dunes support frogs. Proposed impact avoidance and minimization measures include using existing ranch roads to the maximum extent practicable; siting staging areas outside of wetlands; and locating any new access routes such that they avoid wetlands. Should any staging areas, temporary access routes, or fencing need to be installed within 100 feet of breeding habitat during the breeding season (December 1-July 31), a qualified biologist would be present to ensure that no frogs are harmed during vegetation clearance activities. Based on these measures, staging and access may have at most a very negligible adverse impact on red-legged frogs at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Under Alternative B, manual removal of European beachgrass would be conducted in Dune Swale wetlands and in some buffer areas to wetlands. These activities could harm frogs through shovels accidentally striking frogs hiding in the vegetation or through trampling by crews or utility terrain vehicles such as UTVs. These impacts would be avoided or minimized through a number of measures. If the wetland is considered breeding habitat either based on historic records or recent night surveys, manual removal would not be conducted in these wetlands until after breeding is completed (August 1-November 30). If adjacent vegetation to these breeding habitats is very dense, manual removal would not be conducted within 100 feet of identified breeding frogs, or it would only be conducted if a qualified biologist is present to conduct surveys for frogs before vegetation is removed. With USFWS approval, a qualified biologist may relocate these frogs outside of the work in appropriate habitat. In addition to breeding habitat, frogs may also occur in non-breeding habitats, although, given the inhospitable nature of most of the dune areas to amphibians such as red-legged frog, most frogs are likely to occur in either ponded or moist wetland or meadow areas, not in native Dune Mat or areas dominated by European beachgrass or iceplant.

Based on these impact avoidance and minimization measures, there would be the potential for a very negligible to minor effect on red-legged frogs from manual removal at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Short-term minor impacts could occur if sand remobilization buries portions of wetlands where active breeding is occurring, thereby impacting egg masses and tadpoles.

Western Snowy Plover

Long-Term Effects

As with many migratory species, many different factors affect success of western snowy plover nesting and fledging efforts, and some of these factors exert effects on more of a regional or even larger scale. Restoration of coastal dunes can address only some of the threats to these species in the park, which also include disturbance of plovers by people and dogs, as well as predation of adults, eggs, and chicks by native predators. An extensive review of management efforts in Oregon and Washington for this species found that no one management technique was responsible for improvement of plover metrics, although higher numbers of plovers were found in restored areas, and plover nest success rates did correlate with the reduction in vegetation cover and increase in bareground that occurred several years after European beachgrass was removed (Zarnetske et al. 2010).

Under Alternative B, restoration of coastal dunes using manual removal methods could have negligible long-term benefits for snowy plover and its Critical Habitat at AT&T, North Beach, and, to a lesser extent, B Ranch, A Ranch, Davis Property, and Limantour. The intensity of potential benefits to this species under Alternative B is reduced relative to Alternatives C and D. This is due not only to the fact that less restoration would possibly be conducted under this alternative, but to the fact that the highest priority restoration area for plovers would be the foredunes, which are the most difficult to restore manually because of the depth of European beachgrass rhizomes. In foredunes, these rhizomes can extend from 6-12 feet, as was observed during the Abbotts Lagoon project. Using manual removal methods, European beachgrass stands located in the foredunes are likely to quickly re-grow and eliminate any of the benefits of restoration for plover.

Ultimately, other management techniques may be needed in combination with dune restoration to improve the viability of the plover population within the park. As described under Alternative A, current park management actions would also continue, including installation of nest exclosures and reduction of feed sources for corvid predators on adjacent ranchlands. Public education efforts may or may not continue, depending on whether funds are available to continue the docent program during the breeding season. It is possible that success from habitat restoration efforts could increase if non-restoration management techniques reduce or eliminate other existing threats to the plover population within the park.

Implementation-Related and Short-Term Effects

Staging and Access: Western snowy plovers primarily occupy beaches and oceanward portions of the dune system, and so are not expected to occur more than sporadically in the vicinity of staging areas and primary access routes in grasslands adjacent to dunes or parking lots. Potential impacts of secondary access routes within dunes are discussed below. Therefore, staging and access would have very negligible to negligible adverse impacts on western snowy plover at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Manual removal has the potential to have implementation-related effects from disturbance of active nests during the breeding season by crews and use of all terrain-vehicles such as UTVs. Breeding season is typically characterized as extending March 1 through September 15 of each year, but, at Point Reyes, nesting does not typically begin until mid-March or early April based on historical records. One of the primary impact avoidance and minimization measures employed by the Seashore is that no restoration activities involving large crews, vehicles, or heavy construction equipment are conducted within 500 feet of an active snowy plover nest. In the past, hand removal of re-sprouts by a few individuals has taken place with approval of qualified wildlife biologists if the individuals remain out of sight of the nest: this often involves operating on the leeward (or inland) side of foredunes. Even outside breeding season, manual removal could have a temporary impact on some of the constituent elements of Critical Habitat such as the unvegetated foredune and beach, if crews need to access treatment areas using beach routes.

Based on these factors, including proposed impact avoidance and minimization measures, adverse impacts to plovers during implementation would be negligible at most at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

California brown pelican

Under this alternative, the primary impact to pelicans would be from disturbance by crews removing vegetation: the potential for this implementation-related adverse impact is extremely negligible. In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on pelicans.

California least tern

The California least tern is an extremely rare fall migrant that is unlikely to occur within any of the potential restoration areas. Although noise from crews could disturb this species, the chance of treatment occurring at the same time a tern is in the vicinity is considered so low as to be extremely negligible. In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on least terns.

Willow flycatcher

This is a rare migrant to certain riparian scrub areas of the park, including near Abbotts Lagoon, and is present primarily in August, if at all. Although this species may be disturbed by noise from human activity (USFWS 1998), the potential for adverse impacts to this species during or shortly following restoration would be considered extremely negligible. In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on willow flycatchers.

Plant Species of Concern

A more complete description of the potential impacts associated with restoration on plant species of concern can be found under Alternative A. The plant species of concern within the Seashore's Dune systems occur in Dune Mat, Dune Scrub, Coastal Grasslands, Coastal Scrub, and wetland communities.

Potential impacts to these species under Alternative B largely relate to the primary habitat in which they occur. For those species primarily located in the dunes, Alternative B would likely result in negligible to at most minor beneficial effects over the long-term for curlyleaf monardella at AT&T/North Beach and B Ranch/A Ranch/Davis Property and negligible beneficial effects for pink sand verbena at Limantour, A Ranch, and Davis Property. As gilias are less prevalent within many of the dune interiors than curlyleaf monardella, benefits to these species may be negligible and would be similar to benefits for the spineflowers, rose leptosiphon, and Blasdale's bent grass.

For species primarily occurring in adjacent grasslands and wetlands within dunes and grasslands, this alternative should have no effect to a negligible long-term adverse effect on viability of these species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Staging and access would be expected to primarily affect species in adjacent grasslands or dune ecotones. Based on proposed impact avoidance and minimization measures discussed under *Vegetation Resources*, staging and access may have a negligible to minor localized adverse impact during and following implementation. Implementation-related effects on species primarily occurring in Dune Mat and Dune Scrub could occur as a result of manual removal. In general, adverse impacts would be expected to be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Animal Species of Concern

Other than California red-legged frog (discussed earlier), no fish, amphibian, or reptile species of concern are found commonly within the Seashore's dunes.

Terrestrial Invertebrates

Impacts to invertebrate species that may take place under this alternative are similar to those implementation-related and short-term effects discussed earlier for prey items for western snowy plover or Myrtle's silverspot butterfly. In general, sand-burrowing arthropod communities are lower in abundance and diversity within dense European beachgrass stands (Stenzel et al. 1981, Slobodchikoff and Doyen 1977 *in* USFWS 2007), therefore, it is likely that many of these special status beetles do not occur within these stands.

Over the long-term, restoration should actually increase habitat for sand-burrowing arthropods and for dune plant species that could act as nectar and host plant sources, resulting in negligible benefits to these species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. The intensity of these benefits would be reduced under this alternative relative to Alternatives C and D.

Implementation-related and short-term impacts could occur from manual removal. If access through native vegetation communities is required due to the location of some of the invasive plant stands, these areas would be surveyed, and an access route would be chosen that would have the least impact on either rare plants or native dune vegetation. Impacts to adults from vehicular striking of adult butterflies by UTVs would be unlikely due to the fact that the rugged and, in many areas, highly vegetated terrain naturally limits speeds and would keep them below 10 mph, the speed limit which the Seashore has established to avoid impacts to the Myrtle's silverspot butterfly. Due to these factors, including proposed impact avoidance and minimization measures, direct adverse impacts of manual removal on invertebrate species of special concern would likely be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Birds

The majority of bird species of concern occupy habitat around open water bodies such as Abbotts Lagoon and Estero de Limantour and are unlikely to be affected more than negligibly by dune restoration (see Table 4 in *Affected Environment*). Exceptions to this generalization regarding open water being the primary habitat include white-tailed kite, Northern harrier, short eared owl, burrowing owl, and Allen's hummingbird. Impact avoidance and minimization measures for birds include maintaining a buffer around active nests during the breeding season, which extends from March 15 to July 31 for landbirds.

Raptors

Over the long term, these species may not be directly impacted by dune restoration efforts, but they could be indirectly impacted by reduction in prey populations such as rodents due to loss of European beachgrass habitat, which has been shown to support higher abundances of species such as deer mice than native Dune Mat communities (Pitts and Barbour 1979, Fellers and Pratt 2002).

Therefore, this alternative could have at most negligible adverse impacts over the long-term to raptors that frequent dune areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. There would be almost no effect discernable on a park-wide scale due to the fact that these species use many other habitats within the Seashore. Restoration may even benefit the burrowing owl, as it eats crickets, beetles, and other insects that may increase as a result of restoration.

Adverse effects from implementation of dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would be very negligible, as manual removal would generate less noise and disturbance than other restoration methods, and nesting buffers would reduce any potential impact.

Allen's Hummingbird

Over the long term, dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour should increase the number of species from which this species could obtain nectar, as there are far more nectar-bearing plants in Dune Mat vegetation than in wetlands. This should result in at least negligible beneficial effects under Alternative B, although benefits would be reduced relative to Alternatives C and D.

During and shortly following implementation, these species could be disturbed by removal activities. Several impact avoidance and minimization measures would be implemented that would help to preclude this, including avoidance of removal activities during the breeding season unless nesting surveys have been conducted. If a nest is found, a buffer would be established between any active nest and manual removal activities, with the size of the buffer determined by information provided by the park's wildlife biologist and site conditions (e.g., topography), but the buffer would be no smaller than 25 feet.

Based on these factors, including proposed and impact avoidance and minimization measures, adverse impacts would be only negligible during the implementation phase.

Mammals

In the long-term, the only potential adverse effects on Point Reyes jumping mouse from removing European beachgrass and iceplant that could occur is if sand is remobilized by removal and impacts moist meadow or riparian habitats. These impacts would be greater from mechanical removal than either manual removal or chemical control, so, under Alternative B, no beneficial or adverse effects from removing European beachgrass and iceplant manually would generally be expected on the Point Reyes jumping mouse.

During implementation, no direct impacts from manual removal are expected, although indirect impacts in the form of noise disturbance or disturbance from the presence of humans may temporarily displace an individual from its territory. Pacific jumping mice are mainly nocturnal, but show some crepuscular activity (Bolster 1998). Therefore,adverse impacts on this species during and shortly following restoration would be negligible.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have a cumulative impact with Alternative B are the same as discussed under Alternative A.

Please see individual species discussions under Alternative A.

Beach layia. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts would likely have negligible beneficial effects on beach layia distribution and numbers within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently.

Tidestrom's lupine. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts would probably have negligible beneficial effects on Tidestrom's lupine distribution and numbers within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently. On a range-wide scale, the park's efforts, combined with other regional efforts, would be expected to have negligible beneficial impacts on viability of this species, whose distribution is largely centered in the park and in Monterey County, with a few occurrences in Sonoma County.

Sonoma alopecurus. There would be no potential for cumulative impacts with Sonoma alopecurus, as the other dune restoration sites outside the park do not support Sonoma alopecurus, nor do other proposed project sites in the region.

Sonoma spineflower. There would be no potential for cumulative impacts with Sonoma spineflower, as Sonoma spineflower is not currently known to occur outside the park.

Myrtle's silverspot butterfly. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts could have negligible beneficial effects on Myrtle's silverspot butterfly distribution and numbers within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently. Potential benefits on a range-wide scale should be identical to the regional ones addressed above due to the fact that this species has been extirpated from other parts of its range, including south of San Francisco (USFWS 1998).

California red-legged frogs. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts could have potential negligible adverse effects on distribution and numbers of California red-legged frog and Critical Habitat within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation if some of these dune restoration efforts end up being conducted concurrently.

Western Snowy Plover. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts could have potential negligible beneficial effects on distribution and numbers of western snowy plover within the region, with the potential for perhaps cumulative negligible to minor adverse impacts during and following implementation if some of these dune restoration efforts end up being conducted concurrently. The Seashore represents one of the major breeding areas in the local region, but the viability of plovers is affected by many factors, only some of which would be addressed by dune restoration. Therefore, on a range-wide scale, these cumulative restoration efforts may only yield very negligible beneficial efforts for western snowy plover.

Other Federally Listed Species: There would be no cumulative effect on other federally listed species.

Other Species of Special Concern: Potential long-term cumulative effects on other listed species, both plant and wildlife, would be no more than negligible, whether those effects would be adverse or beneficial. For these species, cumulative restoration efforts could have negligible beneficial effects over the long-term on a regional scale, but negligible adverse impacts during and shortly following implementation.

There would be no potential for cumulative effects on either the Point Reyes jumping mouse or the Point Reyes blue butterfly, as these species are of very limited distribution and occur in the park only. For other species, the distribution is widespread enough that any cumulative effects would be very negligible both on a long-term and implementation-related scale.

Conclusions

Restoration under this alternative would primarily use manual methods to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Both initial treatment and re-treatment would be conducted using manual methods. Based on the logistical intensity and cost, the areal extent of dunes restored under this alternative may be reduced relative to Alternatives C and D. If less restoration is conducted, particularly in areas where European beachgrass dominates, then, European beachgrass and iceplant would continue to expand in unrestored areas at a higher rate than under Alternatives C and D.

For certain special status species, particularly those for whom dunes are the primary or at least secondary habitat, dune restoration would, in general, benefit these plants and animals. The degree of benefit varies depending on the extent of restoration. For other species, dune restoration may offer no benefit and could, in fact, over the short or long-term, have adverse impacts on these species, with the intensity of impact related to the scale of restoration.

In general, federally listed species such as beach layia, Tidestrom's lupine, Myrtle's silverspot, and western snowy plover would all benefit from restoration, but, as the extent of restoration under this alternative may be reduced relative to the other action alternatives, so would the benefits. Under Alternative B, populations of beach layia or Tidestrom's lupine could continue to decline or even be lost due to the reduced scale of restoration, and use of certain areas dominated by European beachgrass or iceplant by snowy plover and Myrtle's silverspot may also decrease. Areas where iceplant is the dominant may fare better due to the fact that iceplant is easier and more economical to remove by hand than European beachgrass. Also, relative to Alternatives C and D, areas restored through manual removal of European beachgrass are more likely to be re-impacted in the future through re-growth of this species, as manual removal is not very successful without constant re-treatment. In particular, the foredunes are the least likely to be successfully restored through manual removal due to the depths of the rhizomes in these areas, which can extend 6- 12 feet.

Given these factors, under this alternative, dune restoration would result probably in only negligible benefits for beach layia and western snowy plover and negligible to possibly minor benefits for Tidestrom's lupine and Myrtle's silverspot butterfly at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Restoration at AT&T/North Beach would benefit all of these species, while restoration at B Ranch and Davis Property would benefit largely the federally listed endangered and other rare plants and potentially the butterfly. Snowy plover has not been documented in recent years at B Ranch, A Ranch, or Davis Property and only overwinters currently at Limantour, with the last documented nesting occurring in 2000. Ultimately, other management techniques may be needed in combination with dune restoration to improve the viability of the plover and the butterfly populations within the park.

Restoration would also improve conditions for plant and animal species of special concern that primarily occur in Dune Mat or Dune Scrub. These species include curlyleaf monardella, gilias, pink sand verbena, some of the burrowing terrestrial invertebrates, and, to a lesser extent, non-federally listed spineflowers, rose leptosiphon, and Blasdale's bent grass that occur in more dune transitional habitats. With increases in sand-burrowing arthropods and nectar-providing native dune plants, food sources for wintering owls, Point Reyes butterfly, and Allen's hummingbird could increase, although reductions in extent of European beachgrass could decrease rodent populations, which are the primary prey items for raptors such as northern harriers and short-eared owls. For those species primarily located in the dunes or who may forage on dune plant species, Alternative B would offer fewer benefits (possibly minor) than other alternatives due to the likely reduction in restoration extent. For other non-dune species, restoration would result in at most negligible adverse impacts on a localized scale and either no effect or very negligible impacts on a park-wide scale.

For other federally listed species such as the endangered Sonoma alopecurus and threatened California red-legged frog, dune restoration is unlikely to have measurable benefits for their wetland habitat, which occurs in the dunes themselves (Dune Swales) or in adjacent grasslands (Freshwater Marsh). Removal of invasives could destabilize the sand dunes surrounding Dune Swales or Freshwater Marshes, although the potential for this is reduced relative to Alternative D and Alternative C due to the fact that excavation depths with manual removal are shallower. Under this alternative, there would be the potential for only a very negligible to possibly minor adverse effect long-term on Sonoma alopecurus, California red-legged frog, and the frog's Critical Habitat both at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Sonoma alopecurus only occurs within dunes at the AT&T project area and a freshwater marsh near North Beach, while red-legged frogs occur at least during the wet season within many of the Dune Swale and Freshwater Marsh wetlands. All three project areas fall within Critical Habitat for red-legged frogs.

In addition to federally listed species, this alternative should also have no effect to a most negligible long-term effect on viability of plant species of special concern that primarily occur within adjacent grasslands or their wetlands.

In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on California brown pelicans, California least terns, willow flycatchers, or Point Reyes jumping mouse. There would be no effect on Sonoma spineflower, as it occurs within adjacent grasslands some distance (> 0.5 miles) from the dunes.

During or shortly after implementation, manual removal and staging and access for restoration would have no more than negligible to minor adverse impacts on any of these special status species. Short-term minor impacts could occur on a localized scale for red-legged frog if sand remobilization buries portions of wetlands where active breeding is occurring, thereby impacting egg masses and tadpoles.

Based on the scale of other dune restoration projects proposed within the region, cumulative effects of these projects with those that may be conducted Alternative B would be no more than negligible to at most minor on a regional scale, with the only potential for detectable adverse cumulative effects possibly being on red-legged frogs, although, frogs occur in many different types of wetlands within the park, the intensity of this effect would be relatively negligible.

Impact of Alternative C

Analysis

Under this alternative, restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Listed Plant Species

In the long term, Sonoma spineflower would not likely be affected, as it does not occur in or near (> 0.5 mile) any of the Seashore's dune systems.

Beach Layia

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on beach layia can be found under Alternative A.

Under Alternative C, beach layia would be expected to increase within restored locations, although populations could continue to decline in numbers or even be lost in unrestored areas within AT&T, North Beach, B Ranch, and Davis Property. Beach layia has not been documented at A Ranch or Limantour. There is less information available on success of this particular approach for restoring beach layia than with mechanical removal. However, some of the areas treated chemically at Abbotts Lagoon had beach layia establishing within the first year after treatment. Restoration using this approach should provide benefits for this dune species, and these benefits could be greater than those under Alternatives B and D due to the potential increase in acreage restored at AT&T, North Beach, B Ranch, and Davis Property.

Given these factors, over the long-term, Alternative C could result in potentially minor to moderate long-term benefits to beach layia at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as beach layia has not been documented there.

Implementation-Related and Short-Term Effects

Access and Staging: In general, potential access and staging impacts on beach layia would be similar to those under Alternative A, although the intensity of impacts may increase, as heavy equipment may be mobilized. Access and staging would have negligible adverse impacts on beach layia at AT&T, North Beach, B Ranch, and Davis Property. There would be no effect at A Ranch or Limantour, as beach layia has not been documented there.

Manual Removal: Potential impacts of manual removal on beach layia are similar to those discussed under Alternative B. Adverse impacts from manual removal methods would be no more than negligible to minor at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as beach layia has not been documented there.

Mechanical Removal: The potential for impact during implementation of mechanical removal would depend, to some degree, upon the amount of mechanical removal in wetland and organic pasture buffer areas conducted. Unlike Tidestrom's lupine, beach layia can occur within small pockets of open sand within dense European beachgrass stands, so mechanical removal in buffers could harm a few individuals, although most of the plants preferentially occur in more open, sparsely vegetated areas. Fewer individuals would be expected to occur adjacent to wetlands, so potential impacts from mechanical removal in buffers would potentially be less than in non-buffer stands. Adverse impacts during and shortly following implementation would be no more than negligible at AT&T, North Beach, B Ranch, and Davis Property. There would be no effect at A Ranch or Limantour, as beach layia has not been documented there.

Chemical Control: The primary implementation-related impacts associated with chemical control involve accidental spraying or drift even with direct foliar application using a backpack sprayer onto non-target species, particularly native plant species such as beach layia that are intermixed within dense European beachgrass or iceplant stands. Beach layia occurring within larger native vegetation communities are unlikely to be directly impacted, because these areas would be off-limits to spray crews.

A very detailed description of the potential implementation-related and short-term impacts on non-target plant species associated with chemical control can be found in the *Vegetation Resources*-Alternative C. Information from this discussion pertinent to beach layia is summarized here.

In general, most spraying would be conducted in fall, after beach layia has senesced. It is possible that some spraying may occur during the spring if conditions are dry, but, in general, the herbicides used, particularly, are more effective in the fall, when species such as European beachgrass translocates or moves herbicides and other materials such as carbohydrates to root systems. Therefore, the potential for adverse impacts from accidental foliar application or drift to beach layia is negligible.

For glyphosate, soil exposures are much less toxic than foliar exposures (SERA 2011a). The lesser toxicity of glyphosate in soil is probably attributable in part to the tight binding of glyphosate to some types of soils (e.g., Accinelli et al. 2005; Borggaard and Gimsing 2008; Caceres-Jensen et al. 2009; Glass 1987; Mamy and Barriuso 2005 *in* SERA 2011a). Seedling emergence studies involving three different glyphosate formulations indicate that application rates in the range of 4-5 lb a.e./acre (pounds acid-equivalent/acre) are relatively non-toxic to seedlings emerging after spraying is complete (Bohn 1987; Everett et al. 1996a; Willard 1996 *in* SERA 2011a). For glyphosate treatment of European beachgrass and iceplant, application during dune restoration would result in approximately 4.0 lbs a.e./acre.

Imazapyr differs from glyphosate in that it can exert effects on non-target vegetation both aboveground and belowground. The potential for belowground effects vary depending on the environment in which it is used. Treatment in non-estuarine environments has sometimes led to issues with long-term adverse impacts such as die-off of non-target plant species, specifically seasonal wetlands in the upper margins of San Francisco Bay (Whitcraft and Grewell 2011) and saltcedar-infested riparian areas in Colorado (Douglass 2013). There are no clear-cut studies on potential non-target effects on dune systems, but, in Mendocino County, no evident lasting effects were observed either with respect to germination or establishment of native dune plants, including rare plants (CDPR 2012).

The park has not conducted any formal study of effects of glyphosate/imazapyr treatment on adjacent non-target species, but monitoring of plots one year after herbicide application was completed demonstrated that a number of species established after treatment, including wild cucumber, miner's lettuce, woodland groundsel, galium, fairy mist tarweed, and fescue (*Festuca bromoides*). Additional dune species included sand mat, coast cryptantha, beach morning-glory, and beach primrose. Some individuals of beach layia and another CNPS-listed annual species, curlyleaf monardella, were also observed.

One other form of drift that may affect non-target vegetation such as beach layia is wind erosion (SERA 2011a). Wind erosion leading to off-site movement of pesticides is likely to be highly site-specific and depends on several factors, including application rate, depth of incorporation into the soil, persistence in the soil, wind speed, and topographical and surface conditions of the soil (SERA 2011a). The earlier USFS risk assessment (2003) calculated that for a reasonable worst case scenario – a sandy surface with high wind speeds and arid conditions – approximately 0.54% of the glyphosate applied to an application area would be lost due to wind erosion.

Mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be unlikely to impact beach layia, because it would be conducted in the fall after beach layia has senesced.

Another pre-treatment measure that may be used is prescribed burning. Isolated beach layia individuals within dense European beachgrass stands may be adversely impacted by burning, although prescribed burning is likely to occur after the plant has senesced. No prescribed burning would take place in native Dune Mat, where the highest densities of this species occur. A 20-foot buffer would be established around Dune Mat areas to prevent impacts from prescribed burning.

Based on these factors, including the proposed avoidance and minimization measures, chemical control and associated pre- and post-treatment methods would be expected to result in negligible to minor impacts to beach layia during or shortly after implementation at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as beach layia has not been documented there.

Tidestrom's Lupine

Long-Term Effects

Monitoring of the Abbotts Lagoon population following restoration demonstrated that restoration reduced predation pressure on Tidestrom's lupine. Prior to restoration, the mean percentage of racemes or flowering stalks of the Abbotts Lagoon Tidestrom's lupine population that suffered predation ranged from 38% to 94% across a six-year observation period

(Pardini and Knight 2013). Predation rates were significantly lower in the first four years following the restoration, ranging from 4% in 2013 to 19% in 2011, the year restoration was implemented (Pardini and Knight 2013; E. Pardini, *pers. comm*., Figure 3).

Under Alternative C, Tidestrom's lupine would be expected to prosper within restored locations at AT&T, North Beach, B Ranch, A Ranch, and Davis Property. Restoration benefits would probably be greatest in those areas where poor reproduction due to seed consumption by deer mice has been greatest, such as B Ranch North, B Ranch South, and Davis Property (Dangremond et al. 2010, Pardini and Knight 2013). These benefits could be greater than those under Alternatives B and D due to the potential increase in acreage restored at these project areas.

Given these factors, over the long-term, Alternative C could result in potentially minor to possibly moderate benefits to Tidestrom's lupine at AT&T, North Beach, B Ranch, and Davis Property. Restoration at B Ranch and, to a lesser extent, Davis Property would particularly provide benefits (moderate), as numbers of this species have dropped in this area dramatically in the last decade. The lupine population at AT&T is considered barely stable (Dangremond et al. 2010). There would be no effect at A Ranch or Limantour, as Tidestrom's lupine has not been documented there.

Implementation-Related and Short-Term Effects

Access and Staging: In general, access and staging impacts on Tidestrom's lupine would be similar to those discussed under Alternative B, although the intensity of impacts may increase, as heavy equipment may be mobilized. Access and staging would have at most negligible adverse impacts on Tidestrom's lupine on a localized scale, including at AT&T, North Beach, B Ranch, and Davis Property and on a park-wide scale. There would be no effect at A Ranch or Limantour, as Tidestrom's lupine has not been documented there.

Manual Removal: Impacts of manual removal on Tidestrom's lupine are identical to those discussed under Alternative B. Adverse impacts from manual removal methods would be no more than negligible to perhaps minor at AT&T, North Beach, B Ranch, and Davis Property. Impacts may be minor where iceplant is removed by hand, but negligible for European beachgrass manual removal areas, as manual removal of European beachgrass would be limited primarily to wetlands, buffer areas, and re-treatment. There would be no effect at A Ranch or Limantour, as Tidestrom's lupine has not been documented there.

Mechanical Removal: The potential for impact during implementation would depend, to some degree, upon where mechanical removal would be conducted (e.g., dense European beachgrass stands or buffer areas to wetland). Unlike beach layia, Tidestrom's lupine almost never occurs within small pockets of open sand within dense European beachgrass stands, so mechanical removal in dense stands would be very unlikely to harm a few individuals. It is possible that Tidestrom's lupine could occur, though, on the perimeter of European beachgrass stands adjacent to native Dune Mat communities, where mechanical removal could inadvertently harm a few individuals. Fewer individuals would be expected to occur adjacent to wetlands, so potential impact could be reduced in buffer areas. Adverse impacts during and shortly following implementation would be no more than negligible at AT&T, North Beach, B Ranch, and Davis Property. There would be no effect at A Ranch or Limantour, as Tidestrom's lupine has not been documented there.

Chemical Control: The primary implementation-related impacts associated with chemical control involve accidental spraying or drift even with direct foliar application using a backpack sprayer onto non-target species, particularly native plant species such as Tidestrom's lupine that occur adjacent to European beachgrass and iceplant individuals. Tidestrom's lupine occurring within larger native vegetation communities are unlikely to be directly impacted, because these areas would be off-limits to spray crews.

A very detailed description of the potential implementation-related and short-term impacts on non-target plant species associated with chemical control can be found under Alternative C in the *Vegetation Resources* section. Pertinent information from this discussion to Tidestrom's lupine is summarized here.

In general, most spraying would be conducted in fall, after Tidestrom's lupine has flowered and set seed. It is possible that some spraying may occur during the spring if conditions are dry, but, in general, the herbicides used, particularly, are more effective in the fall, when species such as European beachgrass translocates them to root systems. Therefore, the potential for adverse impacts to a critical life history stage (flowering and setting seed) from accidental foliar application or drift to Tidestrom's lupine is negligible, although impacts to non-flowering individuals could occur. These would be reduced through use of buffers (10 feet) or drift shields.

Foliar exposures to glyphosate are much more toxic than soil exposures, based on seedling emergence data (SERA 2011a). As discussed under beach layia, the lesser toxicity of glyphosate in soil is probably attributable in part to the tight binding of glyphosate to some types of soils (e.g., Accinelli et al. 2005; Borggaard and Gimsing 2008; Caceres-Jensen et al. 2009; Glass 1987; Mamy and Barriuso 2005 in SERA 2011a). For glyphosate treatment of European beachgrass, application would result in approximately 4.0 lbs a.e./acre. However, if non-target plants are hit during spraying, the effects are much more toxic, with the no observed effect concentration (NOEC) levels varying from 0.035 to 0.7 lbs a.e./acre depending largely on type of species (monocot, dicot; Chetram and Lucash 1994 *in* SERA 2011a).

Imazapyr differs from glyphosate in that it can exert effects on non-target vegetation both aboveground and belowground. If directly sprayed with imazapyr at an application rate of 1 lb a.e./acre, even less susceptible species of plants may be damaged (SERA 2011b). Application rate for treatment of European beachgrass in the park would not exceed 1.5 lbs a.e./acre (1.5% concentration) and would be in almost all cases be a 1% concentration. Sensitive species often show non-target effects at concentrations – not application rates – of as little as 0.000064 lbs a.e./acre, while resistant species may be able to tolerate up to 0.4 lbs a.e./acre (SERA 2011b).

One of the standard impact avoidance and minimization measures involves either use of 10-foot buffer between spot-spray operations or a drift shield. Due to the size of European beachgrass, drift shields often involve use of two half 5-gallon containers that can be used to "sandwich" in rare plants and protect them from the effects of accidental foliar application. This technique has proved successful in past operations in protecting Tidestrom's lupine and limiting permanent injury to no more than a few individuals.

As discussed under *Vegetation Resources*-Alternative C and beach layia above, there has been concern about the potential for long-term soil residue effects on non-target plant species in non-estuarine environments (Whitcraft and Grewell 2011, Douglass 2013). There are no clear-cut studies on potential non-target effects on dune systems, but, in Mendocino County, no evident lasting effects were observed either with respect to germination or establishment of native dune plants, including rare plants (CDPR 2012). The park has not observed any effects of glyphosate/imazapyr treatment on establishment of species within sprayed areas at Abbotts Lagoon, with numerous common and even a few rare species such as beach layia and curlyleaf monardella (CNPS-listed annual) observed growing in treatment areas (see beach layia for more information).

In addition to these issues, drift can also impact non-target species that are more distant from the actual treatment area. Drift can result when herbicide application extends beyond the intended area of application and can be influenced by many factors, including the method of application (e.g., aerial or broadcast versus ground), topography, wind speed, humidity, type of herbicide, and droplet size. The park employs a number of impact avoidance and minimization measures during herbicide treatment, including avoidance of broadcast application methods; use of backpack sprayers with calibrated nozzles; and discontinuation of spraying when wind speeds reach an average or consistent gusts of 10 mph at plant level or when conditions are very foggy. Labels for both AquaMaster® (currently marketed as Round-Up Custom®) and Habitat® recommend spraying between 2 or 3 to 10 mph to minimize drift. In addition, wicking of herbicide onto vegetation or drift shields may also be used to minimize the potential for herbicide drift.

Most studies on herbicide drift are focused on either aerial application or boom sprayer-type application methods used in agricultural operations (Salyani and Cromwell 1992, Holterman et al. 1997). However, these studies greatly overestimate the potential for drift for more focused backpack-specific application methods (SERA 2011a). Based on USFS risk assessment worksheets developed by SERA specifically for backpack units, use of the proposed 4.0 pounds a.e./acre of glyphosate as Round-Up® would result in drift of 0.8% (0.033 lbs a.e./acre) of the applied solution within 25 feet of the application area, 0.4% (0.017 lbs a.e./acre) within 50 feet, and 0.03% (0.001 lbs a.e./acre) within 900 feet. As noted earlier, the no observed effect concentration (NOEC) levels for glyphosate for non-target plant species varied from 0.035 to 0.7 lbs a.e./acre depending largely on type of species (monocot, dicot; Chetram and Lucash 1994 *in* SERA 2011a).

Use of an application rate of 1.0 lb a.e./acre of imazapyr would result in drift of 0.008 lbs a.e./acre of the applied solution within 25 feet of the application area, 0.004 lbs a.e./acre within 50 feet, and 0.0006 lbs a.e./acre within 900 feet. NOAEL for imazapyr varied from as little as 0.000064 lbs a.e./acre to as much as 0.4 lbs a.e./acre, depending on the susceptibility of the species (SERA 2011b). As discussed under beach layia, wind erosion can also affect non-target vegetation (SERA 2011a).

Mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have negligible effects on Tidestrom’s lupine, because it does not occur intermixed with European beachgrass stands, but more on the perimeter of these stands. Mowing would not affect a critical life history stage, as it would be conducted in the fall.

Another pre-treatment measure that may be used is prescribed burning. Tidestrom’s lupine individuals on the edges of dense European beachgrass stands may be adversely impacted by burning, although no prescribed burning would take place in native Dune Mat, where the highest densities of this species occurs. A 20-foot buffer would be established around Dune Mat areas to prevent impacts from prescribed burning.

Based on these factors, including proposed avoidance and minimization measures, chemical control and associated pre- and post-treatment methods would be expected to result in negligible to minor impacts to Tidestrom’s lupine during or shortly after implementation at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as Tidestrom’s lupine has not been documented there.

Sonoma Alopecurus

Long-Term Effects

As was discussed under Alternative B, only two of the Seashore's six populations have the potential to be directly or indirectly impacted by this alternative – the AT&T population, which appears to be a highly imperiled population based on steadily declining numbers, and the population that occurs in a freshwater wetland directly adjacent to North Beach dunes. Plants have not been observed at the latter population during the last few years. The potential for impact to these populations is greater for dune swale wetlands that occur within the coastal dune system, such as AT&T, than for ones that occur in the adjacent pastures or grasslands, although both can be impacted by dune restoration.

Removal of invasives such as European beachgrass could destabilize the sand dunes surrounding the swale and increase the potential for this population to be buried by sand. The potential for burial is reduced relative to Alternative D due to the fact that chemical control rather than mechanical removal would be the primary removal method, and this method leaves the slow dying and decomposing rhizome system in place to "hold" the sands, while native plants either establish naturally or are actively planted. Mechanical removal may be implemented within the 60-foot buffer on either side of this swale, which could result in destabilization and movement of sands into the swale. Low-lying basins are less likely to shift with high winds than dune peaks, so movement of sands should be reduced relative to Alternative D, although there are several sections of wetland buffer along this swale in which the dune slopes are quite steep, which could result in substantial fallback of sands into the drainage swale if restoration is not properly implemented, or slopes, properly stabilized.

Active revegetation would be conducted in backdune areas to promote stabilization of these areas: Special efforts would be made to densely revegetate slopes on either side of the swale. Under this alternative, there would be the potential for a possibly moderate adverse effect long-term on Sonoma alopecurus at AT&T. See Possible Additional Mitigation Measures section for proposed measures to reduce these impacts on this Sonoma alopecurus population. There would be no effect at B Ranch, A Ranch, Davis Property, or at Limantour, as Sonoma alopecurus has not been documented there.

Implementation-Related and Short-Term Effects

There would be no access or staging in wetlands within or outside of the dune systems. Some European beachgrass may be removed by digging in wetlands, which could impact root systems of adjacent Sonoma alopecurus plants, although beachgrass only sporadically occurs in Dune Swales, particularly in the wetter portion of these swales. Potential short-term impacts to Sonoma alopecurus from sand burial are addressed under Long-Term Effects. Implementation-related adverse effects on Sonoma alopecurus would be very negligible at AT&T. Prescribed burning would not be expected to impact wetlands, as a 20-foot buffer would be established around all wetland features. There would be no effect at B Ranch or at Limantour, as Sonoma alopecurus does not occur there.

Listed Animal Species

Myrtle's Silverspot Butterfly

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on Myrtle's silverspot butterfly can be found under Alternative B. Under Alternative C, the butterfly would benefit from restoration of native dune vegetation communities such as Dune Mat and Dune Scrub and expansion of potential nectar sources at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Restoration at AT&T and North Beach would benefit this species, as would, perhaps to a lesser degree, restoration at B Ranch, A Ranch, Davis Property, and Limantour, and these benefits would be increased in scale relative to Alternatives B and D.

However, certain restoration techniques can have some long-term adverse impacts on native vegetation communities, particularly mechanical removal. Mechanical often involves "flipping" of soil horizons, which decreases sand stability and result in mobilization of sands into adjacent native dune and grassland vegetation communities. Some of the intensity of the impact may rely on the type of community: native dune vegetation communities are uniquely adapted to sand burial, with the degree of tolerance varying depending on plant species (Ranwell 1958, Huskies 1979). However, Coastal Grassland and Prairie, which supports western dog violet, may be less tolerant of sand movement, particularly over the short-term, resulting potentially in a shift in community from grassland to Dune Scrub or a mix of dune and grassland species. Because most of the areas impacted by sand movement occur at the periphery of the dunes, western dog violet may not be as impacted, because it is typically not a transitional species. Most of the sand remobilization under Alternative C would result from mechanical removal in wetland and organic pasture buffers, and, therefore, impacts would be greatly reduced relative to Alternative D.

Overall, over the long-term, there would be minor to moderate benefits for this species at AT&T, B Ranch, and Limantour. Ultimately, recovery of the butterfly depends on the health of both the dune and grassland systems.

Implementation-Related and Short-Term Effects

Staging and Access: Potential impacts would be identical to those under Alternative B, although the intensity of impacts may be greater due to the fact that heavy equipment may be mobilized. Based on the factors discussed under Alternative B, including proposed impact avoidance and mitigation measures, staging and access would have a negligible adverse impact on Myrtle's silverspot during and following implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Potential impacts would be very similar to those discussed under Alternative B. Based on the factors discussed, including the proposed impact avoidance and minimization measures, manual removal would have no more than a negligible adverse impact on Myrtle's silverspot both during and following implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: The primary implementation-related impacts associated with mechanical removal involve destruction of native plant species that are intermixed within dense European beachgrass or iceplant stands. Larger native vegetation communities such as Dune Mat and Dune Scrub would be typically either flagged or fenced to ensure avoidance by heavy construction equipment, all-terrain vehicles such as UTVs, and construction crews. As noted above, butterflies are more likely to frequent larger Dune Mat and Dune Scrub communities than areas dominated by European beachgrass or iceplant due to higher density of nectar sources. When access through native vegetation communities may be required due to the location of some of the invasive plant stands, these areas would be surveyed, and an access route would be chosen that would have the least impact on either rare plants or native dune vegetation. As noted above, impacts to adults from vehicular striking of adult butterflies by either heavy construction equipment or UTVs would be unlikely due to the fact that the rugged and, in many areas, highly vegetated terrain naturally limits speeds and would keep them below 10 mph and that a 10 mph speed limit would be imposed on all vehicles and equipment.

Due to the factors discussed, including proposed impact avoidance and minimization measures, adverse impacts of mechanical removal on Myrtle's silverspot would likely be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour and reduced relative to Alternative D, because mechanical removal would only be conducted in wetland and organic pasture buffer areas.

Chemical Control: The potential effect of vehicles such as UTVs used in restoration is discussed above. For chemical control, the park would attempt to conduct operations as much as possible outside of the flight season for the butterfly, which extends from June 15 through August 31. Potential impacts to Myrtle's silverspot include accidental spraying of adults; foliar spray onto non-target plant species used as nectar sources; and drift of herbicide onto butterflies, non-target nectar sources, or western dog violet. Nectar sources, again, do not include primary target species such as European beachgrass or iceplant. Because of the impact avoidance and minimization measures employed, the potential for drift on western dog violet, which occurs in adjacent grasslands, is highly unlikely. There is slightly higher potential for accidental over-spray or drift onto butterflies and non-target nectar sources, although these impacts would not occur in the larger Dune Mat or Dune Scrub areas, where there is the highest density of nectar sources and butterflies.

Information in the literature on the effects of glyphosate on terrestrial invertebrates includes contact bioassays, laboratory and field studies, and dietary studies. The honeybee is the standard test organism for assessing the potential effects of pesticides on terrestrial invertebrates, although other species have been studied: There is a standard set of glyphosate studies on this species (Palmer and Beavers 1997; Palmer and Krueger, 2001a; Palmer and Krueger, 2001b *in* SERA 2011a). Bees seem an applicable comparison organism, as they are flying insects that obtain nectar (and pollen) from many of the same types of plant species as butterflies.

In standard oral and contact bioassays on honeybees summarized in USEPA (1993c *in* SERA 2011a), the LD50 (lethal dose; 50% kill) values for bees are >100 µg/bee for glyphosate (SERA 2011a). Almost all of the studies are based on more toxic formulations that incorporate a surfactant rather than the formulation proposed for use by the park, which does not incorporate a surfactant. The dose of 100 µg is classified as a NOAEC (no-observed-adverse-effect concentration) because mortality was not significantly different from mortality in the matched solvent control (SERA 2011a). For a NOAEL (no-observed-adverse-effect-level), the USFS risk assessment adopted a contact and oral toxicity value of 860 mg a.e./kg bw, using 116 mg as an average body weight and a dose of 100 µg/bee (SERA 2011a).

In terms of likely toxic effects in the field, the direct spray a honey bee would experience at an application rate of 7 lbs a.e./acre corresponds to a dose of 1,120 mg a.e./kg bw of body weight. The NOAEC of 100 ug/bee corresponds to a dose of 1,080 mg/kg (SERA 2011a).

The proposed maximum lbs a.e./acre that would occur with the proposed project would be 4.0, so this would seemingly result in considerably less toxic exposure than the NOAEC threshold. As was noted in SERA 2011a, "while risks to honeybees from a direct spray cannot be excluded at the highest application rate (8 lbs a.e./acre of more toxic glyphosate formulation), the effects would not be substantial and probably would not be detectable." Although a ground or boom sprayer such as that used in agriculture may accidentally spray insects, backpack sprayers with controlled dose nozzles proposed for use with this project would greatly minimize the potential for accidental direct spraying of silverspot butterflies.

As discussed in detail under *Vegetation Resources*, concentrations of glyphosate associated with drift of herbicide would decrease with distance. Using the USFS worksheet developed by SERA and an application rate of 4 lbs a.e./acre, drift was estimated to be 0.8% (0.033 lbs a.e./acre) of the applied solution within 25 feet of the application area, 0.4% (0.017 lbs a.e./acre) within 50 feet, and 0.03% (0.001 lbs a.e./acre) within 900 feet. As noted in SERA 2011a, "regardless of the application rate (of more toxic glyphosate formulation), no exposures associated with spray drift exceed the level of concern at any application rate." In addition, if butterflies land on nectar plants or rest on a blade of European beachgrass or iceplant, their exposure would be short-lived and last a matter of seconds, unlike many of the other test organisms used in these studies such as isopods or spider mites (SERA 2011a).

There are fewer studies available for imazapyr (SERA 2011b). In both the oral and contact toxicity studies, the LD50 for imazapyr is >100 µg/bee, approximately the same as glyphosate (SERA 2011b). Taking 116 mg as an average body weight for worker bees, a dose of 100 µg/bee corresponds to about 860 mg a.e./kg bw, which is comparable to the NOAEL values reported for experimental mammals and birds (SERA 2011b). Exposure levels for honeybees are typically far below 860 mg a.e./kg bw, both for contact with and ingestion of contaminated vegetation (SERA 2011b). This apparently low acute toxicity is consistent with the toxicity data on mammals and birds (SERA 2011b).

Compared to bees, fewer studies have been conducted on butterflies, but one study by Bramble et al. (1997 *in* SERA 2011a) conducted a series of studies on the effects of using herbicides (including glyphosate) in rights-of-way maintenance, compared with mechanical maintenance and observed no significant or substantial differences in butterfly populations. Field operation-level concentrations of several herbicides, including Garlon4 and a glyphosate formulation (Accord), all with the adjuvant, EntryII, did not affect egg development of the Karner blue butterfly (*Lycaeides melissa samuelis*) in Wisconsin red and jack pine plantations, but egg hatching was significantly lowered in eggs completely drenched with Accord+Garlon4 (Sucoff et al. 2001). However, even for this formulation, the calculated reduction in adults would be less than 3.6% under operational field spraying (Sucoff et al. 2001). None of the herbicides significantly influenced the percent of larvae that formed pupae or the percentage of pupae that produced adults (Sucoff et al. 2001). In other study in Washington, herbicide had very little to no impact on nectar species, larval survival, or oviposition of the Puget blue butterfly (*Icaricia icarioides blackmorei*), although adult butterflies spent significantly less time in sprayed grassland plots than in controls (LaBar 2009).

Direct consumption of plant matter appears to be of slightly higher concern for terrestrial invertebrates. There is no specific information on consumption of nectar. Consumption of fruit may be the most analogous situation to nectar. In general, fruit consumption appears to pose less toxic risk to terrestrial invertebrates than ingestion of plant matter. Application rates of about 1.4 and 1.7 lbs a.e./acre of the more toxic forms of glyphosate could pose concerns for invertebrates that consume broadleaf vegetation and long grass plant species, respectively (SERA 2011a). In the EPA's report on herbicides and red-legged frogs, it concluded that, for large insects (which can be prey matter for frogs), the level of concern for listed terrestrial invertebrates was exceeded at application rates of glyphosate at 7.5 lbs a.e./acre and above (USEPA 2008: CRLF study).

Based on the proposed application rate and the USFS worksheet developed by SERA, the acute risk from ingesting fruit contaminated by glyphosate would range from 7.68 to 132 mg a.e./kg bw, well below the level the NOAEL threshold of 860 mg a.e./kg bw. Using the same modeling approach for imazapyr, the acute risk from ingesting contaminated fruit would range from 1.92 to 33 mg a.e./kg bw, also well below the level the NOAEL threshold of 860 mg a.e./kg bw.

Another measure of impact is the hazard quotient, which is calculated as the estimated dose in units of mg a.e./kg bw/event for acute exposures or units of mg a.e./kg bw/day for longer-term exposures. For honey bee exposure to imazapyr, the upper bounds of the HQs range from 0.04 to 0.6, with the highest bound of 0.6 being associated with the consumption of contaminated short grasses (SERA 2011b). A HQ of 1 is considered the threshold for concern: "For imazapyr, concern with an HQ of 0.6 is essentially negligible" (SERA 2011b). Application of herbicide towards the end of the Myrtle's silverspot flight season – and either after or towards the end of flowering for many of the nectar plant species – should decrease potential impacts from direct consumption of herbicide-contaminated nectar. HQs are not available for less toxic formulations of glyphosate.

Application primarily during the dry season would mean that runoff is largely a non-issue. Also, because glyphosate would degrade in the soil over time (it has an average 30-day half-life), windblown soil would be relatively free of residues by the time wintering larvae occupy ground litter. The impacts of these sources and concentrations on eggs, pupae, or larvae have not been studied, but given the timing of the application would likely to be no more than negligible.

Mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have negligible effects on Myrtle's silverspot, because mowing would most likely be conducted in the fall, when the flight season is over. Even if butterflies are present, the highest density of nectar sources and butterflies would be in Dune Mat or dense Dune Scrub, which would not be mowed. The speed of the mowing unit would be well below 10 mph, so there is a very minimal chance of butterfly death through vehicle strikes.

Another pre-treatment measure that may be used is prescribed burning. Prescribed burning would not take place during the flight season (June 15-August 31). However, should butterflies be present after August 31, a fast-moving burn could kill an occasional adult. Nectar species on the edges of dense European beachgrass stands may be adversely impacted by burning, although no prescribed burning would take place in native Dune Mat, where the highest densities of this species and its nectar sources occurs. A 20-foot buffer would be established around Dune Mat areas to prevent impacts from prescribed burning.

Based on these factors, including the proposed impact avoidance and minimization measures, adverse impacts from herbicide application and associated pre- and post-treatment methods on Myrtle's silverspot butterfly would be negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

California Red-legged Frog

Long-Term Effects

Under Alternative C, restoration of coastal dunes using primarily chemical control methods could have less long-term adverse effects on red-legged frogs and its Critical Habitat than Alternative D (which uses primarily mechanical removal methods) due to the fact that this method results in less sand destabilization. Some mechanical removal could be conducted in buffers to wetlands, which may destabilize sands immediately adjacent to wetlands and increase the potential for portions of the dune swales to be buried. In general, these low-lying areas would be less subject to high winds and sand movement than dune peaks, although, at AT&T, there are several sections of wetland buffer along this swale in which the dune slopes are quite steep, which could result in substantial fallback of sands into the drainage swale if removal is not properly implemented, or the slopes, properly stabilized.

Active revegetation would be conducted in backdune areas to promote stabilization of these areas: Special efforts would be made to densely revegetate slopes on either side of the AT&T dune swale. Therefore, breeding and non-breeding habitats within dunes and adjacent grasslands would be less directly impacted.

Based on the factors discussed above, including proposed impact avoidance and mitigation measures, potential long-term adverse impacts to populations within restoration areas could range from negligible to possibly moderate under this alternative at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. See Possible Additional Mitigation Measures section for proposed measures to reduce these impacts on the AT&T population of red-legged frog.

Implementation-Related and Short-Term Effects

Staging and Access: Potential impacts would be very similar to those under Alternative B, although the intensity of impacts would increase, because heavy equipment would potentially be mobilized. Based on the factors discussed, including proposed impact avoidance and minimization measures, staging and access would have the potential for a negligible adverse impact on red-legged frog from staging and access at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Potential impacts would be very similar to those discussed under Alternative B. Based on factors discussed, including proposed impact avoidance and minimization measures, negligible adverse effects would potentially be expected during implementation from manual removal at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. The potential for impact could increase in areas where iceplant is the dominant, as iceplant would be more likely removed by hand.

Mechanical Removal: As described under *Vegetation Resources*, mechanical removal efforts would be focused in European beachgrass stands. Frogs are unlikely to occur in these areas, although they can, particularly if beachgrass stands abut wetland areas. Mechanical removal would not occur in wetland areas: in fact, silt fencing stapled to the ground would be used to demarcate wetland boundaries to ensure that no accidental egress of heavy equipment into wetlands. Night surveys would be conducted during the breeding season to determine locations of frogs within work areas: frogs are less likely to be in the dune systems during the late summer and fall, when conditions are driest.

If adjacent wetlands are considered breeding habitat for red-legged frogs based on historic records or night surveys, a 100-foot buffer would be established from the perimeter of the breeding habitat during the breeding season (December 1-July 31). No mechanical removal could occur in this buffer area, unless 1) entrenched or buried silt fencing is established on the perimeter of the wetland, and night surveys indicate that this measure has successfully prevented frogs from entering the work area; or 2) a qualified biologist works with construction equipment to conduct clearance surveys while vegetation is being removed. With USFWS approval, a qualified biologist may relocate these frogs outside of the work in appropriate habitat. Equipment operators would also be trained to identify red-legged frogs and to stop work if frogs are observed: because of their high vantage point, they are often able to better spot animals than ground-based crew. The contractor would be required to check silt fencing daily to ensure that it remains in good condition. No heavy equipment or UTVs would be allowed to use wetlands for accessing work areas.

However, after implementation, there is some potential that sands within the buffer or adjacent dunes could remobilize and bury portions of wetlands, which could impact success of breeding efforts, including egg masses and tadpoles. This would increase the intensity of short-term, if not long-term, impacts.

Based on the fact that mechanical removal would be primarily performed in non red-legged frog breeding habitat and on the proposed impact avoidance and minimization measures, potential adverse impacts during implementation would be expected to be negligible to possibly moderate at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Potential impacts would be reduced relative to Alternative D, because mechanical removal would only be used in wetland and organic pasture buffers.

Chemical Control: Similar to mechanical removal, chemical control would largely be used in European beachgrass stands and dense iceplant patches, both of which are unlikely to support red-legged frogs. These areas constitute more non-breeding habitat, with most frogs using these areas for temporarily shelter, predator avoidance, and dispersal. Impacts to frogs using aquatic breeding and non-breeding habitats such as Dune Swale wetlands or wetlands in adjacent grasslands would be minimized by establishment of buffers to both wetlands with red-legged frogs (60 feet) and wetlands without red-legged frogs (25 feet). During the breeding season, night surveys would be conducted to determine where frogs are present: frogs are less likely to be in the dune systems during the late summer and fall, when conditions are driest. Most of the spot spraying with herbicide would occur during the late summer and fall, although some spraying could occur in the winter if conditions are dry.

Due to the buffers discussed above, the potential for dune restoration to impact red-legged frogs would largely appear related to drift during spray operations and run-off from sprayed areas into adjacent wetlands. The potential for accidental contact to a red-legged frog during spray operations appears extremely negligible due to the fact that sprayed areas are unlikely to be used by this species, particularly during drier periods such as late summer and fall. Based on worksheets developed for USFS by SERA, the proportion of glyphosate subject to drift drops dramatically even at 25 feet to 0.8% of total herbicide applied (0.03 lbs a.e./acre) and at 50 feet to 0.4% (0.017 lbs a.e./acre). Using similar worksheets for imazapyr, a similar proportion of this herbicide would drift with backpack application, but the volume was lower, ranging from 0.008 lbs a.e./acre at 25 feet and 0.004 lbs a.e./acre at 50 feet due to the lower total volume of imazapyr used.

As was discussed in greater detail under *Vegetation Resources*-Alternative C, for the 2011 USFS risk assessment, the run-off value for glyphosate in arid areas with predominantly loam or sandy soils was estimated at 0.0000001 lbs a.e./acre, with 0.089 lbs a.e./acre calculated as the maximum run-off rate for areas with predominantly clay soils, cool temperatures, and high rainfall (SERA 2011a). A recent study conducted for MMWD found that glyphosate and its breakdown product, AMPA, were not found either in dissolved or particulate phases of stormwater run-off collected from an application area, probably due to strong soil and litter adsorption (Hwang and Young 2011).Based on climate and soils, coastal dunes within the Seashore would tend towards the lower value due to the very sandy soils and moderate rainfall totals. The same is true for imazapyr: "In areas with predominantly sandy soils, the runoff of imazapyr following foliar applications should be negligible" (SERA 2011b). The potential for impact associated with run-off would be further reduced by impact avoidance and mitigation measures such as spraying during dry periods, not spraying 24 hours before a rainfall event with a 20% probability of occurrence, or 24 hours after a rainfall event. In addition, herbicide application methods emphasize avoidance of any drip of herbicide from foliage onto the ground.

Exposure of amphibians to herbicides has generated strong concerns in recent years due to a number of studies that have reported herbicide-associated adverse effects on frogs' deformities in the field. Use of glyphosate has been the cause of most of the concerns to date. The skin of amphibians is highly permeable to glyphosate, at least relative to the skin of mammals (Quaranta et al. 2009 *in* SERA 2011a). As in fish, amphibian embryos may be less sensitive than larvae to glyphosate exposure (Edginton et al. 2004a *in* SERA 2011a) indicated that frog embryos are less sensitive than frog larvae to glyphosate/surfactant exposures probably due to lack of fully developed gills in embryos.

Numerous studies, most of which are reviewed in USEPA documents (USEPA 2008a *in* SERA 2011a), address the acute lethal potency of glyphosate and glyphosate formulations to amphibians. Also, as with fish, most acute LC50 studies in amphibians are conducted over a 96 -hour exposure period, but intermediate LC50 values are typically reported at 24, 48, and 72 hours. For the purposes of ecotoxicology, glyphosate formulations are often separated into toxic and less toxic formulations. Glyphosate is an acid molecule, but it is formulated as a salt for packaging and handling. Various salt formulations include isopropylamine (IPA), diammonium, monoammonium, or potassium. The IPA salt of glyphosate is much less toxic than glyphosate acid, which probably reflects buffering by the IPA cation (SERA 2011a). Other factors that can affect toxicity of glyphosate formulations are whether they include adjuvants, such as surfactants. Most of the herbicide-related concerns for amphibians have revolved around glyphosate formulations that incorporate a surfactant called polyoxyethyleneamine (POEA). The park has proposed use of aquatic-label glyphosate formulations such as AquaMaster® (currently marketed as Round-Up Custom®), which is an IPA-type glyphosate without any integrated surfactant.

In amphibians, the lesser toxicity of glyphosate IPA is well documented (SERA 2011a). One of the strongest studies involved use of different glyphosate formulations with three species of amphibians: The acute LC50 values for glyphosate acid ranged from 81.2 to 121 mg a.e./L, while all of the LC50 values for the glyphosate IPA were "non-definitive" and were reported as >343 to >466 mg a.e./L (Mann and Bidwell 1999 *in* SERA 2011a). One study reported an acute LC50 for the original Round-Up® formulation that was as low as 2.2 mg a.e./L to >8 mg a.e./L (Howe et al. 2004), while the LC50 values for Rodeo®, with no surfactant incorporated or added, were considerably higher, ranging from 604.2 mg a.e./L to 6,870 mg a.e./L (Perkins 1997, Perkins et al. 2000, Edginton et al. 2004b *in* SERA 2011a). Mann and Bidwell (1999) classify glyphosate IPA as essentially nontoxic and indicate that "… no mortality was observed in equivalent concentrations of glyphosate IPA" (*in* SERA 2011a). The longer-term NOAEC (no-observed-adverse-effect concentration) for developmental effects is 1.8 mg a.e./L based on the study by Howe et al. (2004 *in* SERA 2011a), in which leopard frogs (*Rana pipiens*) were exposed to glyphosate IPA at a concentration of 1.8 mg a.e./L for

42 days: No adverse effects were noted on growth, development, or survival (Howe et al. 2004 *in* SERA 2011a).

Given the dose-response assessment for less toxic glyphosate formulations, the risk characterization for red-legged frogs can be described as follows for aquatic situations. At an application rate of 1 lb a.e./acre, the highest hazard quotient (HQ) is 0.06—i.e., the upper bound HQ for longer-term exposures (SERA 2011a). A hazard quotient of less than 1 indicates that no adverse effects are likely over a lifetime of exposure. At the maximum application rate, the HQ would be 0.2, below the level of concern by a factor of 5 (SERA 2011a). "Thus, there is no basis for asserting that adverse effects in amphibians would be apparent even at the upper bound estimates of exposure at the maximum application rate" for less toxic formulations (SERA 2011a).

Based on the approach used by the USEPA (USEPA 2004 *in* SERA 2011a), risks to terrestrial -phase amphibians would be characterized as the same as risks to birds (SERA 2011a). The highest HQ would be 0.00005, associated with the longer-term consumption of contaminated water (SERA 2011a). At the maximum aquatic application rate, this HQ value would be about 0.0002, which is below the level of concern by a factor of 5,000 (SERA 2011a).

Based on the available literature on glyphosate and its effects on amphibians and fish, the USEPA conducted an assessment to evaluate potential direct and indirect effects on red-legged frog arising from use of glyphosate and its salts on agricultural and non-agricultural sites (USEPA 2008). Various formulations and/or application scenarios and techniques were investigated (USEPA 2008). In addition to effects on frogs, the evaluation also took into account direct and indirect effects on primary constituent elements of Critical Habitat (USEPA 2008). In general, most of the uses that would have resulted in "Likely to Adversely Affect" scenarios were those with higher application rates (e.g., 7.5 lbs a.e./acre in forestry settings), those using reduced application rates of particular formulations, or those using reduced rates but with an aerial spraying approach (~3.5 lbs a.e./acre; USEPA 2008). Use of glyphosate at application rates of 3.85 lb a.e./acre and below had no acute or chronic direct effects on aquatic or terrestrial habitats for red-legged frog (No Effect; USEPA 2008). Indirect effects to the terrestrial-phase red-legged frog due to a reduction in the prey base may occur at any application rate for small insect prey and following chronic exposure at application rates of 3.84 lbs a.e./acre and above for mammalian prey (USEPA 2008). Again, the potential for effects under this alternative to terrestrial phases would be greatly reduced by conducting spray operations during the times of the year when frogs are least likely to occur within most portions of the dune systems.

There is no information regarding toxicity of imazapyr to reptiles or terrestrial-phase amphibians in the open literature or in studies submitted to the USEPA (USEPA/OPP 2005b, 2006a, 2007a *in* SERA 2011b). Risks to terrestrial phase amphibians are addressed in some of the USEPA ecological risk assessment by using birds as surrogates for red-legged frogs (SERA 2011b). A concern with the use of birds as a surrogate for amphibians involves the permeability of amphibian skin to pesticides and other chemicals (SERA 2011b). While no data are available on the permeability of amphibian skin to imazapyr, Quaranta et al. (2009 *in* SERA 2011b) have noted that the skin of the one frog species, the edible frog (*Pelophylax esculentus*), is much more permeable to several pesticides than pig skin and that these differences in permeability are consistent with differences in the structure and function of amphibian skin relative to mammalian skin. It should be noted that imazapyr is considered to have "a low order of acute toxicity in birds" (SERA 2011b).

Similarly, there is also little to no information regarding the toxicity of imazapyr to aquatic-phase amphibians. In view of this lack of data, the USEPA follows a standard USEPA approach that assumes that fish are approximately as sensitive as aquatic phase amphibians (SERA 2011b). For assessing risks to fish, the most recent USEPA ecological risk assessment uses a NOAEC of >100 mg a.e./L in trout for acute exposures and an NOAEC of 43.1 mg a.e./L in trout for longer-term exposures (EPA 2007a). However, a concern with the USEPA dose-response assessment for fish involves the greater toxicity of the Arsenal® formulation relative to imazapyr acid and the isopropylamine salt of imazapyr (SERA 2011b). The available information suggests that Arsenal® is more toxic than imazapyr acid by a factor of at least 5 (SERA 2011b). In the USFS risk assessment, a much lower acute NOAEC of 10.4 mg a.e./L is used to represent thresholds for the Arsenal® formulation of imazapyr (SERA 2011b).

However, even with use of a lower NOAEC, risk characterization remains below the level of concern (HQ=1) for all non-accidental exposures at application rates of 1.0 lbs a.e./acre (SERA 2011b). For terrestrial applications of imazapyr, the highest HQ was for consumption of short grass by a small bird(1.4), which is only slightly above the level of concern (1.0; SERA 2011b). While there are no specific amphibian studies for imazapyr, "there is no basis for assuming that reptiles or terrestrial phase amphibians are likely to be at risk from exposures to imazapyr" (SERA 2011b). These conclusions are similar to those reached by Trumbo and Waligora (2009), who concluded based on tests with bullfrogs (*Rana catesbiana*) that imazapyr fell within the EPA's "practically non-toxic" category and below the level of concern for listed aquatic species, with the exception of the Stalker® formulation of imazapyr. The park would be using a less toxic formulation (Habitat®) for chemical control. Another recently published study evaluated effects of a "tank mix" of imazapyr, a surfactant (Agri-Dex®), and a marker dye on state-endangered juvenile Oregon spotted frogs (*Rana pretiosa*): the study found no mortalities or significant differences in latent growth endpoints such as feeding behavior, growth, and body and liver condition indices (Yahnke et al. 2013).

The USEPA also conducted a risk assessment on imazapyr (USEPA 2007). This risk assessment indicates that no direct effects are expected on either the aquatic or terrestrial phase for red-legged frog, nor were there indirect effects expected for the frog through direct effects to either its terrestrial or aquatic food sources (No Effect; USEPA 2007). It did conclude that red-legged frogs might be adversely affected through direct effects on habitat and/or primary productivity (i.e., aquatic plant community and riparian vegetation; EPA 2007). Critical habitat might also be adversely modified based on direct effects to aquatic vascular plants and terrestrial plants (USEPA 2007). The assessment stated that risks exceed the level of concern for non-listed non-target terrestrial plants (monocots and dicots) for all imazapyr uses (LAA; USEPA 2007). However, some uses would not exceed the level of concern for terrestrial plants, including monocots exposed via spray drift following either ground or aerial application at 1.5 lbs a.e./acre and some monocots and dicots exposed via spray drift following ground spray at 0.91 lbs a.e./acre (USEPA 2007). As noted earlier, application rates proposed in terrestrial environments under this project would not exceed 1.0 lb a.e./acre.

For amphibians, there is very little information regarding the toxicity of surfactants that may be used with less toxic formulations of glyphosate (SERA 2011a). One type of surfactant that would be used by the park, Competitor®, has only slight acute toxicity to aquatic organisms, and it is one of the least-toxic surfactants used as an herbicide adjuvant (PRI 2010). The use of a relatively non-toxic surfactant would probably have no impact on the risk characterization (SERA 2011a). If a toxic surfactant is used, the toxicity of the surfactant could dominate the risk characterization (SERA 2011a). There is no information on the aquatic toxicity of the mixture of this surfactant with Aquamaster® (currently marketed as Round-Up Custom®; PRI 2010).

Mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have negligible effects on California red-legged frog, because mowing would most likely be conducted in the fall, when the breeding season is over, and frogs typically move from drier dune habitats into wetter or moist habitats. No mowing would be conducted in wetlands or in other moist dune habitats.

Another pre-treatment measure that may be used is prescribed burning. Prescribed burning would also be likely to occur in the fall, when the breeding season is over, and most of the frogs have moved out of the drier dune habitats into wetter or moister habitats. Burning would not be conducted in wetlands, and a 20-foot buffer would be established around wetlands to prevent impacts from prescribed burning. However, should frogs be present in the fall, a fast-moving burn could kill an occasional adult, and frogs may be adversely affected by smoke and heat from the fire. Surveys would be conducted prior to prescribed burning to ensure that this species is not impacted, and should frogs be present, areas immediately surrounding the frog would not be burned, or frogs would be relocated outside of the work area by a qualified biologist.

Based on the fact that less toxic formulations of glyposhate and imazapyr would be used and on the proposed impact avoidance and minimization measures, adverse impacts during and shortly after implementation would be expected to be negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Western Snowy Plover

Long-Term Effects

Additional description of the long-term impacts associated with restoration on western snowy plover can be found under Alternative B. Under Alternative C, restoration of coastal dunes using primarily chemical control methods could have more long-term benefits for plovers and its Critical Habitat, because the scale of restoration would be increased relative to Alternatives B and D. This would also offer greater benefits for plover habitat at AT&T and North Beach and, possibly to a lesser degree, at Limantour, B Ranch, A Ranch, and Davis Property than Alternatives B and D.

Use of mechanical removal in certain areas may decrease insect prey populations for more than a few years due to the “flipping” of sand horizons, although these insect communities are expected to re-establish in future years after restoration, perhaps with even higher insect abundances than previously, as European beachgrass supports a lower diversity and abundance of sand-burrowing arthropods that are food sources for plovers (Stenzel et al. 1981, Slobodchikoff and Doyen 1977).

Based on these factors and results from recent restoration efforts in the park, Alternative C would be expected to have negligible to minor long-term benefits for nesting or use by plovers at AT&T, Limantour, and B Ranch, as well as for Critical Habitat, with more nesting benefits expected at AT&T and North Beach in particular. Ultimately, however, other management techniques may be needed in combination with dune restoration to improve the viability of the plover population within the park.

Implementation-Related and Short-Term Effects

Staging and Access: Potential impacts would be very similar to those under Alternative B. Based on the factors discussed, including proposed impact avoidance and minimization measures, staging and access in adjacent grassland areas would have at most negligible adverse impacts on western snowy plover at AT&T/North Beach, B Ranch/A Ranch, Davis Property, and Limantour.

Manual Removal: Potential impacts would be very similar to those under Alternative B. The intensity of impacts would be reduced relative to Alternative B, as manual removal would primarily occur in wetlands, buffers, and for re-treatment, except for iceplant-dominated areas. Based on these measures, including proposed impact avoidance and minimization measures, adverse impacts to plovers from manual removal during implementation would be very negligible at most at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Mechanical removal could have potential implementation-related impacts to western snowy plover from operation and access of heavy equipment and other vehicles. There could be also impacts from equipment noise and short-term, as well as long-term, disturbance of soils that support sand-burrowing arthropods that plovers forage upon in and near the foredunes. Depending upon the size of the mechanical removal effort, the park would attempt to conduct most of the restoration outside of the plover breeding season (March 1 – September 15). If restoration must be conducted within the breeding season, no mechanical removal or access of heavy equipment or other vehicles would be allowed within 500 feet of an active nest. Secondary access by heavy or other equipment along the beach would be minimized during this period to the maximum extent practicable and would not occur within 500 feet of an active nest. However, there may be some temporary impacts to primary constituent elements of Critical Habitat such as unvegetated foredune and beach, even outside the breeding season.

In general, establishment of buffers would avoid any direct impact of equipment or crews on plover nests. However, buffers would reduce, but not eliminate, noise from heavy construction equipment and UTVs. Snowy plovers are thought to be highly disturbed by loud noise, such as fireworks and low-flying aircraft (USFWS 2007, Hatch 1996). Animal response to sound depends on a number of complicated factors, including noise level and frequency, distance and event duration, equipment type and condition, frequency of noise events, slope, topography, weather conditions, previous exposure to similar noises, hearing sensitivity, reproductive status, time of day, behavior during the noise event, and location relative to the noise source (Delaney and Grubb 2003 *in* WSDOT 2013). Threshold distances are defined as a known distance where noise at a given level elicits some response from a target species (WSDOT 2013). This response can be visual, as in head-turning or flushing from a nest, or the animal may show little reaction (WSDOT 2013). Particularly in birds, little or no reaction does not mean that no effect has occurred (WSDOT 2013).

Average maximum noise levels (Lmax) at 50 feet from heavy equipment range from about 73 to 101 dBA for equipment (WSDOT 2013). These numbers were identified from several studies and represent average maximum noise levels of reported values (WSDOT 2013). Based on the type of equipment used during Phase I at Abbotts – teams of two excavators and one bulldozer – the maximum noise generated at 50 feet would be 86 dBA. Based on noise attenuation, noise levels would drop to 78.5 dBA at 100 feet and 61 dBA at 500 feet. During construction, noise is generated more or less at a constant level (WSDOT 2013). USEPA guidance suggested that long-term noise increase of 5 to 10 dBA (frequency weighted sound decibels) above background noise should be considered to have a noticeable effect (USEPA 1980 *in* ICF 2010). As was discussed under *Soundscapes* in Affected Environment, ambient noise levels along the Great Beach and adjacent coastal dunes, scrub, and grasslands were recently estimated in a FAA study as ranging between 30 to <40 dBA-

LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011).

In a USFWS Biological Opinion issued for Washington Department of Transportation (WDOT) construction activities, the USFWS estimated the noise-only harassment/injury threshold for murrelets and owls is approximately 92 dBA at nest sites (WSDOT 2013). Disturbance thresholds were estimated at 70 dBA, and detectability thresholds were estimated at 44 dBA. Should response dynamics between these species and plover be similar, this would suggest that birds within 100 feet of the construction area would be disturbed; at 500 feet, the activity would still be detectable by birds, but not perceived as a disturbance. These numbers agree fairly well with analyses conducted for mechanical dune restoration efforts in Oregon for snowy plover using the USEPA noise guidance. Based on this guidance, bulldozer noise would dissipate to within 10 dBA of background noise or inconsequential levels within 500 to 900 feet when ambient noise levels are quiet (45 dBA) and 200 to 300 feet when conditions are windy (55 dBA; ICF 2010). For the Oregon restoration project, impacts to plovers were characterized as "minimal," although ambient noise levels were slightly higher along the Oregon coast.

During past projects, noise and exposure to excavators and UTVs adjacent to the beach indicated that plovers do fly away from noisy vehicles, but land very shortly thereafter and may even roost in excavator tracks (K. Peterlein, PRBO, *pers. comm*. *in* NPS 2009). Plovers did not leave the Abbotts Lagoon Phase I restoration area when foredune restoration was being conducted, and, in fact, some nests were initiated on the beach adjacent to the project area that required establishment of construction avoidance buffer zones. While sounds of construction equipment may at first startle birds and cause behavior that results in energetic losses, over a short period of time, they may become part of the ambient noise, particularly as excavators and bulldozers do not move quickly either when working or when moving between work areas: no more than 0.5 to 0.3 acre of dune can be restored per day using mechanical removal techniques employed by the park. UTVs move more quickly, but they are still constrained to slower speeds by topography and the 10 mph speed limit established to preclude impacts to Myrtle's silverspot. If plovers become too acclimated to construction sounds, adults and chicks may move closer to equipment and even roost in tracks, as was observed during the earlier Abbotts Lagoon mechanical removal project. If contractors or Park Service staff observe plover broods in the immediate work area, such that chicks or adults could be threatened, operations in the work area would be temporarily halted, and a Park Service wildlife biologist would be contacted for direction.

As mechanical removal involves "flipping" of dune soils, it may impact sand-burrowing arthropod communities both on a short-term and long-term scale, however, these communities may be already impoverished due to the fact that European beachgrass encroachment appears to reduce these sand-burrowing insect communities (Stenzel et al. 1981, Slobodchikoff and Doyen 1977 *in* USFWS 2007), thereby reducing the potential for impact relative to native Dune Mat or American Dunegrass vegetation communities.

Based on these factors, including proposed impact avoidance and minimization measures, potential impacts to western snowy plover during and shortly after implementation would be characterized as negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Potential impacts from mechanical removal would be reduced relative to Alternative D due to the fact that mechanical removal would only be used in wetland and organic pasture buffers.

Chemical Control: Potential impacts to western snowy plover associated with chemical control include accidental contact during spraying, drift during spray operations, contact of bird with sprayed vegetation, and ingestion of insects affected by sprayed ground areas. As discussed above, impact avoidance and minimization measures include establishment of a 500-foot buffer from any active nest: it is possible, though, that some adults and chicks move into the more inland dune areas to roost and feed. In addition, most spray operations would occur in the late summer or fall towards the end of or after nesting season, although some spraying may occur in the winter if conditions are dry. Even outside breeding season, chemical control could have a temporary impact on some of the constituent elements of Critical Habitat such as the unvegetated foredune and beach, if crews need to access treatment areas using beach routes.

Accidental spray of either adults or chicks is unlikely, as they would be likely to flush if approached even from a distance. In studies conducted on nests, adult birds flushed from nests – even if they had eggs or chicks present – approximately 78% of the time when people came within 165 feet of the nest and 34% of the time when people came within 300 feet of the nest (Page et al. 1977 *in* USFWS 2007). On the very small chance that a human spraying glyphosate comes within 500 feet of a foraging plover, this escape behavior would prevent any contamination by herbicide spray. If the plover hides and stays in place, it is still unlikely that birds themselves would be accidentally sprayed as herbicide would be applied by people using a backpacker sprayer with a wand that allows for targeted sprayer, and birds would be observed first, even if they didn't flush. Should adults or chicks occur within work areas during treatment, treatment crews would be directed to stop treatment and move operations elsewhere until plovers move out of the area.

Contamination from drift is a remote possibility. Potential impacts associated with drift are discussed in much greater detail under the *Vegetation Resources*-Alternative C section. The proportion of herbicide applied to a target area that would be subject to drift is identical for both glyphosate and imazapyr, although the total volume of each chemical would differ. Approximately 0.8% of the herbicide applied could drift within 25 feet of the sprayed area, with the percentage dropping to 0.4% at 50 feet, 0.2% at 100 feet, and 0.06% at 500 feet, based on USFS worksheets developed by SERA. These numbers translate to volumes of chemical ranging from 0.03 lbs a.e./acre (25 feet) and 0.002 lbs a.e./acre (500 feet) for glyphosate and 0.008 lbs a.e./acre (25 feet) and 0.0006 lbs a.e./acre (500 feet) for imazapyr.

However, the concerns for birds in areas sprayed by glyphosate are primarily associated with ingesting contaminated vegetation or insects. Plovers typically probe in sands for invertebrates and insects, although they can eat insects off low-growing vegetation. Acute dietary studies on the glyphosate formulation do suggest that the formulation is not highly toxic to birds (SERA 2011a), although decreased body weight was observed in the two studies involving dietary exposure (Evans and Batty 1986; Kubena et al. 1981 *in* SERA 2011a). None of the field studies report adverse effects in birds (SERA 2011a).

For less toxic formulations of glyphosate, the NOAEC – or the maximum concentration at which no adverse effects has been observed – of 5,000 ppm a.e. is used (SERA 2011a). For more toxic glyphosate formulations, the acute dietary concentration of 1,800 ppm a.e. is used instead (SERA 2011a). Using the factor for quail, which results in a lower and more conservative NOAEL (no-observed-adverse-effect level), the NOAEC of 5,000 ppm a.e. for technical grade glyphosate corresponds to a NOAEL of 1,500 mg a.e./kg bw (SERA 2011a). (In contrast, the NOAEL for the more toxic Round-Up® formulation would be 540 mg a.e./kg bw (SERA 2011a)). With application of 4 lbs a.e./acre, acute exposures of small birds such as plovers to contaminated insects could range from 50.3 to 452 mg a.e./kg/day, based on worksheets developed for USFS by SERA. As a less toxic formulation of glyphosate would be used, this would represent less than one-third of the NOAEL limit. Based on this same model, consumption of contaminated vegetation could result in exposures of large birds to 41.7 to 334 mg a.e./kg/day, which is again is well below the NOAEL of 1500 mg a.e./kg bw: no equation was available for small birds.

For longer-term or chronic exposures to less toxic formulations of glyphosate, the current USFS risk assessment adopts the USEPA reproductive NOAEC of 830 ppm a.e. for exposure of bobwhite quail to technical grade glyphosate (SERA 2011a). The dietary NOAEC of 830 ppm a.e. corresponds to an NOAEL of about 58 mg a.e./kg bw (SERA 2011a). Based on worksheets developed for USFS by SERA, with application rates of 4 lbs a.e./acre, long-term consumption of contaminated vegetation on-site could result in levels ranging from 0.6 to 53.4 mg a.e./kg/bw, which is either well or at least slightly below the NOAEL for long-term exposure. The risk characterization for glyphosate associated with consumption of contaminated insects by small birds and contaminated grasses by large birds suggests that, at an application rate of 4 lbs a.e./acre, there would be no or minimal effects, as HQ estimates ranged from 0.09 to 0.8 for insects and 0.08 to 0.6 for grasses, all of which fall below the threshold level of concern value of 1.

As with acute and chronic studies in mammals, the available avian studies on imazapyr, all of which were conducted up to limit doses, do not report any signs of toxicity for birds (SERA 2011b). Similarly, the longer-term (≈18 week) reproduction studies on imazapyr acid indicate no adverse effects following exposures to dietary concentrations of up to 2,000 ppm a.e (Fletcher et al. 1995a,b; Ahmed et al. 1990 *in* SERA 2011b). A field study by Brooks et al. (1995 *in* SERA 2011b) reported no changes in bird populations after imazapyr was applied at about 3.7 lb a.e./acre. Based on visual surveys, no impact was noted on bird diversity relative to sites treated with other herbicides such as picloram, triclopyr, or hexazinone (Brooks et al. 1995 *in* SERA 2011b).

Imazapyr is believed to have low acute toxicity in birds (SERA 2011b). The current USFS risk assessment adopts the USEPA (2007a) standard of 2,510 mg a.e./kg bw in quail and mallards as the NOAEL to characterize risks associated with acute exposures of birds to imazapyr (SERA 2011b). Based on worksheets developed for USFS by SERA, at an application rate of 1 lb a.e./acre, acute exposures for small birds eating contaminated insects would range from 4.38 to 224 mg a.e./kg/bw and for those eating contaminated short grasses would range from 37.7 to 1,713 mg a.e./kg/bw. Both sets of results fall well below the NOAEL. For chronic toxicity, the USEPA and USFS risk assessment use a dietary NOAEC of 1,670 ppm a.e., which is based on reproductive endpoints (i.e., egg production, hatchability, survival of hatchlings) in bobwhite quail (Ahmed et al. 1969 *in* SERA 2011b). The dietary NOAEC corresponds to a NOAEL dose of about 610 mg a.e./kg bw/day (SERA 2011b). Based on worksheets developed for USFS by SERA, at an application rate of 1 lb a.e./acre, chronic exposures for small birds eating contaminated grasses would range from 8.92 to 826 mg a.e./kg/bw, which slightly exceeds the NOAEL at the upper end. Chronic risks may be overstated, however, for while pharmacokinetic studies in birds are not available, the similarity between the acute and chronic NOAELs is consistent with a compound that is rapidly excreted (SERA 2011b).

In terms of evaluating risk, the highest HQ (1.4) comes from consumption of contaminated grass by small birds, which modestly exceeds the level of concern (HQ=1; SERA 2011b). From a practical perspective, HQs are typically rounded to the nearest digit; hence, an HQ of 1.4 does not reflect a substantial risk (SERA 2011b). In addition, the exposure scenarios for the exclusive consumption of contaminated grass by either a small bird or a small mammal should be viewed as extreme worst-case scenarios (SERA 2011b). Typically, neither small birds nor small mammals would consume only contaminated grass (SERA 2011b). All other HQs for birds at the proposed imazapyr application rates are below – and in most cases substantially below – the level of concern, ranging from 0.002 (acute exposure following consumption of contaminated insects) to 0.7 (acute exposure following consumption of contaminated grasses).

Mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have negligible effects on western snowy plover, because mowing would most likely be conducted in the fall, when the breeding season is over. No mowing would be conducted within 500 feet of an active nest.

Another pre-treatment measure that may be used is prescribed burning. Prescribed burning would also be likely to occur in the fall, when the breeding season is over. Burning would not be conducted within 500 feet of an active nest. Even with a 500-foot buffer, plovers may be disturbed by drifting smoke. No information on the effects of fire or smoke on snowy plovers is available, except for reports of potential nest abandonment due to disturbance from human camping, campfires, and smoke (USFWS 2007).

Based on these factors, including proposed impact avoidance and minimization measures, chemical control and its associated pre- and post-treatment methods would have negligible to minor adverse impacts during and shortly after implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Potential additional mitigation measures to protect broods, discussed later in this section, could reduce impacts to negligible.

California brown pelican

The California brown pelican was recently delisted by the USFWS. Brown pelicans may occupy open water habitats near some dunes where restoration could occur, but do not occur within the dunes themselves. Under this alternative, the primary impact to pelicans would be from mechanical removal of European beachgrass and, to a much lesser degree, run-off of herbicides into adjacent water bodies such as Estero de Limantour.

Use of heavy equipment near open water bodies such as Limantour may disturb this species, or even cause individuals to temporarily abandon the area, especially if it is very loud and/or extends over several days. Although some individual pelicans may habituate to non-threatening, continuous or frequently occurring noise levels, others do not. Waterfowl studies indicate that this group of birds is particularly slow in acclimating to continuous noise (Bowles 1995). Pelicans could retreat to other areas of the same water body or the ocean to get away from the noise of excavators or other heavy equipment, and some individuals may permanently leave the area. Each of these behaviors would have negative impacts on pelicans, as swimming or flying away from the source of noise increases energy expenditures, and time spent in escape can take away from feeding. In addition, pelicans may be displaced from higher quality habitat if the noise is so disruptive as to cause them to abandon the site.

Because treatment would be distant from most water bodies and relatively short-term, adverse impacts during and shortly following restoration would be negligible or perhaps minor at Estero de Limantour. As discussed for *Vegetation Resources* and some of the other *Special Status Species* subsections, the likelihood of herbicide run-off into adjacent open water bodies is very low and would, therefore, pose only a very negligible potential adverse impact on this species. In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on pelicans.

California least tern

The California least tern is an extremely rare fall migrant that is unlikely to occur within any of the potential restoration areas. Although noise from excavation or bulldozing during mechanical removal could disturb this species, the chance of treatment occurring at the same time a tern is in the vicinity is considered so low as to be very negligible. In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on least terns.

Willow flycatcher

This is a rare migrant to certain areas of the park, including near Abbotts Lagoon, and is present primarily in August, if at all. The willow flycatcher is a riparian scrub species and could rest in vegetation that surrounds dune hollows and other permanent and semi-permanent wetlands within restoration areas. Although this species may be disturbed by the noise from heavy equipment or utility vehicles or from human activity, when this species occurs, it only occurs for a very short period of time. The chance of treatment occurring in the vicinity of where the flycatcher may be roosting is considered very low, and adverse impacts to this species during or shortly following restoration would be considered very negligible. In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on willow flycatchers.

Plant Species of Concern

Potential impacts would be very similar to those discussed in detail under Alternative B. As with the other alternatives, potential impacts to these species from Alternative C largely relate to the primary habitat in which they occur. For those species primarily located in the dunes, Alternative C would likely result in minor to possibly moderate beneficial impacts over the long-term on a localized and park-wide scale for curlyleaf monardella and possibly even pink sand verbena at Limantour, A Ranch, and Davis Property. As gilias are less prevalent within many of the dune interiors than curlyleaf monardella, benefits to these species may be negligible to minor on both a localized and park-wide scale and would be similar to benefits for the spineflowers, rose leptosiphon, and Blasdale's bent grass. Many of these species occur at AT&T, North Beach, Davis Property, B Ranch, and A Ranch.

For species primarily occurring in adjacent grasslands and wetlands, dune restoration should not necessarily have direct benefits to these species, although mechanical removal in wetland and organic pasture buffer areas could have long-term impacts to adjacent grassland communities. By "flipping" soil horizons, sands within dunes are destabilized and can move during the windy season into adjacent habitats. Some of the intensity of the impact may rely on the type of community: native dune vegetation communities are uniquely adapted to sand burial, with the degree of tolerance varying depending on plant species (Ranwell 1958, Huiskies 1979). However, Coastal Grassland and wetlands may be less tolerant of sand movement, particularly over the short-term, resulting potentially in a shift in community from grassland or wetland to Dune Scrub or a mix of dune and grassland species. Relative to Alternative D, long-term impacts associated with sand movement into adjacent grasslands and wetlands would be reduced, with minor adverse effects expected where remobilization of sands along wetland buffers causes burial of portions of dune swale and grassland wetlands. However, some species that occur in dune ecotones such as gilia and spineflower may actually establish within some of these new sandy areas.

Staging and access would be expected to primarily affect species in adjacent grasslands or dune ecotones. Based on factors discussed under Alternative B, including proposed impact avoidance and minimization measures, staging and access may have a negligible to minor adverse impact during and following implementation at AT&T/North Beach, B Ranch/A

Ranch/Davis Property, and Limantour. Implementation-related effects on species primarily occurring in Dune Mat and Dune Scrub could occur as a result of chemical control, mechanical removal, and manual removal, but, based on impact avoidance and minimization measures, adverse impacts would be expected to be negligible to minor at these dune system areas.

Animal Species of Concern

Additional description of the potential impacts associated with restoration on animal species of concern can be found under Alternative B.

Terrestrial Invertebrates

In general, sand-burrowing arthropod communities are lower in abundance and diversity within dense European beachgrass stands (Stenzel et al. 1981, Slobodchikoff and Doyen 1977 *in* USFWS 2007), therefore, it is likely that many of these beetles do not occur within these stands. Over the long-term, restoration should actually increase habitat for sand-burrowing arthropods and for dune plant species that could act as nectar and host plant sources, resulting in a negligible to perhaps minor benefits to these species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. The intensity of these benefits could be greater under this alternative than under Alternatives B and D. Sand remobilization within wetland and organic pasture buffer areas could affect the potential for dunes to provide habitat, although these impacts would be reduced relative to Alternative D.

Implementation-related and short-term impacts could occur from mechanical removal, chemical control, and, to a lesser extent, manual removal. Impacts to invertebrate species that may take place under this alternative are similar to those implementation-related and short-term effects discussed earlier for prey items for western snowy plover or Myrtle's silverspot butterfly.

Mechanical removal involves flipping soil horizons within dense European beachgrass stands, which could have adverse impacts on species such as globose dune beetle (*Coelus glubosus)*, bumblebee scarab (*Lichnanthe ursine)*, and tiger beetles (*Cicendela* spp.). The globose dune beetle typically occurs within 100 feet of the wash zone, so use of heavy equipment in this area could crush globose beetles or their burrows during implementation. Other invertebrates of concern, including the Point Reyes butterfly (*Icaricia icarioides parapheres)*, are mobile and could avoid heavy equipment. Butterflies are more likely to frequent larger Dune Mat and Dune Scrub communities than areas dominated by European beachgrass or iceplant due to higher density of nectar sources. If access through native vegetation communities is required due to the location of some of the invasive plant stands, these areas would be surveyed, and an access route would be chosen that would have the least impact on either rare plants or native dune vegetation. Impacts to adults from vehicular striking of adult butterflies by either heavy construction equipment or UTVs would be unlikely due to the fact that the rugged and, in many areas, highly vegetated terrain naturally limits speeds and would keep them below 10 mph, the speed limit which the Seashore has established to avoid impacts to the Myrtle's silverspot butterfly. Due to these factors, including proposed impact avoidance and minimization measures, direct adverse impacts of mechanical removal on invertebrate species of special concern would likely range from negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour and would be reduced relative to Alternative D due to the fact that mechanical removal would only be used in wetland and organic pasture areas.

A detailed discussion of the impacts of chemical control on terrestrial invertebrates can be found under Myrtle's silverspot butterfly. For chemical control, the park would attempt to conduct operations as much as possible outside of the flight season for the Myrtle's silverspot butterfly, which extends from June 15 through August 31. This should also have benefits for other terrestrial invertebrates such as the Point Reyes blue butterfly, beetles, and scarabs. Potential impacts to terrestrial invertebrates include accidental spraying of individuals; foliar spray onto non-target plant species used as host plants by butterflies such as bush lupine and manycolored lupine (*Lupinus variicolor*); and drift of herbicide onto terrestrial invertebrates and non-target host and nectar plants. Nectar and host sources, again, are not known to include primary target species such as European beachgrass or iceplant, although this has not been well studied in California dune ecosystems or other systems outside these plants' natural ranges. There is a potential for accidental over-spray or drift onto non-target nectar or host plant sources, although these impacts would not occur in the larger Dune Mat or Dune Scrub areas, where there is the highest density of nectar sources and butterflies.

The discussion on Myrtle's silverspot addresses much of the current literature or information on the potential toxicity of these activities on terrestrial invertebrates. The honeybee is the standard test organism for assessing the potential effects of pesticides on terrestrial invertebrates, although other organisms have been studied at least for glyphosate (SERA 2011a, 2011b). As discussed in detail under Myrtle's silverspot butterfly, fewer studies have been conducted on butterflies, but few effects were documented (Bramble et al. 1997 *in* SERA 2011a, Sucoff et al. 2001, LaBar 2009), with the exception of egg hatching when eggs were completely drenched with Accord+Garlon4 (Sucoff et al. 2001) and foraging time by adults in sprayed grasslands (LaBar 2009).

For glyphosate, almost all of the studies are based on more toxic formulations that incorporate a surfactant rather than the formulation proposed for use by the park, which does not incorporate a surfactant. Based on comparative evaluations of no-observed-adverse-effect concentrations (NOAEC) and application rates, the proposed glyphosate application rate of 4.0 lbs a.e./acre would seemingly result in considerably less toxic exposure than the NOAEC threshold. As was noted in SERA 2011a, "while risks to honeybees from a direct spray cannot be excluded at the highest application rate (8 lbs a.e./acre of more toxic glyphosate formulation), the effects would not be substantial and probably would not be detectable." Backpack sprayers with controlled dose nozzles proposed for use with this project would greatly minimize the potential for accidental direct spraying of silverspot butterflies. In terms of drift, "regardless of the application rate (of more toxic glyphosate formulation), no exposures associated with spray drift exceed the level of concern at any application rate" (SERA 2011a).

Exposure levels for honeybees are typically far below 860 mg a.e./kg bw, which is the no-observed-adverse-effect level (NOAEL) both for contact with and ingestion of vegetation contaminated with imazapyr (SERA 2011b). The apparently low acute toxicity of imazapyr for terrestrial invertebrates is consistent with the toxicity data on mammals and birds (SERA 2011b).

The greatest concern for terrestrial invertebrates appears to be direct consumption of plant matter. There is no specific information on nectar consumption, so fruit consumption was used as a surrogate measure: the effects of ingesting contaminated fruit appear to have less impact than ingesting contaminated vegetation (SERA 2011a). Based on the proposed application rate of 4 lbs a.e./acre and the USFS worksheets developed by SERA, the acute risk from ingesting fruit contaminated by glyphosate would range from 7.68 to 132 mg a.e./kg bw, which is well below the level the NOAEL threshold of 860 mg a.e./kg bw for less toxic glyphosate forms. Using the same modeling approach for imazapyr, the acute risk from ingesting contaminated fruit would range from 1.92 to 33 mg a.e./kg bw, which is also well below the level the NOAEL threshold of 860 mg a.e./kg bw.

However, consumption by terrestrial invertebrates of contaminated insects or grasses lead to a much broader – and more elevated range – for acute exposure that ranged from 36.0 to 2,110 mg a.e./kg bw. The upper part of the range exceeds the NOAEL threshold, with the highest dosage numbers being for consumption of broadleaf plants, insects, and short grasses: the central value, however, did not exceed the NOAEL for any of these food sources. As was noted in SERA (2011a), application rates of as low as 1.4 and 1.7 lbs a.e./ acre of glyphosate could pose concerns for invertebrates that consume broadleaf vegetation and long grass plant species, respectively (SERA 2011a). While one of the target species includes a grass (European beachgrass), it is unclear that any of the terrestrial invertebrates eat this species, so risks may come from primarily from accidental spraying of non-target plants or insects.

Another measure of impact is the hazard quotient or HQ. For honeybee exposure to imazapyr, the upper bounds of the HQs range from 0.04 to 0.6, with the highest bound of 0.6 being associated with the consumption of contaminated short grasses (SERA 2011b). "For imazapyr, concern with an HQ of 0.6 is essentially negligible" (SERA 2011b). Application of herbicide towards the end of the flight season for butterflies – and either after or towards the end of flowering for many of the host and nectar plant species – should decrease potential impacts from direct consumption of herbicide-contaminated nectar. No HQs have been developed for terrestrial invertebrate exposure to less toxic forms of glyphosate (SERA 2011a).

Based on these factors, including the proposed impact avoidance and minimization measures, adverse impacts from herbicide application on invertebrate species of special concern would be negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with potentially moderate impacts occurring for terrestrial invertebrates that forage on target species such as European beachgrass or non-target plants or insects within European beachgrass stands.

Birds

The majority of bird species of concern occupy habitat around open water bodies such as Abbotts Lagoon and Estero de Limantour and are unlikely to be affected more than negligibly by dune restoration (see Table 4 in *Affected Environment*). Exceptions to this generalization regarding open water being the primary habitat include white-tailed kite, Northern harrier, short eared owl, burrowing owl, and Allen's hummingbird. Impact avoidance and minimization measures for birds include maintaining a buffer around active nests during the breeding season, which extends from March 15 to July 31 for landbirds.

Raptors

Over the long term, these species may not be directly impacted by dune restoration efforts, but they could be indirectly impacted by reduction in prey populations such as rodents due to loss of European beachgrass habitat, which has been shown to support higher abundances of species such as deer mice than native Dune Mat communities (Pitts and Barbour 1979, Fellers and Pratt 2002).

The largest impacts to rodents would occur with mechanical removal, which have both long-term and implementation-related impacts due to rodent species such as deer mice due to extensive turnover of soil horizons. The slow speed at which mechanical removal takes place – 0.3 to 0.5 acre/day based on time required during Phase I at Abbotts Lagoon – would allow many of the deer mice and other rodents to escape work areas before direct impacts occurred, but these mice may be eaten by predators before they can reach other beachgrass areas, or the carrying capacity of the remaining beachgrass stands may be exceeded, causing a die-off. Therefore, this alternative could have negligible to minor adverse impacts over the long-term to raptors that frequent dune areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with almost no effect discernable on a park-wide scale due to the fact that these species use many other habitats within the Seashore. Restoration may even benefit the burrowing owl, as it eats crickets, beetles, and other insects that may increase as a result of restoration.

Mechanical removal within wetland and organic pasture buffers may have other implementation-related or short-term impacts. Raptors can be affected by noise. As was discussed in considerable detail under Western snowy plover, animal response to sound varies considerably due to a number of factors. Based on the type of equipment and past analyses from other projects, at 100 feet from construction, birds would be disturbed; at 500 feet, the activity would still be detectable by birds, but would be unlikely to be perceived as a disturbance.

Several species of raptors increased their home range size during military activity that included vehicle activity, human activity, and helicopter flights. Red-tailed hawks shifted their activity away from the noise, but returned when training had ceased (FHWA 2004 *in* NPS 2009). Ellis and colleagues (Ellis et al. 1991 *in* AMEC 2005 *in* NPS 2009) reported frequent and nearby jet aircraft passes noticeably alarmed peregrine falcons and sometimes caused a flight response, but never caused nest abandonment or reproductive failure. Fraser et al. (1985 *in* AMEC 2005 *in* NPS 2009) found that 10% of nesting bald eagles interrupted their incubation or brooding activities during overflights. Mexican spotted owls were observed to flush at noise levels of 92 dBA, but returned to pre-disturbance behavior within 10 to 15 minutes after the noise (Delaney et al. 1999 *in* AMEC 2005 *in* NPS 2009).

As noted above, mechanical removal can have some benefits for species, as raptors will often take advantage of disturbance to prey populations and actually increase hunting efforts within construction sites, as was observed with white-tailed kites and the park's Giacomini Wetland Restoration Project. Manual removal is unlikely to affect these species, unless removal takes place directly near a nest, which is unlikely as the park tries to avoid removal activities in the breeding season for birds unless nest surveys have been conducted.

Chemical control could also impact these bird species. These types of birds are unlikely to be affected by accidental spraying or drift onto individuals themselves, but more by ingestion of contaminated species. As was discussed in considerable detail under Western snowy plover, research into glyphosate and its effect on birds has been conducted, with effects split between toxic and less toxic formulations. The type of glyphosate used by the Seashore is considered less toxic. For acute toxicity values for less toxic glyphosate formulations, the current USFS risk assessment uses a NOAEC of 5,000 ppm a.e. and a NOAEL of 1,500 mg a.e./kg/bw (SERA 2011a). For longer-term exposures to less toxic formulations, the USFS risk assessment uses a NOAEC of 830 ppm a.e., which corresponds to an NOAEL of about 58 mg a.e./kg bw (SERA 2011a). Based on worksheets developed for USFS by SERA, at an application rate of 4 lbs a.e./acre of glyphosate, estimates of exposure from a small mammal being directly sprayed and then consumed by a carnivorous bird were 12.9 mg a.e./kg/bw, which falls far below the acute NOAEL of 1,500 mg a.e./kg/bw. The HQ for this exposure would be 0.02, which also falls far below 1.0, the level of concern.

The available avian studies on imazapyr did not report any signs of toxicity (SERA 2011b). The current USFS risk assessment uses a NOAEL of 2,510 mg a.e./kg bw from studies on quail and mallards to characterize acute exposure risks and a NOAEL of 610 mg a.e./kg bw/ day for chronic exposure risks (SERA 2011b). Based on worksheets developed for USFS by SERA, at an application rate of 1 lb a.e./acre of imazapyr, estimates of acute risk exposure from consumption of contaminated small mammals by a carnivorous bird were 3.23 mg a.e./kg/bw, which falls dramatically below the acute NOAEL of 2,510 mg a.e./kg/bw. The HQ for this exposure would be 0.001, which also falls far below 1.0, the level of concern. No estimates were available for chronic exposure to herbicide-contaminated mice.

Based on these factors, including the proposed impact avoidance and minimization measures, Alternative C could have negligible adverse impacts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Allen's Hummingbird

Dune restoration under Alternative C could increase the number of species from which Allen's hummingbirds obtain nectar relative to Alternatives B and possibly Alternative D.

In terms of implementation, a 25-foot buffer to wetlands, where Allen's hummingbirds often nest, would be established for chemical control activities, and most of the chemical control activities would happen in the late summer and fall, which is outside of this species' nesting season. There is some potential for this species to be adversely impacted by obtaining nectar from a native dune plant that was indirectly sprayed or affected by drift, but, as was discussed under Myrtle's silverspot butterfly, these implementation-related adverse impacts are expected to be negligible to minor. Impacts from foraging on target species are very unlikely due to the fact that European beachgrass is a grass species that does not produce nectar, and hummingbirds are not known to forage upon nectar produced by iceplant.

Mechanical removal could disturb nesting Allen's hummingbird. As noted above, there would be a 100-foot buffer between mechanical removal and nesting birds, however, impacts from noise may extend beyond 100 feet. Studies of birds have found that some birds will not nest near chronic noise (such as road noise), but others are unaffected (*in* NPS 2009). One study had similar results, finding that the density of 7 of 12 grassland species was reduced as noise levels increased. Some birds do become habituated to continuous or frequent noise. As the impact would likely occur within project areas for no more than a year, unless the project is very large or would need to be constructed within two seasons, any impacts on nesting would be restricted to the implementation period and would not likely extend beyond that timeframe.

Based on the type of method used and proposed impact avoidance and minimization measures, adverse impacts are expected to be only negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mammals

In the long-term, no benefits or adverse effects from removing European beachgrass and iceplant are expected on Point Reyes jumping mouse. The only potential adverse effects on Point Reyes jumping mouse from removing European beachgrass and iceplant that could occur is if sand is remobilized by removal in wetland and organic pasture buffer areas and impacts adjacent moist meadow or riparian habitats. These impacts would be minimized under Alternative C relative to Alternative D, because mechanical is not the primary removal method.

During implementation, no direct impacts from mechanical or manual removal are expected, although indirect impacts in the form of noise disturbance or disturbance from the presence of humans may temporarily displace an individual from its territory. Pacific jumping mice are mainly nocturnal, but show some crepuscular activity (Bolster 1998).

Also, there is the potential for mice to be impacted by drift associated with chemical control, however, based on the discussion of this threat for other special status species and the proposed impact avoidance and minimization measures, the potential for this impact is very minimal, particularly as this species may be primarily nocturnal. Pacific jumping mice are primarily granivorous, preferring seeds of forbs, grasses and grass-like monocots (Jones et al. 1978 *in* Bolster 1998). They also eat fruits, berries, certain fungi, and insects (Krutzsch 1954, Jones et al. 1978 *in* Bolster 1998). Pacific jumping mice forage mostly at ground level in moist places where they cut plant stems in order to reach ripening seed heads (Bailey 1936, Gannon 1988 *in* Bolster 1998).

Non-target impacts to seeds and fruits that these mice might eat would be minimized by the 25-foot non-spray buffer to wetlands where they might occur. Based on worksheets developed for USFS by SERA, at application rates of 4 lbs a.e./acre, accidental spraying of glyphosate onto non-target plant species could result in acute exposure of mice from contaminated fruits ranging from 2.15 to 10.1 mg/kg/day. For the current USFS risk assessment, the no-observed-adverse-effect level (NOAEL) of 500 mg/kg bw/day is used to characterize risks associated with applications of less toxic glyphosate formulations (SERA 2011a), which corresponds at the proposed application rate of 4 lbs a.e./acre into a HQ of <0.01 to 0.06, which is well below the level of concern (1). At an application rate of 1 lb a.e./acre, accidental spraying of imazapyr onto non-target plant species could result in acute exposure of mice from contaminated fruits ranging from 0.52 to 28.0 mg/kg/day. For the current USFS risk assessment, the NOAEL of 738 mg/kg bw/day is used to characterize risks associated with applications of imazapyr to non-canid mammalian species (SERA 2011b), which corresponds at this application rate into a HQ of 0.003 to 0.08, which is well below the level of concern (1).

Based on these factors and the impact avoidance and minimization measures proposed, adverse impacts during and shortly following restoration would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Possible Additional Mitigation Measures: To reduce potential localized adverse impacts during and after implementation to Sonoma alopecurus and California red-legged frog at AT&T, the following measures may be taken. In addition to densely revegetating adjacent dune slopes as discussed earlier, mechanical removal could be performed as a straight cut, which would reduce the mobility of sands adjacent to the swale. This would require transport of excavated sands to another location. Another potential measure would be to eliminate or delay treatment within the 60-foot wetland buffer adjacent to this particular swale, or mechanical removal may be performed only on the downwind edge and in areas where the steepness of slope would not encourage fallback of sands into the drainage swale. The latter approach would decrease sustainability of restoration efforts due to the propensity for European beachgrass to reinvade treated areas. Lastly, the dune peaks to the west and east of the drainage swale could also be reshaped using heavy equipment to a lower elevation to minimize the amount of sand movement that would occur during spring winds.

Should western snowy plover adults and chicks move into the immediate work area during chemical treatment operations, treatment would be stopped immediately, and treatment crews would move operations elsewhere until plovers leave the area (chemical control).

Effectiveness of Possible Additional Mitigation Measures: Possible additional mitigation measures for Sonoma alopecurus and red-legged frog would reduce the range of potential adverse long-term impacts from negligible to possibly moderate to negligible to minor. In addition, short-term impacts to red-legged frog would be reduced from negligible to possibly moderate to negligible to minor at AT&T. Possible additional mitigation measures for snowy plover would reduce potential adverse implementation-related effects from no more than minor to negligible.

Cumulative Impacts

Projects with the potential to have cumulative impacts with Alternative C are the same as those discussed under Alternative A.

Please see individual species discussions under Alternative A.

Beach layia. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts would likely have minor to possibly moderate beneficial effects on beach layia distribution and numbers within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently. On a range-wide scale, the park's efforts, combined with other regional efforts, would be expected to have negligible to minor beneficial impacts on viability of this species.

Tidestrom's lupine. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts would probably have minor to possibly moderate beneficial effects on Tidestrom's lupine distribution and numbers within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently. On a range-wide scale, the park's efforts, combined with other regional efforts, would be expected to have minor to possibly moderate beneficial impacts on viability of this species, whose distribution is largely centered in the park and in Monterey County, with a few occurrences in Sonoma County.

Sonoma alopecurus. There would be no potential for cumulative impacts with Sonoma alopecurus, as the other dune restoration sites outside the park do not support Sonoma alopecurus, nor do other proposed project sites in the region.

Sonoma spineflower. There would be no potential for cumulative impacts with Sonoma spineflower, as Sonoma spineflower is not currently known to occur outside the park.

Myrtle's silverspot butterfly. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts could have negligible to minor beneficial effects on Myrtle's silverspot butterfly distribution, numbers, and quality of Critical Habitat within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently.

California red-legged frogs. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts could have potential negligible adverse effects on distribution and numbers of California red-legged frog and Critical Habitat within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation if some of these dune restoration efforts end up being conducted concurrently.

Western Snowy Plover. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts could have potential negligible to minor beneficial effects on distribution and numbers of western snowy plover and the quality of Critical Habitat within the region, with the potential for perhaps cumulative negligible to minor adverse impacts during and following implementation if some of these dune restoration efforts end up being conducted concurrently. The Seashore represents one of the major breeding areas in the local region, but the viability of plovers is affected by many factors, only some of which would be addressed by dune restoration. Therefore, on a range-wide scale, these cumulative restoration efforts may only yield negligible to perhaps minor beneficial efforts for western snowy plover.

Other Federally Listed Species: There would be no cumulative effect on other federally listed species.

Other Species of Special Concern: Potential long-term cumulative effects on other listed species, both plant and wildlife such as gilia, Blasdale's bent grass, woolly-headed spineflower, short-leaved evax, and beach starwort, would be no more than minor, whether those effects would be adverse or beneficial. For these species, cumulative restoration efforts could have negligible to perhaps minor beneficial effects over the long-term on a regional scale, but negligible adverse impacts during and shortly following implementation.

There would be no potential for cumulative effects on either the Point Reyes jumping mouse or the Point Reyes blue butterfly, as these species are of very limited distribution and occur in the park only. For other species, the distribution is widespread enough that any cumulative effects would be very negligible both on a long-term and implementation-related scale.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass, although it would also incorporate manual and mechanical removal potentially.

For certain special status species, particularly those for whom dunes are the primary or at least secondary habitat, dune restoration would, in general, benefit these plants and animals. The degree of benefit varies depending on the extent of restoration and how restoration is implemented. For other species, dune restoration may offer no benefit and could, in fact, over the short or long-term, have adverse impacts on these species, with the intensity of impact often related to restoration approach. A more complete description of the impacts – and benefits – associated with restoration on special status species can be found under Alternative B.

In general, federally listed species such as beach layia, Tidestrom's lupine, Myrtle's silverspot, and western snowy plover would all benefit from restoration, and this alternative would offer the most benefits to these species relative to Alternatives B and D. On a localized scale, dune restoration would result over the long-term in probably negligible to minor benefits for western snowy plover; minor to moderate benefits for beach layia and Myrtle's silverspot butterfly; and minor to possibly moderate benefits for Tidestrom's lupine. Ultimately, other management techniques may be needed in combination with dune restoration to improve the viability of the plover population within the park. Restoration at AT&T and North Beach would benefit all of these species, with restoration at B Ranch, A Ranch, and

Davis Property benefitting many of the species, as well. Restoration at Limantour would primarily benefit plovers and potentially the Myrtle's silverspot butterfly.

Restoration would also improve conditions for plant and animal species of special concern that primarily occur in Dune Mat or Dune Scrub. These species include curlyleaf monardella, gilias, some of the burrowing terrestrial invertebrates, and, to a lesser extent, non-federally listed spineflowers, rose leptosiphon, and Blasdale's bent grass that occur in more dune transitional habitats. With increases in sand-burrowing arthropods and nectar-providing native dune plants, food sources for wintering owls, Point Reyes butterfly, and Allen's hummingbird could increase, although reductions in extent of European beachgrass could decrease rodent populations, which are the primary prey items for raptors such as northern harriers and short-eared owls. For those species primarily located in the dunes or who may forage on dune plant species, Alternative C would offer more benefits than other alternatives due to the likely increase in restoration extent (negligible to possibly moderate). For other non-dune species, restoration would result in at most negligible to possibly minor adverse impacts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

For other federally listed species such as the endangered Sonoma alopecurus and threatened California red-legged frog, dune restoration is unlikely to have measurable benefits for their wetland habitat, which occurs in the dunes themselves (Dune Swales) or in adjacent grasslands (Freshwater Marsh). Removal of invasives could destabilize the sand dunes surrounding Dune Swales or Freshwater Marshes, although the potential for this is reduced relative to Alternative D due to the fact that mechanical removal would only be conducted within wetland and organic pasture buffers. Under this alternative, there would be the potential for negligible to possibly moderate adverse effect long-term on California red-legged frog and the frog's Critical Habitat and a possibly moderate adverse impact on Sonoma alopecurus at AT&T. Within the project areas, Sonoma alopecurus only occurs within dunes at AT&T and historically in a freshwater wetland adjacent to North Beach, while red-legged frogs occur at least during the wet season within many of the dune swale wetlands at AT&T, North Beach, Davis Property, B Ranch, A Ranch, and in freshwater wetlands adjacent to Limantour. To reduce potential localized adverse impacts during implementation to Sonoma alopecurus and red-legged frog at AT&T, in particular, other measures could be used to mitigate impacts, including retaining an unrestored buffer, using mechanical removal only on downwind and less steeply sloped dunes, recontouring dunes to eliminate tall peaks more likely to remobilize, and densely planting surrounding dunes. These measures could reduce long-term and short-term impacts from negligible to possibly moderate to negligible to minor.

In addition to federally listed species, this alternative should also have at most a minor long-term adverse effect on viability of plant species of special concern that primarily occur within adjacent grasslands or either dune swale or grassland wetlands.

In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on California brown pelicans, California least terns, willow flycatchers, or Point Reyes jumping mouse. There would be no effect on Sonoma spineflower, as it occurs within adjacent grasslands some distance (> 0.5 miles) from the dunes.

Implementation, staging, and access would have no more than negligible to possibly moderate adverse impacts on any of these special status species. Short-term moderate impacts could occur at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour for red-legged frog if sand remobilization buries portions of wetlands where active breeding is occurring, thereby impacting egg masses and tadpoles.

Based on the scale of other dune restoration projects proposed within the region, cumulative effects of these projects with those that may be conducted under Alternative C would be no more than negligible to possibly moderate on a regional scale, with the only potential for detectable adverse cumulative effects possibly being on red-legged frogs, although, as dunes are not this species' primary habitat, the intensity of this effect would be relatively negligible.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour by using primarily a mechanical approach to remove European beachgrass. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Listed Plant Species

In the long term, Sonoma spineflower would not likely be affected, as it does not occur in or near (> 0.5 mile) any of the Seashore's dune systems.

Beach Layia

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on beach layia can be found under Alternatives B and C. Under Alternative D, beach layia would be expected to prosper within restored locations, although populations could continue to decline in numbers or even be lost in unrestored areas at AT&T, North Beach, Davis Property, and B Ranch.

Past restoration projects at the park suggest that this species could benefit from mechanical removal projects, although benefits have not been as dramatic perhaps as for Tidestrom's lupine for unknown reasons. Following mechanical removal of European beachgrass near the mouth of Abbotts Lagoon in 2003-2004, 182 Tidestrom's lupine and 18 beach layia seedlings were found growing (Rodgers 2006). Establishment of beach layia in newly restored areas south of Abbotts Lagoon has also been reduced relative to that of Tidestrom's lupine, with most of the new beach layia plants found on the edges of the restored area adjacent to native dunes or along access roads until 2014, when beach layia was found within the interior portions of mechanically restored areas. Some of this disparity between Tidestrom's lupine and beach layia in the speed with which new habitat was colonized may be due to the that beach layia is an annual and/or due to seedbank dynamics, such that this species' seeds are not as long-lived or resilient as Tidestrom's lupine's.

Restoration primarily utilizing mechanical removal as the primary treatment approach should provide benefits for this dune species, although these benefits could be lower under this alternative than under Alternative C due to the potential decrease in total restored acreage, as well as the acreage restored at individual project areas.

Given these factors, over the long-term, Alternative D could result in negligible to minor benefits at AT&T, North Beach, Davis Property, and B Ranch. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Implementation-Related and Short-Term Effects

Access and Staging: In general, potential access and staging impacts on beach layia would be identical to those under Alternative C. Access and staging would have negligible to minor adverse impacts on beach layia at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Manual Removal: Potential impacts of manual removal on beach layia are similar to those discussed under Alternative A. Adverse impacts from manual removal methods would be no more than negligible to minor at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Mechanical Removal: Potential impacts of mechanical removal on beach layia are similar to those discussed under Alternative C, although the intensity of impact would be greater than under Alternative C as mechanical removal would be the primary removal method and not just used in buffer areas. Adverse impacts during and shortly following implementation would be negligible to minor at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Chemical Control: Potential impacts of chemical control on beach layia would be similar to those discussed under Alternative C, although the intensity of impact would be reduced as chemical control would only be used for treatment of re-sprouts in mechanical removal areas. There would be extremely minimal potential for non-target effects, as any beach layia would be very visible in "flipped" sands, and either a buffer (10 feet) or drift shield would be used to minimize impacts. Based on these factors and proposed avoidance and minimization measures, chemical control would be expected to result in negligible impacts on beach layia at AT&T/North Beach and B Ranch/A Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Tidestrom's Lupine

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on Tidestrom's lupine can be found under Alternatives B and C. Under Alternative D, Tidestrom's lupine would be expected to prosper within restored locations, although populations could continue to decline in numbers or even be lost in unrestored areas at AT&T and B Ranch.

This species appears to respond dramatically – and immediately – to mechanical removal restoration approaches. Following mechanical removal of European beachgrass near the mouth of Abbotts Lagoon in 2003-2004, 182 Tidestrom's lupine seedlings were found growing in the restored area (Rodgers 2006). Tens of thousands of new Tidestrom's lupine seedlings germinated in restored areas starting even in the non-rainy season, August 2011 (Johnson et al. 2012). In summer 2012, approximately 15,884 individuals were counted, with 25% of these perennial plants already becoming reproductive and setting seed in the first year (Johnson et al. 2012b). In 2012, Tidestrom's lupine covered approximately 15.8 of the 80 restored acres in varying densities (Johnson et al. 2012b). At least 25% of these plants actually flowered and set seed, setting the stage for potentially even more plants to establish in the second year after restoration (Johnson et al. 2012b). In 2013, the number of plants appeared to increase slightly to 20,552 individuals, with most of the plants establishing in the same portions of the restoration area as in 2012 (NPS, unpub. data). In 2014, estimated numbers appeared to jump dramatically to almost 72,000 plants, but only 22,457 were adult plants, suggesting that even the very dry conditions in 2014 still did not discourage extensive recruitment of seedlings, although most of these will probably not persist (NPS, unpub. data).

Monitoring at Abbotts following restoration demonstrated that mechanical removal of European beachgrass also reduced predation pressure on the Tidestrom's lupine population that was already established in this area prior to restoration (Population #1). Before dunes were restored, the mean percentage of racemes or flowering stalks of the Abbotts Lagoon Tidestrom's lupine population that suffered predation ranged from 38% to 94% across a six-year observation period (Pardini and Knight 2013). Predation rates were significantly lower in the four years following the restoration, ranging from 4% in 2013 to 19% in 2011, the year restoration was implemented (Pardini and Knight 2013, E. Pardini, *pers. comm.*; Figure 3).

While there was colonization of new plants in recently restored areas and improvement in reproduction success for already established plants, the resident population at Abbotts did appear to be impacted by remobilization of sands from the 2011 mechanical removal project. Tidestrom's lupine appears to respond favorably to sand movement, but too much remobilization may impact established plants by burying plants under as much as 18 inches of sand or by leaving 6- to 12 inches of exposed root. Some of the established plants in high remobilization areas were not reproductive (E. Pardini, *pers. comm.*). So far, however, the population appears to be persisting despite sand encroachment threats. Plants numbers at Population #1 were estimated at 159,906 in 2010 and 183,726 in 2011, which represented conditions prior to and during restoration (NPS, unpub. data). Following restoration, plant numbers were estimated at 156,552 in 2012 and 195,994 in 2013, so there has not been a clear reduction in numbers within the established population, although additional years of data will be required to make definitive conclusions (NPS, unpub. data).

Restoration benefits would probably be greatest in those areas where poor reproduction due to seed consumption by deer mice has been greatest, such as B Ranch North, B Ranch South, and Davis Property (Dangremond et al. 2010, Pardini and Knight 2013). These benefits could be reduced, however, under Alternative D relative to Alternative C or possibly even Alternative B due to the potential decrease in total acreage restored due to higher costs of mechanical removal.

Given these factors, over the long-term, Alternative D could result in potentially minor to moderate benefits to Tidestrom's lupine, with benefits ranging from minor (AT&T) to moderate (North Beach, B Ranch, Davis Property). Restoration at B Ranch and Davis Property would particularly provide benefits, as numbers of this species have dropped in this area dramatically in the last decade (Pardini and Knight 2013). The lupine population at AT&T is considered barely stable (Dangremond et al. 2010). There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Implementation-Related and Short-Term Effects

Access and Staging: In general, access and staging impacts on Tidestrom's lupine would be identical to those under Alternative C. Access and staging would have at most negligible adverse impacts on Tidestrom's lupine at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Manual Removal: Impacts of manual removal on Tidestrom's lupine are identical to those discussed under Alternative B. Adverse impacts from manual removal methods would be no more than negligible to perhaps minor at AT&T/North Beach and B Ranch/Davis Property. Impacts may be minor where iceplant is removed by hand, but negligible for European beachgrass, as manual removal of European beachgrass would be limited primarily to wetlands and re-treatment. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Mechanical Removal: Potential impacts of mechanical removal on Tidestrom's lupine are similar to those discussed under Alternative C, although the intensity of impact may be greater than under Alternative A as mechanical removal would be the primary removal method and not just used in buffer areas. Adverse impacts during and shortly following implementation would be no more than negligible to minor at AT&T/North Beach and B Ranch/ Davis Property. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Chemical Control: Potential impacts of chemical control on Tidestrom's lupine are similar to those discussed under Alternative C, although the intensity of impact would be reduced as chemical control would only be used for treatment of re-sprouts in mechanical removal areas. There would be extremely minimal potential for non-target effects, as any Tidestrom's lupine would be very visible in "flipped" sands, and either a buffer (10 feet) or drift shield would be used to minimize impacts. Based on these factors, including proposed avoidance and minimization measures, chemical control would be expected to result in negligible impacts to Tidestrom's lupine during or shortly after implementation at AT&T/North Beach and B Ranch/Davis Property. There would be no effect at A Ranch or Limantour, as this species has not been documented there.

Sonoma Alopecurus

Long-Term Effects

Potential impacts to this species were discussed under Alternatives B and C. Dune restoration would not necessarily appear to benefit this species, as removal of invasives such as European beachgrass could destabilize the sand dunes surrounding the swale and increase the potential for the population to be buried by sand. This impact is more likely to occur under this alternative than Alternative C, because mechanical removal would be the primary removal method and would remove vegetation from adjacent dune peaks, which are most likely to mobilize during high wind conditions. As discussed under Alternative C, some stabilization would occur through active dense revegetation of backdune areas, however, the positive effects of revegetation may be delayed until new plants establish, allowing sands to move in the interim.

Under this alternative, there would be the potential for a minor to moderate adverse effect long-term on Sonoma alopecurus at AT&T. See Possible Additional Mitigation Measures section for proposed measures to reduce potentially moderate impacts on the AT&T population of Sonoma alopecurus. Restoration at North Beach may have a potentially minor impact on the wetland at North Beach where Sonoma alopecurus has historically occurred, although plants have not been recorded there in recent years. There would be no effect at Davis Property, B Ranch, A Ranch, and Limantour, as this species has not been documented there.

Implementation-Related and Short-Term Effects

There would be no access or staging in wetlands within or outside of the dune systems. Some European beachgrass may be removed by digging in wetlands, which could impact root systems of adjacent Sonoma alopecurus plants, although beachgrass only sporadically occurs in Dune Swales, particularly in the wetter portion of these swales. Short-term impacts from remobilization of sand adjacent to wetlands are addressed under Long-Term Effects. Implementation-related adverse effects on Sonoma alopecurus would be very negligible at AT&T and North Beach. There would be no effect at Davis Property, B Ranch, A Ranch, and Limantour, as this species has not been documented there.

Listed Animal Species

Myrtle's Silverspot Butterfly

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on Myrtle's silverspot butterfly can be found under Alternatives B and C. Under Alternative D, the butterfly would benefit from restoration of native dune vegetation communities such as Dune Mat and Dune Scrub and expansion of potential nectar sources, although the degree of benefit may be reduced relative to Alternative C. Overall, over the long-term, there would be negligible to minor benefits for this species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Ultimately, recovery of the butterfly depends on the health of both the dune and grassland systems.

Implementation-Related and Short-Term Effects

Staging and Access: Potential impacts would be very similar in intensity to those under Alternative C. Based on the factors discussed, including proposed impact avoidance and minimization measures, staging and access would have a negligible to minor adverse impact on Myrtle's silverspot at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Potential impacts would be very similar to those discussed under Alternative B. Based on the factors discussed, including proposed impact avoidance and minimization measures, manual removal would have no more than a negligible adverse impact on Myrtle's silverspot both during and following implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Potential impacts would be similar to those discussed under Alternative C, although the intensity of impacts may be greater because mechanical removal be the primary removal method. Based on the factors discussed, including proposed impact avoidance and minimization measures, adverse impacts of mechanical removal on Myrtle's silverspot would likely be minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: Potential impacts would be very similar to those discussed in detail under Alternative C, although the intensity of impact would be reduced as chemical control would only be used for treatment of re-sprouts in mechanical removal areas. There would be extremely minimal potential for non-target effects on either butterflies or nectar sources, as nectar sources would be greatly reduced within mechanically treated areas, at least initially, and both butterflies and nectar sources would be easy to avoid with backpack sprayers. Based on the factors discussed, including the proposed impact avoidance and minimization measures, adverse impacts from herbicide application on Myrtle's silverspot butterfly would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

California Red-legged Frog

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on California red-legged frog can be found under Alternative B and C. Under Alternative D, restoration of coastal dunes using primarily mechanical removal methods could have increased long-term adverse effects on red-legged frogs and Critical Habitat than Alternatives B and C due to the fact that this method results in considerably more sand destabilization and could increase the potential for burial of the wetland, thereby eliminating habitat for frogs. European beachgrass and iceplant would be removed from dune peaks, which are most likely to mobilize during high wind conditions. As discussed under Alternative C, some stabilization would occur through active revegetation of backdune areas, however, the positive effects of revegetation may be delayed until new plants establish, allowing sands to move in the interim. However, breeding and non-breeding habitats within dunes and adjacent grasslands could be directly impacted by sand remobilization.

Based on the factors discussed above, restoration under this alternative could have minor to moderate adverse long-term impacts on this species and its breeding and non-breeding habitat at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. See Possible Additional Mitigation Measures section for proposed measures to reduce potential moderate impacts on the AT&T population of red-legged frog. On a park-wide scale, potential impacts are expected to be no more than negligible, because red-legged frogs occur in many other types of wetlands within the park.

Implementation-Related and Short-Term Effects

Staging and Access: Potential impacts would be very similar to those under Alternative B. Based on the factors discussed, including proposed impact avoidance and minimization measures, staging and access would have the potential for a negligible adverse impact on red-legged frog during and following implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Potential impacts would be very similar to those discussed under Alternative B. Based on factors discussed, including proposed impact avoidance and minimization measures, manual removal could potentially have a negligible adverse impact on frogs during implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. The potential for impact could increase in areas where iceplant is the dominant, as iceplant would be more likely removed by hand.

Mechanical Removal: Potential impacts would be similar to those discussed under Alternative C, although the intensity of impacts would be increased under this alternative, because mechanical removal would be the primary removal method. Movement of sands over the short-term in wetland buffers could bury a certain portion of dune swale and pasture freshwater wetlands, impacting breeding success of red-legged frogs through impacts to egg masses and tadpoles. Based on factors discussed, including proposed impact avoidance and minimization measures, potential adverse impacts during and shortly after implementation would be expected to be negligible to moderate at AT&T/North Beach, B Ranch/A Ranch/ Davis Property, and Limantour.

Chemical Control: Potential impacts would be very similar to those discussed in detail under Alternative C, although the intensity of impact would be reduced as chemical control would only be used for treatment of re-sprouts in mechanical removal areas. There would be extremely minimal potential for non-target effects on either red-legged frogs or breeding and non-breeding habitats, as spot-spraying of herbicide would only occur in "flipped" open sand areas at least 60 feet from known red-legged frog habitat and 25-feet from any wetlands. Based on factors discussed, including proposed impact avoidance and minimization measures, adverse impacts from herbicide application on California red-legged frog would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Western Snowy Plover

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on western snowy plover can be found under Alternatives B and C. Under Alternative D, restoration of coastal dunes using primarily mechanical removal methods could have less benefits for plovers and Critical Habitat relative to Alternative C, because the scale of restoration would be decreased relative to those alternatives due to greater cost per acre. Alternative D may also offer fewer benefits for plover habitat at AT&T and North Beach and, possibly to a lesser degree, at Limantour, Davis Property, B Ranch, and A Ranch than Alternative C for this same reason. Regardless of the number of acres restored, however, other management techniques may be needed in combination with dune restoration to improve the viability of the plover population within the park.

Based on these factors, including results from recent restoration efforts in the park, Alternative D would be expected to have negligible to perhaps minor long-term benefits at AT&T, Limantour, and B Ranch, with the highest level of benefits (minor) occurring at AT&T and North Beach where plovers still actively nest. Plovers have not nested at Limantour since 2000, although they still commonly use those dunes for overwintering. Plovers have also not nested at Davis Property, B Ranch, or A Ranch recently.

Implementation-Related and Short-Term Effects

Staging and Access: Potential impacts would be very similar to those under Alternative C, although the possible intensity of impacts may increase slightly, because there would be more pieces of heavy equipment used during restoration. Based on the factors discussed, staging and access in adjacent grassland areas would have at most negligible adverse impacts on western snowy plover at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Potential impacts would be very similar to those under Alternatives B. Based on these measures, including proposed impact avoidance and minimization measures, adverse impacts to plovers from manual removal during implementation would be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Potential impacts from mechanical removal would be very similar to those discussed under Alternative C, although the intensity would be greater due to the fact that mechanical removal would be the primary removal method. Based on these factors, including proposed impact avoidance and minimization measures for plover nests and broods, potential impacts to western snowy plover and its Critical Habitat during and shortly implementation would be characterized as negligible to minor at AT&T, Limantour, and B Ranch, with higher intensity impacts (minor) occurring potentially at AT&T and North Beach, where plover still actively nest. Potential additional mitigation measures to protect broods, discussed later in this section, could reduce localized impacts to negligible.

Chemical Control: Potential impacts from mechanical removal would be very similar to those discussed under Alternative C, although the intensity of impact would be reduced as chemical control would only be used for treatment of re-sprouts in mechanically treated areas. There would be extremely minimal potential for non-target effects on snowy plovers, as spot-spraying of herbicide would most likely occur towards the end or after breeding season and would only be conducted more than 500 feet from any nests still active at that time, and work would be halted and moved elsewhere should plover adult and chicks move into the immediate work area during operations. Based on these factors including proposed impact avoidance and minimization measures, chemical control would have only negligible adverse impacts during implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Potential additional mitigation measures to protect broods could reduce localized impacts to negligible.

California brown pelican

Potential impacts would be the same as discussed under Alternative C.

California least tern

Potential impacts would be the same as discussed under Alternative C.

Willow flycatcher

Potential impacts would be the same as discussed under Alternative C.

Plant Species of Concern

Potential impacts would be very similar to those discussed in detail under Alternative C. As with the other alternatives, potential impacts to these species from Alternative D largely relate to the primary habitat in which they occur. For those species primarily located in the dunes, Alternative D would likely result over the long-term in negligible to minor benefits for curlyleaf monardella at AT&T/North Beach and B Ranch/A Ranch/Davis Property and pink sand verbena at Limantour, Davis Property, and A Ranch. As gilias are less prevalent within many of the dune interiors than curlyleaf monardella, benefits to these species may be negligible to minor on a localized scale and negligible on a park-wide scale. These benefits would be similar to benefits for the non-federally listed spineflowers, rose leptosiphon, and Blasdale's bent grass.

For species primarily occurring in adjacent grasslands and wetlands, this alternative should have no effect to at most minor long-term adverse effects on viability of this species within particular sites and the park. Minor localized effects may occur if remobilized sand buries any immediately adjacent grasslands or wetlands that support special status species, although active revegetation in backdune areas should help to minimize this impact.

Staging and access would be expected to primarily affect species in adjacent grasslands or dune ecotones. Based on factors discussed, including proposed impact avoidance and minimization measures, staging and access may have a negligible to minor localized adverse impacts during and shortly following implementation, with park-wide impacts only negligible. Implementation-related effects on species primarily occurring in Dune Mat and Dune Scrub could occur as a result of chemical control, mechanical removal, and manual removal, but, based on impact avoidance and minimization measures, adverse impacts would be expected to be negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Animal Species of Concern

A more complete description of the potential impacts associated with restoration on animal species of concern can be found under Alternatives B and C.

Terrestrial Invertebrates

Over the long-term, the intensity of restoration benefits for sand-burrowing arthropods and for dune plant species that could act as nectar and host plant sources could be reduced under this alternative relative to Alternative C. This would result in negligible benefits to these species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Minor adverse effects could also occur during implementation from mechanical removal, as the extent of soil disturbance would be greatest under this alternative. Staging and access would be expected to have very negligible adverse effects on invertebrates at these dune system areas.

Birds

The majority of bird species of concern occupy habitat around open water bodies such as Abbotts Lagoon and Estero de Limantour and are unlikely to be affected more than negligibly by dune restoration (see Table 4 in *Affected Environment*). Exceptions to this generalization regarding open water being the primary habitat include white-tailed kite, Northern harrier, short eared owl, burrowing owl, and Allen's hummingbird. Impact avoidance and minimization measures for birds include maintaining a buffer around active nests during the breeding season, which extends from March 15 to July 31 for landbirds.

Raptors

Over the long-term, restoration may have minor to even moderate adverse impacts to northern harriers and short-eared owls at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, because these species feed on small rodents whose numbers may decrease with restoration. There would be almost no discernable effect on a park-wide scale due to the fact that these species use many other habitats within the Seashore. Based on factors discussed under Alternative C, adverse impacts during implementation from noise and disturbance are likely to be negligible at these dune system areas. Staging and access would be expected to have at most a very negligible adverse effect

Allen's Hummingbird

Dune restoration should have negligible long-term benefits for Allen's hummingbirds at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour by increasing nectar species. Based on proposed impact avoidance and minimization measures, adverse impacts during implementation are expected to be only negligible to minor at these dune system areas. Staging and access would be expected to have at most a very negligible adverse effect.

Mammals

Over the long-term, no benefits or adverse effects from removing European beachgrass and iceplant would be expected on Point Reyes jumping mouse. Based on factors discussed under Alternative C, adverse impacts during implementation from noise and disturbance would be negligible to possibly minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Staging and access would be expected to have at most a very negligible adverse effect at these dune system areas.

Possible Additional Mitigation Measures: To reduce potential localized adverse impacts during and after implementation to Sonoma alopecurus and California red-legged frog at AT&T, the following measures may be taken. In addition to densely revegetating adjacent dune slopes as discussed earlier, mechanical removal could be performed as a straight cut, which would reduce the mobility of sands adjacent to the swale. This would require transport of excavated sands to another location. Another potential measure would be to eliminate or delay treatment within the 60-foot wetland buffer adjacent to this particular swale, or mechanical removal may be performed only on the downwind edge and in areas where the steepness of slope would not encourage fallback of sands into the drainage swale. The latter approach would decrease sustainability of restoration efforts due to the propensity for European beachgrass to reinvade treated areas. Lastly, the dune peaks to the west and east of the drainage swale could also be reshaped using heavy equipment to a lower elevation to minimize the amount of sand movement that would occur during spring winds.

Should western snowy plover adults and chicks move into the immediate work area during either mechanical removal or chemical treatment operations, construction or treatment would be stopped immediately, and either treatment crews would move operations elsewhere until plovers leave the area (chemical control), or Park Service oversight staff would contact the Park Service wildlife biologist for further direction.

Effectiveness of Possible Additional Mitigation Measures: This would reduce the range of potential adverse long-term impacts to Sonoma alopecurus and red-legged frog at AT&T from minor to moderate to negligible to minor/possibly moderate. In addition, short-term impacts to red-legged frog at AT&T would be reduced from negligible to minor.

Possible additional mitigation measures for snowy plover would reduce potential impacts during implementation of both mechanical removal and chemical control from no more than minor to negligible.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on special status species would be the same as described under Alternative A.

Beach layia. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts would likely have negligible to minor beneficial effects on beach layia distribution and numbers within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently. On a range-wide scale, the park's efforts, combined with other regional efforts, would be expected to have negligible beneficial impacts on viability of this species.

Tidestrom's lupine. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts would probably have negligible to minor beneficial effects on Tidestrom's lupine distribution and numbers within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently. On a range-wide scale, the park's efforts, combined with other regional efforts, would be expected to have negligible to minor beneficial impacts on viability of this species, whose distribution is largely centered in the park and in Monterey County, with a few occurrences in Sonoma County.

Sonoma alopecurus. There would be no potential for cumulative impacts with Sonoma alopecurus, as the other dune restoration sites outside the park do not support Sonoma alopecurus, nor do other proposed project sites in the region.

Sonoma spineflower. There would be no potential for cumulative impacts with Sonoma spineflower, as Sonoma spineflower is not currently known to occur outside the park.

Myrtle's silverspot butterfly. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts could have negligible to minor beneficial effects on Myrtle's silverspot butterfly distribution and numbers within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation should some of these dune restoration efforts end up being conducted concurrently. Potential benefits on a range-wide scale should be identical to the regional ones addressed above due to the fact that this species has been extirpated from other parts of its range, including south of San Francisco (USFWS 1998).

California red-legged frogs. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts could have potential negligible adverse effects on distribution and numbers of California red-legged frog and Critical Habitat within the region, with the potential for perhaps cumulative negligible adverse impacts during and following implementation if some of these dune restoration efforts end up being conducted concurrently.

Western Snowy Plover. Based on the scale of projects likely to be conducted under this alternative and proposed outside the park, the proposed dune restoration efforts could have potential negligible to possibly minor beneficial effects on distribution and numbers of western snowy plover and the quality of Critical Habitat within the region, with the potential for perhaps cumulative negligible to minor adverse impacts on plovers and Critical Habitat during and following implementation if some of these dune restoration efforts end up being conducted concurrently. The Seashore represents one of the major breeding areas in the local region, but the viability of plovers is affected by many factors, only some of which would be addressed by dune restoration. Therefore, on a range-wide scale, these cumulative restoration efforts may only yield negligible beneficial efforts for western snowy plover.

Other Federally Listed Species: There would be no cumulative effect on other federally listed species.

Other Species of Special Concern: Potential long-term cumulative effects on other listed species, both plant and wildlife, would be no more than minor, whether those effects would be adverse or beneficial. For CNPS-listed plant species that occur in other non-park project areas, cumulative restoration efforts could have negligible to possibly minor beneficial effects over the long-term on a regional scale, but negligible adverse impacts during and shortly following implementation.

There would be no potential for cumulative effects on either the Point Reyes jumping mouse or the Point Reyes blue butterfly, as these species are of very limited distribution and occur in the park only. For other species, the distribution is widespread enough that any cumulative effects would be very negligible both on a long-term and implementation-related scale.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant. Based on logistical factors and cost, the acreage of dunes restored under this alternative is likely to be reduced relative to Alternative C due to the higher cost per acre for mechanical removal.

For certain special status species, particularly those for whom dunes are the primary or at least secondary habitat, dune restoration would, in general, benefit these plants and animals. The degree of benefit varies depending on the extent of restoration and how restoration is implemented. For other species, dune restoration may offer no benefit and could, in fact, over the short or long-term, have adverse impacts on these species, with the intensity of impact often related to restoration approach. A more complete description of the impacts – and benefits – associated with restoration on special status species can be found under Alternatives B and C.

In general, federally listed species such as beach layia, Tidestrom's lupine, Myrtle's silverspot, and western snowy plover would all benefit from restoration, although this alternative may offer less benefits to these species than Alternative C. On a localized scale, dune restoration would result in negligible to minor or possibly minor benefits for western snowy plover, beach layia, and Myrtle's silverspot butterfly. Benefits for Tidestrom's lupine may be slightly higher (moderate beneficial on a localized scale), as this species appears to respond well to mechanical restoration techniques. Ultimately, other management techniques may be needed in combination with dune restoration to improve the viability of the plover population within the park. Restoration at AT&T and North Beach would benefit all of these species, while restoration at B Ranch and Davis Property would benefit many of these species. Restoration at Limantour would benefit plovers and potentially Myrtle's silverspot butterfly. As the scale of restoration may be compressed under this alternative relative to Alternative C, the benefits offered by this alternative may be fewer than Alternative C, but higher than Alternative B.

Restoration would also improve conditions for plant and animal species of special concern that primarily occur in Dune Mat or Dune Scrub. These species include curlyleaf monardella, gilias, pink sand verbena, some of the burrowing terrestrial invertebrates, and, to a lesser extent, non-federally listed spineflowers, rose leptosiphon, and Blasdale's bent grass that occur in more dune transitional habitats. With increases in sand-burrowing arthropods and nectar-providing native dune plants, food sources for wintering owls, Point Reyes butterfly, and Allen's hummingbird could increase, although reductions in extent of European beachgrass could decrease rodent populations, which are the primary prey items for raptors such as northern harriers and short-eared owls. For those species primarily located in the dunes or who may forage on dune plant species, Alternative D would offer negligible to minor benefits at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. For other non-dune species, restoration would result in at most negligible to minor adverse impacts at these three dune system areas.

For other federally listed species such as the endangered Sonoma alopecurus and threatened California red-legged frog, dune restoration is unlikely to have measurable benefits for their wetland habitat, which occurs in the dunes themselves (Dune Swales) or in adjacent grasslands (Freshwater Marsh). Removal of invasives could destabilize the sand dunes surrounding Dune Swales or Freshwater Marshes: Due to the amount of earthmoving, this alternative would have the highest potential for sand remobilization, although active revegetation would be used to stabilize back dune areas. Under this alternative, over the long-term, there would be the potential for a minor to moderate adverse effect long-term on California red-legged frog and the frog's Critical Habitat and on Sonoma alopecurus at AT&T. Within the project areas, Sonoma alopecurus only occurs within dunes at AT&T and in a freshwater wetland adjacent to North Beach, while red-legged frogs occur at least during the wet season within many of the Dune Swale wetlands. Impacts to Sonoma alopecurus and red-legged frog could be reduced by incorporating additional mitigation measures, including retaining an unrestored buffer, using mechanical removal only on downwind and less steeply sloped dunes, recontouring dunes to eliminate tall peaks more likely to remobilize, and densely planting surrounding dunes. These measures could reduce the range of long-term and short-term impacts from minor to moderate to negligible to minor.

In addition to federally listed species, this alternative should also have at most a minor long-term effect on viability of plant species of special concern that primarily occur within adjacent grasslands or wetlands within dunes or grasslands.

In the long term, removal of European beachgrass or iceplant would be unlikely to have any beneficial or adverse effect on California brown pelicans, California least terns, willow flycatchers, or Point Reyes jumping mouse. There would be no effect on Sonoma spineflower, as it occurs within adjacent grasslands some distance (> 0.5 miles) from the dunes.

Implementation, staging, and access would have no more than negligible to minor adverse impacts on any of these special status species. Short-term moderate impacts could occur on a localized scale for red-legged frog if sand remobilization buries portions of wetlands where active breeding is occurring, thereby impacting egg masses and tadpoles.

Based on the scale of other dune restoration projects proposed within the region, cumulative effects of these projects with those that may be conducted under Alternative D would be no more than negligible to minor on a regional scale, with the only potential for detectable adverse cumulative effects possibly being on red-legged frogs, although, as frogs occur in many other types of wetland habitat, the intensity of this effect would be relatively negligible.

WILDLIFE

Policies and Regulations

The Park Service *Management Policies 2006* require parks to maintain animals (and plants) that are native to park ecosystems (Section. 4.4.1). Specifically, parks are directed to preserve and restore natural abundances, diversities, distribution and behaviors and restore native animal populations where they have been extirpated by past human actions and minimize human impacts.

Some groups of wildlife, including marine mammals, commercial fish species and migratory birds, are subject to further regulation. For example, "Essential Fish Habitat," as established under the Magnusen-Stevens Fishery Management Act, is intended to protect spawning and rearing habitat of more than 65 commercially fished species. Protection is managed through the National Marine Fisheries Service.

The Federal Migratory Bird Treaty Act enacts the provisions of treaties between North American and European countries. Over 800 bird species are protected under the legislation. It mandates federal agencies to consider impacts to protected breeding birds during implementation of projects on federal lands, including disruption to nesting and egg-laying activities.

Assessment Methodology

The sources of information used to determine the types of wildlife present in the Seashore's dune systems include a limited number of published and unpublished reports on wildlife in various portions of the park's dunes, as well as in dunes in other areas. A sizeable amount of information was collected during implementation of the Abbotts Lagoon project, as a number of general and species-specific surveys were required. With some exceptions (California red-legged frog – discussed under *Special Status Species*), no focused wildlife surveys have been conducted specifically for this EA. Natural history information including habitat use, breeding cycles, and sensitivity to noise or disturbance was gathered from the scientific literature.

Context and Duration

Implementation-Related: Implementation-related impacts are those that occur only during implementation.

Short-Term: Short-term impacts are those that last no more than one year or one reproductive season after implementation.

Long-Term: Long-term impacts would extend beyond a single year or reproductive season.

Impact Thresholds

The following thresholds were used to determine the magnitude of effects on wildlife and wildlife habitat:

Negligible**:** There would be no measurable change native wildlife species, their habitats, or the natural processes sustaining them, or change would be barely detectable and often within the natural range of variability.

Minor**:** Impacts would be detectable or measurable, but they would be small and would, over the long term, result in only small changes in the number of native wildlife individuals, the extent or quality of wildlife habitats, or the natural processes sustaining wildlife. Generally, no discernable impacts would occur at the population level or to key ecosystem processes. At a localized scale, wildlife individuals may be disturbed during implementation, but without detectable interference to key life history stages such as breeding, reproduction, pupation or other factors affecting the species at a population level.

Moderate**:** Impacts on native wildlife, the extent or quality of wildlife habitats, or the natural processes sustaining wildlife would be apparent or appreciable although impacts at a population level or to key ecosystem processes would be detectable, but small. At a localized scale, wildlife individuals would be disturbed during implementation, and there may be small effects on key life history stages such as breeding, reproduction, pupation, or other factors affecting the species at a population level. However, these impacts would occur only during implementation or shortly afterwards: there would be no long-term effects on key life history stages.

***Major*:** Impacts on native wildlife, the extent or quality of wildlife habitats, or the natural processes sustaining wildlife would be striking or highly noticeable, with changes at a population level or to key ecosystem processes apparent or appreciable. At a localized scale, wildlife individuals would be disturbed during implementation, and there would be apparent or appreciable effects on key life history stages such as breeding, reproduction, pupation, or other factors affecting the species at a population level that could have longer term effects on these stages and possibly even be permanent.

Impact of Alternative A

Analysis

Under Alternative A, no near-term restoration projects would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, except for previously permitted projects.

As was discussed in the Affected Environment section of this document, species diversity and abundance of small terrestrial vertebrates and mammals within the Seashore's dunes is probably lower than that of other habitats within the park (Fellers and Pratt 2002). However, based on published and unpublished information, a range of species do use these habitats, including terrestrial invertebrates, small terrestrial vertebrates, mammals, birds, and, in adjacent open water habitats, fish.

Small Terrestrial Mammals

Long-Term Effects

In general, the diversity and abundance of small terrestrial vertebrates within the Seashore's dunes is probably lower than any other habitat in the park (Fellers and Pratt 2002). Small terrestrial invertebrates in this system includes Trowbridge's shrews (*Sorex trowbridgii*), western harvest mice (*Reithrodontomys megalotis*), vagrant shrews (*Sorex vagrans*), as well as deer mice (*Peromyscus maniculatus*). Deer mice may actually occur in high abundances within dunes (Pitts and Barbour 1979, Fellers and Pratt 2002), although the deer mouse was one of the few small terrestrial vertebrates captured in all the Seashore's habitats during a terrestrial vertebrate inventory (Fellers and Pratt 2002). Deer mice numbers appear to be much higher in areas vegetated with European beachgrass and rush (*Juncus*; Pitts and Barbour 1979): Pitts and Barbour hypothesized that European beachgrass may provide a more stable substrate for nesting. However, the beachgrass would also seemingly provide more cover from predators: Aerial predators of deer mice and other small rodents in the dune area where the 1979 study took place included barn owl, red-tailed hawk, Northern harrier, great horned owl and American kestrel (Pitts and Barbour 1979).

Under Alternative A, the areal extent of European beachgrass would continue to increase, which would provide more habitat and cover for deer mice, so, ultimately, deer mice populations could increase within dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. The prevalence of deer mice within iceplant stands has been less well studied, but this species was also frequently caught in traps within dense iceplant in the Fellers and Pratt (2002) inventory. Other small species would either be unaffected or could actually increase slightly in population size, as European beachgrass and iceplant stands continue to increase in extent.

Based on these factors, Alternative A could have either no effect or a negligible beneficial effect on small mammal populations at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with beneficial effects specifically for species such as deer mice due to continued expansion of European beachgrass habitat.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, because no near-term restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, except for previously permitted projects.

Large Mammals

Long-Term Effects

In general, the diversity and abundance of medium to large-sized terrestrial mammals within the Seashore's dunes is probably lower than any other habitat in the park (Fellers and Pratt 2002). Mammals in this system include mule deer (*Odocoileus hemionus*), striped skunk (*Mephitis mephitis*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), American badger (*Taxidea taxus*), black-tailed jackrabbit (*Lepus californicus*), and brush rabbit (*Sylvilagus bachmani*; Fellers and Pratt 2002; NPS, unpub. data). Marine mammals such as California sea lion (*Zalophus californianus*), harbor seals (*Phoca vitulina*), and northern elephant seals (*Mirounga angustirostris*) may also occur on beaches adjacent to project areas or at the end of Limantour Spit.

Under Alternative A, the areal extent of European beachgrass and iceplant would be expected to continue to expand. With the possible exception of brush rabbit, increases in the areal extent of these invasive, non-native plants would not appear to affect use of dunes by large mammal species. Some species such as mule deer may rest or bed within European beachgrass stands, but continued expansion of European beachgrass would not detectably affect any key life history stage. None of these large mammal species appear to forage on European beachgrass, although ranchers report that cows find the grass more palatable when it's young and not well established (Department of Agriculture 1896). Some of the carnivores such as bobcats, coyotes, gray fox, and others may actually benefit from potential increases in particular small mammal populations such as deer mice (see discussion under small mammals above).

Based on these factors, Alternative A would have no effect on large mammal populations within dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, because no near-term restoration would be conducted at AT&T, B Ranch, or Limantour, except for previously permitted projects.

Birds

Long-Term Effects

Over the long term, predatory bird species would not be noticeably affected by continued expansion of European beachgrass and iceplant in unrestored dunes at AT&T/North Beach, B Ranch/Davis Property, and Limantour, although they may benefit somewhat from increases in prey population such as deer mice. European beachgrass areas have been shown to support higher abundances of species such as deer mice than native Dune Mat communities (Pitts and Barbour 1979, Fellers and Pratt 2002).

Most of the passerines that have been primarily observed in the dunes during nesting season either exclusively use habitat within native Dune Mat or Dune Scrub adjacent to European beachgrass stands (e.g., killdeer/*Charadrius vociferus* and California horned lark/ *Eremophila alpestris actia*) or use those areas in addition to sometimes nesting in native shrubs that are intermixed within or on the edge of beachgrass stands (e.g., savannah sparrow/*Passerculus sandwichensis*, song sparrow/*Melospiza melodia*, Nuttall's white-crowned sparrow/*Zonotrichia leucophrys*).

Backdune areas supporting shrubs such as coyotebrush and bush lupine supported fairly high densities of Nuttall's white crowned sparrow and Song sparrow, with the latter more abundant where shrubby areas adjoined dune swale wetlands (ARA 2012). Savannah sparrows were more common on the edges of shrub-dominated areas, particularly where it abutted barren ground or more open, dune mat habitat (ARA 2012). Most of these species forage upon a combination of insects and seeds of grasses and herbs. For these species, the lack of restoration and continued expansion of European beachgrass and iceplant into native Dune Mat and Dune Scrub could decrease available habitat for nesting, as they do not directly nest in either European beachgrass or iceplant.

Dune Swale wetlands may be sporadically used by waterfowl species such as gadwall (*Anas strepera*), mallard (*Anas platyrhynchos*), cinnamon teal (*Anas cyanoptera*), and bufflehead (*Bucephala albeola*), as well as shorebirds such Wilson's snipe (*Gallinago delicata*) and long-billed curlew (*Numenius americanus*; ARA 2012). Some of the visiting waterbirds may come from larger water bodies nearby such as Abbotts Lagoon or Estero de Limantour, but dune swales are not large enough features to provide long-term support for shorebird species (ARA 2012).

Beach areas oceanward of beachgrass-dominated foredunes were frequented by western snowy plover (discussed earlier), common ravens, and migrant and wintering shorebirds such as dunlin (*Calidris alpine*), sanderling (*Calidris alba*), and willet (*Tringa semipalmata*) foraging along the tideline and higher beach (ARA 2012). Available habitat for these species could decrease in extent, if European beachgrass and iceplant stands in foredune areas continue to expand oceanward into beach areas. This could increase impacts associated with human activity, as visitors would be more concentrated into a narrow strip of beach.

Therefore, bird populations may remain similar or, at least for predatory birds, increase at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, as European beachgrass and iceplant stands would continue to expand and provide cover for small mammals that may attract raptors. Based on these factors, Alternative A would either have no effect or a very negligible beneficial effect on birds within dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, because no near-term restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, except for previously permitted projects.

Amphibians and Reptiles

Long-Term Effects

The effect of Alternative A on California red-legged frog is discussed under *Special Status Species*. The Fellers and Pratt inventory found one reptile at the North Beach dunes – northern alligator lizard (*Elgaria coerulea*) – at very low densities. During the Abbotts Lagoon dune restoration project in 2011, a number of amphibians and reptiles were observed by biological monitors, including western terrestrial garter snake (*Thamnophis elegans*), western fence lizard (*Sceloporus occidentalis*), Pacific tree frog (*Pseudacris regilla*), and California red-legged frogs (FT), which have recently been documented as occurring in many of the Dune Swale wetlands along the Great Beach (P. Kleeman, USGS, *pers. comm*.). Amphibians, as well as garter snakes, are likely to principally occur in wetland and riparian habitat, although these species may travel between the wetlands through dune habitat.

Over the long term, these species may not be directly impacted by continued expansion of European beachgrass and iceplant in dune areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, as these species either occur in wetland or moist habitats or, in the case of fence lizards, utilize both native and non-native habitats. However, a study conducted at Fort Funston in GGNRA found that the abundance of ground-dwelling vertebrates, which included small mammals, amphibians, and reptiles, was greatest in restored dune areas, which, along with long-term unrestored visitor-restricted areas, had also had the greatest diversity of ground-dwelling vertebrate species (Russell et al. 2009). This study included species such as northern alligator lizards, southern alligator lizards (*Elgaria multicarinata*), California newt (*Taricha torosa*), and California slender salamanders (*Batrachoseps attenuatus*), so results of this may suggest that areas dominated by native dune plant species rather than iceplant have positive benefits for certain amphibians and reptiles.

Overall, no discernable effect on amphibian and reptile populations would be expected from continued expansion of invasive plant species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, because no near-term restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, except for previously permitted projects.

Other Species

In general, sand-burrowing arthropod communities are lower in abundance and diversity within dense European beachgrass stands (Stenzel et al. 1981, Slobodchikoff and Doyen 1977 *in* USFWS 2007), therefore, it is likely that many terrestrial invertebrates do not occur within these stands. Terrestrial invertebrate populations may remain similar to current numbers or decrease slightly (negligible adverse) at AT&T/North Beach, B Ranch/A Ranch/Davis

Property, and Limantour in response to continued expansion of European beachgrass and iceplant.

Fish species would typically only occur in adjacent open water bodies or in marshes in adjacent wetlands due to the ephemeral nature of most Dune Swale wetlands. No long term effects would be expected on fish species from continued expansion of European beachgrass and iceplant stands at AT&T, B Ranch, and Limantour.

There would be no implementation-related or short-term effects, because no near-term restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, except for previously permitted projects.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wildlife would be restoration of coastal dunes at Bodega Marine Laboratory in Sonoma County, continued restoration of coastal dunes at Tom's Point in Marin County, possible restoration of dunes at Lawson's Landing, and wetland and small-scale dune restoration efforts being conducted as part of the Muir Beach Restoration Project at GGNRA. The Wildlife Protection and Habitat Improvement Plan proposed by MMWD would principally affect vegetation communities such as oak woodland and grassland habitat that have been invaded by non-native brooms or invasive species, so it could have a negligible cumulative effect with this alternative, as many of the wildlife species discussed here occur in numerous types of habitats throughout the region. Actions in the park that may have cumulative effects on wildlife include fire management activities, maintenance and upgrade of park facilities, and other habitat restoration projects.

From a regional perspective, based on the scale of projects proposed outside the park, the lack of restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would likely have either no effect or very negligible beneficial or adverse effects on wildlife species within the region.

Conclusions

Under Alternative A, no near-term restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, except for previously permitted projects.

For certain wildlife species, continued expansion of European beachgrass and iceplant in these dune systems would either have no effect or negligible adverse effects. These include certain small mammal, passerine bird, and sand-burrowing arthropod species. For other species, continued expansion of European beachgrass may have negligible beneficial effects. European beachgrass and iceplant may provide more cover and habitat for certain species such as brush rabbits and deer mice, thereby artificially inflating populations of these and potentially other small and medium-sized mammal species. Larger populations of deer mice and rabbits would attract potentially higher numbers of predatory species such as raptors and mammals such as coyotes, fox, and bobcats. Overall, however, as almost all of these wildlife species occurs in multiple habitats both within and outside the park, Alternative A would be expected to have almost no effect to a very negligible effect on populations of these species within the Seashore and local region.

For some of the wetland-associated species such as amphibians, certain reptiles, and visiting waterfowl and shorebirds, continued expansion of European beachgrass and iceplant is unlikely to have measurable impacts on their wetland habitat, which occurs in the dunes themselves (Dune Swales) or in adjacent grasslands (Freshwater Marsh). There would be no effects on wildlife at AT&T and B Ranch, as no near-term restoration would be conducted at either area in the near-term, except for already permitted projects.

Based on the scale of other dune restoration projects proposed within the region, cumulative adverse and beneficial effects of these projects with Alternative A would be no more than negligible adverse on a regional scale.

There would be no implementation-related or short-term effects, because no near-term restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, except for previously permitted projects.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

As was discussed in the Affected Environment section of this document, species diversity and abundance of small terrestrial vertebrates and mammals within the Seashore's dunes is probably lower than that of other habitats within the park (Fellers and Pratt 2002). However, based on published and unpublished information, a range of species do use these habitats, including terrestrial invertebrates, small terrestrial vertebrates, mammals, birds, and, in adjacent open water habitats, fish.

Small Terrestrial Mammals

Long-Term Effects

A more complete description of use of dune systems by small terrestrial mammals can be found under Alternative A. Under Alternative B, the areal extent of European beachgrass would decrease, which would provide less habitat and cover for deer mice, so, ultimately, deer mice populations could decrease within restored dunes. The prevalence of deer mice within iceplant stands has been less well studied, but this species was also frequently caught in traps within dense iceplant in the Fellers and Pratt (2002) inventory. The scale of restoration under Alternative B would be reduced relative to Alternatives C and D, so potential reductions in deer mice numbers with restoration should also be lower.

While densities of deer mice before and after dune restoration has not been specifically studied, changes can be inferred to some degree from the reduction in raceme or flowering stalk predation of Tidestrom's lupine documented after the Abbotts Lagoon project: predation dropped from between 38% to 94% before restoration to between 4% and 19%

after restoration (Pardini and Knight 2013, E. Pardini, *pers. comm*.). Deer mice have been implicated as one of the primary predators of Tidestrom's lupine seed (Dangremond et al. 2010). Ironically, increases in Tidestrom's lupine following restoration could increase food sources for remaining deer mice and other mammals. In addition, manual removal is more likely to result in re-growth of treated European beachgrass, which would offset impacts to deer mice over the long-term.

Abundance of other small mammals may also decrease within restored dunes, although habitat preferences of these species within dunes have been less well studied. A study conducted at Fort Funston in GGNRA found that the abundance of ground-dwelling vertebrates, which included small mammals, was greatest in restored dune areas, which, along with long-term unrestored visitor-restricted areas, had also had the greatest diversity of ground-dwelling vertebrate species (Russell et al. 2009). This study included species such as deer mice, pocket gophers (*Thomomys bottae*), California vole (*Microtus californicus*), Trowbridge shew, and vagrant shrew, so results of this may suggest that areas dominated by native dune plant species rather than at least iceplant – if not European beachgrass – have positive benefits for certain small mammals, including deer mice. Again, long-term benefits to small mammal species may be lower under Alternative B than Alternatives C and D.

Based on these factors, Alternative B could have negligible beneficial long-term effects on small mammal species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with negligible to potentially minor adverse effects on deer mice. There may also possibly be very negligible adverse effects for other small mammals, although removal of at least iceplant would provide negligible benefits for these species based on recent studies (Russell et al. 2009). Restoration may also restore a more natural dynamic to small mammal populations within the Seashore's dunes, although this and other benefits would be reduced to negligible under this alternative. As these species occur in many other habitats at higher abundances, adverse impacts would have only very negligible to almost no effect on park populations of these species.

Implementation-Related and Short-Term Effects

Staging and Access: Staging and access could adversely affect small mammals through vehicles driving over mammals or inadvertently crushing burrows. Impacts would be minimized by utilizing existing ranch roads as much as possible, where less burrows may be located, and keeping speeds below 10 mph. Staging and access may have negligible adverse effects on small mammals at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Manual removal may impact small mammals through running over of small mammals by all terrain vehicles (UTVs), accidental striking by shovels of small mammals that do not move away from crews, or through disturbance to burrows from excavation of European beachgrass and iceplant. These species may also be disturbed less directly by noise of the crew. In general, mammals should have time to escape from most of the potential impacts, as crews by necessity work slowly, and vehicle speed is limited to 10 mph and is likely to be even lower within dunes due to the rough terrain. Overall, these implementation-related impacts would be expected to be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Large Mammals

Long-Term Effects

A more complete description of use of dune systems by large terrestrial mammals can be found under Alternative A.

Under Alternative B, the areal extent of European beachgrass and iceplant would decrease. With the possible exception of brush rabbit, reductions in these invasive, non-native plants would not appear to impact use of dunes by these species. Some of these species such as mule deer may rest or bed within European beachgrass stands, but elimination of beachgrass would not affect any key life history stage. None of these species appear to forage on European beachgrass, although ranchers report that cows find the grass more palatable when it's young and not well established (Department of Agriculture 1896). Some of the carnivores such as bobcats, coyotes, gray fox, and others may be adversely affected by reductions in small mammal prey populations (see discussion under small mammals above). However, the intensity of any adverse impacts under Alternative B is reduced relative to Alternatives C and D due to the fact the scale of restoration conducted would be smaller with primarily a manual removal approach due to the logistical difficulties and higher cost per acre. Marine mammals such as California sea lion, harbor seals, and northern elephant seals may also occur on beaches adjacent to project areas, but no long-term effects would be expected from dune restoration efforts.

Based on these factors, Alternative B would be expected to have either no effect (large herbivores) or negligible long-term adverse effects (small herbivores, carnivores) at AT&T/ North Beach, B Ranch/A Ranch/Davis Property, and Limantour. However, as these species occur in many other habitats at higher abundances, even adverse impacts would have only very negligible to almost no effect on park populations of these species.

Implementation-Related and Short-Term Impacts

Staging and Access: Staging and access has a small potential to impact some mammals through vehicles inadvertently crushing burrows. Impacts would be minimized by utilizing existing ranch roads as much as possible, where less burrows may be located, and keeping speeds below 10 mph. Staging and access may have very negligible adverse effects on larger mammals at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Manual removal may impact larger mammals through disturbance to burrows from excavation of European beachgrass and iceplant. These species may also be disturbed less directly by noise of the crew. In general, mammals should have time to escape from most of the potential impacts, as crews by necessity work slowly, and vehicle speed is limited to 10 mph and is likely to be even lower within dunes due to the rough terrain. Crews or vehicle noise could temporarily disturb marine mammals present on the adjacent beach, although it is unlikely that animals would flush into the water. Overall, these implementation-related impacts would be expected to be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Birds

Long-Term Effects

A more complete description of bird use of dune systems can be found under Alternative A.

Over the long term, predatory bird species may not be directly impacted by dune restoration efforts, but they could be indirectly impact by reduction in prey populations such as rodents due to loss of European beachgrass habitat, which has been shown to support higher abundances of species such as deer mice than native Dune Mat communities (Pitts and Barbour 1979, Fellers and Pratt 2002).

Most of the passerines that have been primarily observed in the dunes during nesting season either exclusively use habitat within native Dune Mat or Dune Scrub adjacent to European beachgrass stands (e.g., killdeer and California horned lark) or use those areas in addition to sometimes nesting in native shrubs that are intermixed within or on the edge of beachgrass stands (e.g., savannah sparrow, song sparrow, Nuttall's white-crowned sparrow). Backdune areas supporting shrubs such as coyotebrush and bush lupine supported fairly high densities of Nuttall's white crowned sparrow and Song sparrow, with the latter more abundant where shrubby areas adjoined dune swale wetlands (ARA 2012). Savannah sparrows were more common on the edges of shrub-dominated areas, particularly where it abutted barren ground or more open, dune mat habitat (ARA 2012). Most of these species forage upon a combination of insects and seeds of grasses and herbs.

For these species, restoration to native Dune Mat and Dune Scrub could increase available habitat for nesting, as they do not directly nest in either European beachgrass or iceplant. A study conducted at Fort Funston in GGNRA found that the number of bird species in restored dune areas was higher than in unrestored areas and in unrestored areas where visitor access was restricted (Russell et al. 2009).

Dune Swale wetlands may be sporadically used by waterfowl species. Some of the visiting waterbirds may come from larger water bodies nearby such as Abbotts Lagoon or Estero de Limantour, but dune swales are not large enough features to provide long-term support for shorebird species (ARA 2012). Manual removal methods are less likely to impact existing wetlands, so long-term adverse impacts on waterfowl species would be minimal and probably non-existent.

Beach areas oceanward of beachgrass-dominated foredunes were frequented by western snowy plover (discussed earlier), common ravens, and migrant and wintering shorebirds such as dunlin, sanderling, and willet foraging along the tideline and higher beach (ARA 2012). Restoration could increase the width of open beach available to shorebirds to feed and could lessen impacts associated human activity as visitors would be less concentrated into a narrow strip of beach due to oceanward encroachment by European beachgrass in foredunes. However, manual removal is least successful in eradicating European beachgrass in foredune areas, where rhizomes can extend down as much as 6- to 12 feet, so benefits to these species under Alternative B would be reduced relative to Alternatives C and D.

In general, dune restoration could have both adverse and beneficial long-term effects on birds, although the intensity of both types of effects would be reduced relative to Alternatives C and D. Predatory bird species could be impacted by reductions in prey populations (e.g., small mammals such as deer mice). Passerine birds could be benefitted by increases in nesting habitat such as native Dune Mat and Dune Scrub vegetation, while shorebirds would benefit from higher quality foredune and nearshore habitats, although this alternative would be less likely to successfully restore native foredunes. No discernable impact would be expected on waterbirds that use dune slack or Dune Swale wetlands.

Therefore, depending on the species, this alternative could have either negligible adverse or beneficial impacts over the long-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. As these species occur within many different areas of the park, these actions would have negligible to no effect on park populations of these species.

Implementation-Related and Short-Term Impacts

Staging and Access: Staging and access has a small potential to impact some birds through operations occurring potentially near nesting areas. Impacts would be minimized by utilizing existing ranch roads as much as possible and keeping speeds below 10 mph. If implementation occurs in the spring or summer, nesting surveys would be conducted prior to establishment of new primary access roads or staging areas, and up to a 100-foot no-work buffer would be established between access or staging and nests. Staging and access may have very negligible adverse effects on birds at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Manual removal may impact birds through disturbance to nests either within or outside of European beachgrass and iceplant stands. These species may also be disturbed by noise of the crew. In general, birds should have time to escape from most of the potential impacts, as crews by necessity work slowly, and vehicle speed is limited to 10 mph and is likely to be even lower within dunes due to the rough terrain. If implementation occurs in the spring or summer, nesting surveys would be conducted prior to start of work, and up to a 100-foot no-work buffer would be established between access or staging and nests. Work would not be conducted within this buffer until nesting is complete. Some species can "re-nest" or nest several times within a season, so surveys would be conducted regularly until August 1. Overall, these implementation-related adverse impacts would be expected to be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Amphibians and Reptiles

Long-Term Effects

A more complete description of use of dune systems by amphibians and reptiles can be found under Alternative A. Over the long term, these species may not be directly impacted by dune restoration efforts, as these species either occur in wetland or moist habitats or, in the case of fence lizards, utilize both native and non-native habitats. However, a study conducted at Fort Funston in GGNRA found that the abundance of ground-dwelling vertebrates, which included small mammals, amphibians, and reptiles, was greatest in restored dune areas, which, along with long-term unrestored visitor-restricted areas, had also had the greatest diversity of ground-dwelling vertebrate species (Russell et al. 2009). This study included species such as northern alligator lizards, southern alligator lizards, California newt, and California slender salamanders, so results of this may suggest that areas dominated by native dune plant species rather than iceplant have positive benefits for certain amphibians and reptiles.

In general, restoration of coastal dunes could have negligible long-term adverse effects on amphibians and garter snake populations, with adverse effects related primarily remobilization of destabilized dune sands into adjacent wetland and grassland habitats. The potential for remobilization is much lower under Alternative B than the other action alternatives (Alternatives C and D).

Overall, under Alternative B, there could be no effect for some of these more wetland-associated species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, but a negligible benefit for other species over the long-term. As these species occur in many habitats within the Seashore, there would be no effect on park populations.

Implementation-Related and Short-Term Effects

Staging and Access: Staging and access could adversely affect amphibians and reptiles through vehicles striking or driving over them or inadvertently crushing burrows. Impacts would be minimized by utilizing existing ranch roads as much as possible, where less burrows may be located, and keeping speeds below 10 mph. Staging and access may have very negligible adverse effects on amphibians and reptiles at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Manual removal may impact amphibians and reptiles through striking or driving over them by all terrain vehicles (UTVs), accidental striking by shovels of animals that do not move away from crews, or through disturbance to burrows from excavation of European beachgrass and iceplant. These species may also be disturbed by crew noise. In general, amphibians and reptiles should have time to escape from most potential impacts, as crews by necessity work slowly, and vehicle speed is limited to 10 mph and is likely to be even lower within dunes due to the rough terrain. Overall, these implementation-related impacts would be expected to be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Other Species

A more complete description of use of dune systems by terrestrial invertebrates and fish can be found under Alternative A.

In general, sand-burrowing arthropod communities are lower in abundance and diversity within dense European beachgrass stands (Stenzel et al. 1981, Slobodchikoff and Doyen 1977 *in* USFWS 2007), therefore, it is likely that many terrestrial invertebrates do not occur within these stands. Over the long-term, restoration should actually increase habitat for sand-burrowing arthropods and for dune plant species that could act as nectar and host plant sources. In general, Alternative B could have negligible benefits for terrestrial invertebrates, although the intensity of both types of effects would be reduced relative to Alternatives C and D due to the reduced scale of restoration under Alternative B and reduced efficacy rate of manual removal in eradicating European beachgrass.

Implementation-related and short-term impacts to terrestrial invertebrates could occur from staging and access and manual removal, but they would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Fish species would typically only occur in adjacent open water bodies or in marshes in adjacent wetlands due to the ephemeral nature of most Dune Swale wetlands. Implementation would be expected to have no effect or very negligible impacts on fish communities within adjacent water bodies such as Estero de Limantour. Over the long-term, dune restoration would be expected to have no effect on fish populations in adjacent water bodies such as Estero de Limantour.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wildlife would be the same as discussed under Alternative A. From a regional perspective, based on the scale of projects conducted historically in the park and proposed outside the park, the proposed dune restoration efforts would likely have no effect to very negligible effects on wildlife species within the region, as most of the species are common ones that occur in a diverse number of habitats.

Conclusions

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Under Alternative B, dune restoration could provide negligible benefits for certain wildlife species, but these benefit could be reduced relative to Alternatives C and possibly D due to the fact that there would probably be less restoration implemented. These include certain small mammal, reptile, passerine bird, and sand-burrowing arthropod species. For other species, dune restoration may offer no benefit (large herbivores, amphibians, and certain reptiles) and could, for some, have negligible to possibly minor adverse impacts on a localized scale, with the direction and intensity of impact often related to the species and restoration approach. Adverse impacts could result from the fact that European beachgrass and iceplant may provide more cover and habitat for certain species such as brush rabbits and deer mice, thereby artificially inflating populations of these and potentially other small and medium-sized mammal species. Larger populations of deer mice and rabbits would attract potentially higher numbers of predatory species such as raptors and mammals such as coyotes, fox, and bobcats. Negligible adverse impacts could also occur if sand remobilization impacts wetlands used seasonally by waterfowl or shorebirds, although impacts of remobilization are expected to be much lower under Alternative B than under Alternative D and possibly Alternative C. No long term effects would be expected on marine mammals such as California sea lion, harbor seals, and northern elephant seals, which may occur on beaches adjacent to project areas.

While possibly affecting abundance of these species on a localized scale, removal of European beachgrass and iceplant would restore more natural population dynamics and could possibly even benefit other species that have been preyed upon by higher than normal numbers of carnivores, including western snowy plovers and other bird species. However, the degree of this benefit under Alternative B is reduced relative to Alternatives C and possibly Alternative D. In addition, as almost all of these wildlife species occurs in multiple habitats both within and outside the park, restoration efforts would be expected to have almost no effect to a very negligible effect on populations of these species within the Seashore and local region.

Implementation, staging, and access would have at most negligible adverse impacts on any of these wildlife species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Based on the scale of other dune restoration and other types of projects proposed within the region, cumulative adverse and beneficial effects of these projects with those that may be conducted under Alternative B would have either no effect or no more than a very negligible effect on a regional scale.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

As was discussed in the Affected Environment section of this document, species diversity and abundance of small terrestrial vertebrates and mammals within the Seashore's dunes is probably lower than that of other habitats within the park (Fellers and Pratt 2002). However, based on published and unpublished information, a range of species do use these habitats, including terrestrial invertebrates, small terrestrial vertebrates, mammals, birds, and, in adjacent open water habitats, fish.

Small Terrestrial Mammals

Long-Term Effects

A more complete description of use of dune systems by small terrestrial mammals can be found under Alternative A, while effects of dune restoration are discussed under Alternative B. In general, with expanded removal of European beachgrass and iceplant under Alternative C, there could be greater impact to deer mice populations, particularly relative to Alternative B. However, potential benefits for other small mammals would also increase relative to Alternative B and possibly Alternative D.

Based on these factors, Alternative C could have minor long-term adverse effects at least for deer mice. There may also possibly be adverse effects for other small mammals, although removal of at least iceplant would provide minor benefits for some of these species based on recent studies (Russell et al. 2009). Restoration may also restore a more natural dynamic to small mammal populations within dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, particularly relative to Alternative B. As these species occur in many other habitats at higher abundances, adverse impacts would have only very negligible to almost no effect on park populations of these species.

Implementation-Related and Short-Term Effects

Staging and Access: The impacts of staging and access would be very similar to those discussed under Alternative B, although the intensity of impact may be greater than under Alternative B due to the fact that heavy equipment may be used for removal in wetland and organic pasture buffer areas. Staging and access may have negligible to minor adverse effects on small mammals at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: The impacts of manual removal would be identical to those discussed under Alternative B, although the intensity may be decreased relative to Alternative B due to the fact that manual removal would only be used for removal of iceplant and European beachgrass in buffers and wetlands. Overall, these implementation-related impacts would be expected to be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Potentially, one of the largest impacts to small mammals would occur with mechanical removal, which could have considerable impacts due use of heavy equipment and extensive turnover of soil horizons. The slow speed at which mechanical removal takes place – 0.3 to 0.5 acre/day based on time required during Phase I at Abbotts Lagoon – would allow many of the small mammals to escape the work area before direct impacts occurred, but they may be eaten by predators before they can reach other beachgrass areas, or the carrying capacity of the remaining beachgrass stands may be exceeded, causing a die-off.

Mechanical removal can impact animals indirectly due to the noise of heavy equipment and UTVs. Animal response to sound depends on a number of complicated factors, including noise level and frequency, slope, topography, weather conditions, previous exposure to similar noises, hearing sensitivity, time of day, behavior during the noise event (Delaney and Grubb 2003 *in* WSDOT 2013). Noise can simply cause animals to flush or can cause even more deleterious effect on reproduction, care of young, or physiology. A more detailed discussion of potential noise effects is provided under Large Mammals, but, in summary, noise from heavy equipment could have impacts at least as far as 900 feet from dune restoration work areas.

Overall, use of mechanical removal in buffers would be expected to have negligible to minor adverse impacts on small mammal species that frequent dune areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: Use of chemical control can affect small mammals directly through accidental spraying of individuals or more indirectly through drift or ingestion of contaminated vegetation or other food sources. The potential for accidental spraying is higher for these species than many others, because they actively use European beachgrass and iceplant stands as habitat. As discussed under Manual Removal, small mammals would likely flush out of the work area before individuals could be directly sprayed, as spray crews move through areas slowly due to need to ensure that each plant is sprayed. However, there is the potential for animals to freeze if suddenly startled and, therefore, be accidentally sprayed.

Two herbicides would be used under this alternative, as well as a surfactant and a dye. The two herbicides are glyphosate and imazapyr. By far, glyphosate has received the most attention. Many formulations of glyphosate either incorporate a surfactant or require that a surfactant be separately added during mixing. Round-Up® is one of the most familiar glyphosate formulations, and it incorporates a surfactant called polyoxyethyleneamine (POEA). The toxicity data in mammals clearly indicate that the toxicity of POEA may be of equal or greater concern than glyphosate itself (SERA 2011a). Acute oral toxicity data indicate that the POEA surfactant is about nine times more toxic than glyphosate (SERA 2011a). The park would not use this formulation, but would use Aqua-Master® or another aquatic-label glyphosate brand that does not incorporate a surfactant. A non-ionic surfactant such as Competitor® would be added instead during mixing.

As has been discussed in detail under the *Special Status Species* section, considerable research into glyphosate and its effect on mammals has been conducted, with effects split between toxic and less toxic formulations. The type of glyphosate used by the Seashore is considered less toxic. Based on USFS risk assessment worksheets developed by SERA, acute exposure to small mammals from 100% direct exposure to glyphosate at application rates of 4 lbs a.e./acre could result in an absorbed dose approximating 97.0 mg/kg bw. For the current USFS risk assessment, a NOAEL of 500 mg/kg bw/day is used to characterize risks associated with applications of less toxic glyphosate formulations (SERA 2011a), which corresponds at this application rate into a hazard quotient of 0.6, which is below the level of concern (1.0).

Based on USFS risk assessment worksheets developed by SERA, acute exposure to small mammals from 100% direct exposure to imazapyr at application rates of 1 lb a.e./acre could result in an absorbed dose approximating 24.2 mg/kg bw. For the current USFS risk assessment, the NOAEL of 738 mg/kg bw/day is used to characterize risks associated with applications of imazapyr to non-canid mammalian species (SERA 2011b), which corresponds at this application rate into a hazard quotient of 0.03, which is, again, well below the level of concern (1.0).

Even if small mammals aren't present in the work area, they may be affected by drift. A more complete description of the potential impacts associated with drift can be found in *Vegetation Resources*-Alternative C. In summary, based on USFS risk assessment worksheets developed by SERA, use of the proposed 4.0 pounds a.e./acre of glyphosate would result in drift of 0.8% (0.033 lbs a.e./acre) of the applied solution within 25 feet of the application area, 0.4% (0.017 lbs a.e./acre) within 50 feet, and 0.03% (0.001 lbs a.e./acre) within 900 feet. Use of a maximum of 1.0 pounds a.e./acre of imazapyr would result in the same percentage of drift, but lower volumes, ranging from 0.008 lbs a.e./acre of the applied solution within 25 feet of the application area, 0.004 lbs a.e./acre within 50 feet, and 0.0003 lbs a.e./acre within 900 feet. As direct spray did not appear to result in acute toxicity to small mammals, it is unlikely that drift in the volumes as described above would result in any acute toxicity.

Following spray activities, small mammals may eat seeds, vegetation, or insects contaminated by herbicide. Unlike other studies that have characterized deer mice as largely insectivorous (Kritzman 1974 *in* Pitts and Barbour 1979), deer mice in dunes at Point Reyes appeared to largely eat plant matter, although they also consumed insects (Pitts and Barbour 1979). In this study, choice experiments showed that mice preferentially ate leaves of miner's lettuce, wallflower (*Erysmium*), chickweed (*Stellaria* sp.), and European sea-rocket, along with seeds of beach pea, lupine, European sea-rocket, and fiddleneck (Pitts and Barbour 1979). To a lesser degree, mice also consumed seed of European beachgrass and bluegrass (*Poa* sp.), but it did not eat foliage of either of these species (Pitts and Barbour 1979). Use of backpack sprayer with wands would mean that most of these non-target plant species would be avoided, with the exception of European beachgrass, although some may be accidentally hit during spray operations (non-target effects). At the Seashore, European beachgrass does not flower as profusively as some species, as it spreads primarily vegetatively.

Based on USFS risk assessment worksheets developed by SERA, at application rates of 4 lbs a.e./acre, spraying of glyphosate onto non-target (and target) plant species could result in acute exposure of mice from contaminated fruits ranging from 2.15 to 10.1 mg/kg/day. Consumption of contaminated grasses – there is no separate model for herbaceous plants – could result in higher acute exposures of 20.2 to 161 mg/kg/day, while consumption of contaminated insects could lead to exposures ranging from 30.8 to 278 mg/kg/day. Chronic, longer-term consumption of contaminated vegetation on-site could expose small mammals to doses ranging from 0.02 to 0.3 mg/kg/day. For the current USFS risk assessment, the NOAEL of 500 mg/kg bw/day is used to characterize risks associated with applications of less toxic glyphosate formulations (SERA 2011a). All of these estimated risk exposures fall below that NOAEL. No hazard quotient estimates are available for less toxic glyphosate formulations.

At an application rate of 1 lb a.e./acre, accidental spraying of imazapyr onto target and non-target plant species could result in acute exposure of mice from contaminated fruits ranging from 2.18 to 57.9 mg/kg/day. Consumption of contaminated grasses could result in higher acute exposures of 15.2 to 691 mg/kg/day, while consumption of contaminated insects could lead to exposures ranging from 1.9 to 98.2 mg/kg/day. Chronic, longer-term consumption of contaminated fruits and grasses on-site could expose small mammals to doses ranging from 0.5 to 334 mg/kg/day. For the current USFS risk assessment, the NOAEL of 738 mg/kg bw/day is used to characterize risks associated with applications of imazapyr to non-canid mammalian species (SERA 2011b), which corresponds at this application rate into a hazard quotient of 0.003 to 0.9, which is below the level of concern (1.0).

Under this alternative, mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have minor to possibly moderate effects on small mammals at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. By necessity, the rough terrain would keep the speed of the mowing unit down well below 10 mph, so small mammals within dense European beachgrass stands could flee prior to being struck or killed. However, there is a potential for some animals to freeze in response to disturbance.

Another pre-treatment measure that may be used is prescribed burning. Slower moving animals, such as small mammals, may be unable to outrun a prescribed fire and would be killed. Deer mice may experience particularly adverse impacts from burning.

Based on these factors, adverse impacts during and shortly following restoration would be negligible to possibly moderate at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with potential moderate impacts resulting from either pre- or post-treatment mowing or prescribed burning. While deer mice and other small mammals may consume seeds of European beachgrass (Pitts and Barbour 1979), risk assessment analyses suggest that risk exposure from contact toxicity or consumption of either sprayed fruits or vegetation still falls below the level of concern.

Large Mammals

Long-Term Effects

A more complete description of use of dune systems by large terrestrial mammals can be found under Alternative A. Also, description of the effect of dune restoration on large mammals can be found under Alternative B.

In general, under Alternative C, there would be greater long-term adverse impacts to medium-sized mammals such as brush rabbits or carnivores that prey upon the unnaturally high densities of deer mice and possibly other small mammals within dense European beachgrass and iceplant stands than under Alternative B. For other species such as mule deer, decreases -– or increases – in invasive, non-native plants would not appear to impact their use of dune habitats. None of these species appear to forage on European beachgrass, although ranchers report that cows find the grass more palatable when it's young and not well established (Department of Agriculture 1896). Some of the carnivores such as bobcats, coyotes, gray fox, and others may be adversely affected by reductions in small mammal prey populations (see discussion under small mammals above). Marine mammals such as California sea lion, harbor seals, and northern elephant seals may also occur on beaches adjacent to project areas, but no long-term effects would be expected from dune restoration efforts.

Based on these factors, Alternative C would be expected to have either no effect (large herbivores, marine mammals) or minor long-term adverse effects (small herbivores, carnivores) at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. However, as these species occur in many other habitats at higher abundances, even adverse impacts would have only very negligible to almost no effect on park populations of these species.

Implementation-Related and Short-Term Effects

Staging and Access: The impacts of staging and access would be very similar to those discussed under Alternative B, although the intensity of impact may be slightly higher as heavy equipment may be used for removal in wetland and organic pasture buffer areas. Staging and access may have negligible adverse effects on larger mammals at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: The impacts of manual removal would be identical to those discussed under Alternative B, although the intensity may be decreased due to the fact that manual removal would be used primarily for removal of iceplant and European beachgrass in wetlands and buffer areas. Overall, these implementation-related impacts would be expected to be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Mechanical removal can injure or kill larger mammals, although this is less likely than with smaller mammals due to higher mobility of large mammals. The slow speed at which mechanical removal takes place – 0.3 to 0.5 acre/day based on time required during Phase I at Abbotts Lagoon – would allow most of the larger mammals to escape the work area before direct impacts occurred, although some animals such as brush rabbits may freeze in response to the noises and be injured or killed by equipment. Also, flushing of at least brush rabbits into open Dune Mat areas may increase the likelihood that they may be eaten by predators before they can reach other beachgrass areas.

As was discussed in detail under *Special Status Species*, mechanical removal can impact animals indirectly due to the noise of heavy equipment and UTVs. Animal response to sound depends on a number of complicated factors (Delaney and Grubb 2003 *in* WSDOT 2013). Noise can simply cause animals to flush or can cause even more deleterious effect on reproduction, care of young, or physiology.

For terrestrial mammals, the impact of construction noise has not been as closely studied as in birds, and most of the studies that have been done focused on traffic, airplane, or sonic boom noise. Mammals have a wider range of sensitivity to noise than other animal groups, ranging from <10 Hz to 150 kHz, with sensitivity as low as -20 dB (FHWA 2011-web page). Based on a review of the available literature, FHWA concluded that many of the studies on noise and terrestrial wildlife conducted show conflicting results, because it is difficult to separate out the effects of roads versus noise (FHWA 2011), particularly as some mammals learn to associate roads with hunting (Rost and Bailey 1979 *in* FHWA 2011).

Based on analyses described in more detail under *Special Status Species*, construction noise within dune restoration areas could reach 86 dBA at 50 feet. Based on noise attenuation, noise levels would drop to 78.5 dBA at 100 feet and 61 dBA at 500 feet. EPA guidance suggested that long-term noise increase of 5 to 10 dBA (frequency weighted sound decibels) above background noise should be considered to have a noticeable effect (USEPA 1980 *in* ICF 2010). Ambient noise levels along the Great Beach and adjacent coastal dunes, scrub, and grasslands were recently estimated in a FAA study as ranging between 30 to <40 dBA-LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011). Using the EPA guidance, bulldozer noise would dissipate to within 10 dBA of background noise or inconsequential levels within 500 to 900 feet when ambient noise levels are quiet (45 dBA) and 200 to 300 feet when conditions are windy (55 dBA; ICF 2010). This would suggest that larger terrestrial mammals within 900 feet could be disturbed in some way, although the degree of disturbance is unknown.

Ironically, during construction of the Giacomini Wetland Restoration Project in Point Reyes, the abundance of many larger mammals and certain bird species actually seemingly increased relative to pre-restoration numbers. Coyotes and white-tailed kites (*Elanus leucurus*) frequently occurred on-site in close proximity to construction and hauling equipment, and mule deer and bobcats were also observed. Coyotes and kites appeared to be hunting small mammals disturbed by the construction process, and coyotes became acclimated enough to the noise of equipment that they would often run alongside the blades of bulldozers.

Little information exists on response of marine mammals to mechanical invasives removal activities in coastal dunes. Pinnipeds will occasionally pull out along the Great Beach, but only rarely. Consistent noise from excavators and bulldozers could cause disturbance or even flushing of the animals. Known haul-out or breeding areas such as at the end of Limantour Spit would be avoided during the breeding season (Mar. 1- July 31).

Overall, use of mechanical removal in buffers would be expected to have negligible adverse impacts on large mammals that frequent dune areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: Use of chemical control can affect larger mammals directly through accidental spraying of individuals or more indirectly through drift or ingestion of contaminated vegetation or other food sources. The potential for accidental spraying is higher for some of the medium-sized species such as brush rabbits than others such as mule deer, coyotes, or fox, because they are more likely to frequent European beachgrass and iceplant stands. As discussed under Manual Removal, most mammals would likely flush out of the work area before individuals could be directly sprayed, as spray crews move through areas slowly due to need to ensure that each plant is sprayed. However, there is the potential for animals such as brush rabbits to freeze if suddenly startled and, therefore, be accidentally sprayed.

As was discussed under earlier impact sections, considerable research into glyphosate and its effect on mammals has been conducted, with effects split between toxic and less toxic formulations. The type of glyphosate used by the Seashore is considered less toxic. Unlike with small mammals, the USFS risk assessment worksheets developed by SERA did not include equivalent calculations for acute exposure of large mammals to accidental spraying, possibly perhaps because it is less likely. Using the information discussed above for 100% direct exposure of small mammals to both glyphosate and imazapyr, it can be inferred that absorbed doses would also be well below the NOAEL for larger mammals. Even if larger mammals aren't present in the work area, they may be affected by drift. A more complete discussion of the potential impacts posed by drift can be found under *Vegetation Resources-*

Alternative A and small mammal sub-section above. In summary, as direct spray did not appear to result in acute toxicity to small mammals, it is unlikely that drift in the volumes as described above would result in any acute toxicity to larger mammals, either.

Following spray activities, larger mammals may consume fruit, vegetation, or small mammals contaminated by herbicide. Based on USFS risk assessment worksheets developed by SERA, at application rates of 4 lbs a.e./acre, spraying of glyphosate onto non-target (and target) plant species could result in acute exposure of large mammals from contaminated grasses ranging from 26.4 to 211 mg/kg/day. There is no specific assessment for consumption of glyphosate-contaminated fruit or seed by larger mammals, but at least one study documented that rabbits will eat seeds of iceplant (Novoa et al. 2012). Consumption of contaminated small mammals by carnivorous mammals could result in acute exposure of 8.39 mg/kg/day. Chronic, longer-term consumption of contaminated vegetation on-site could expose large mammals to doses ranging from 0.42 to 33.8 mg/kg/day. For the current USFS risk assessment, the NOAEL of 500 mg/kg bw/day is used to characterize risks associated with applications of less toxic glyphosate formulations (SERA 2011a). All of these estimated risk exposures fall well below that NOAEL. No hazard quotient estimates are available for less toxic glyphosate formulations.

At an application rate of 1 lb a.e./acre, accidental spraying of imazapyr onto target and non-target plant and animal species could result in acute exposure of larger mammals from consumption of contaminated fruit ranging from 0.3 to 13.2 mg/kg/day. Consumption of contaminated grasses could result in higher acute exposures of 2.0 to 158 mg/kg/day, while consumption of contaminated insects and contaminated mammals could lead to exposures ranging from 0.4 to 22.4 mg/kg/day (insects) and 2.72 mg/kg/day (small mammals). Chronic, longer-term consumption of contaminated fruits and grasses on-site could expose larger mammals to doses ranging from 0.07 to 76.2 mg/kg/day. For the current USFS risk assessment, the NOAEL of 738 mg/kg bw/day is used to characterize risks associated with applications of imazapyr to non-canid mammalian species (SERA 2011b), which corresponds at this application rate into a hazard quotient of 0.00009 to 0.1, which is well below the level of concern (1.0).

Under this alternative, mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have negligible to possibly minor effects on larger mammals. By necessity, the rough terrain would keep the speed of the mowing unit down well below 10 mph, so larger mammals within dense European beachgrass stands could flee prior to being struck or killed. However, there is a potential for some medium-sized mammals to freeze in response to disturbance.

Another pre-treatment measure that may be used is prescribed burning. Larger mammals would be able to escape a fire and would likely vacate the area when humans or UTVs approach. Impacts would be short-term, adverse and at most minor for most species, with most impacts occurring for medium-sized mammals such as brush rabbits and raccoons.

Based on these factors, adverse impacts during and shortly following restoration would be negligible to possibly minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with minor impacts to medium-sized mammals resulting from either pre- or post-treatment mowing or prescribed burning.

Birds

Long-Term Effects

A more complete description of use of dune systems by birds can be found under Alternative A. Additional information on effects on restoration on use of dunes by birds can be found under Alternative B. In general, dune restoration could have both adverse and beneficial long-term effects on birds, although the intensity of both types of effects would be increased relative to Alternative B. Predatory bird species could be impacted more under this alternative than Alternative B by reductions in prey populations (e.g., small mammals such as deer mice) associated with expanded restoration of dune habitat. Passerine birds could also be benefitted more by increases in nesting habitat such as native Dune Mat and Dune Scrub vegetation under this alternative relative to Alternative B, and shorebirds would benefit from higher quality foredune and nearshore habitats.

Dune Swale wetlands may be sporadically used by waterfowl species, as well as shorebirds. Some of the visiting waterbirds may come from larger water bodies nearby such as Abbotts Lagoon or Estero de Limantour, but dune swales are not large enough features to provide long-term support for shorebird species (ARA 2012). Impacts to these species may depend on the type of restoration implemented: mechanical removal could cause burial of wetland features within dune systems. Other removal methods are less likely to impact existing wetlands, so long-term adverse impacts in these situations would be minimal and perhaps even non-existent. Impacts to waterbirds would be reduced under Alternative C relative to Alternative D due to the fact that no large-scale dune excavation would occur except in buffer areas.

Therefore, depending on the species, this alternative could have either negligible to minor beneficial effects or negligible adverse effects over the long-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. As these species occur within many different areas of the park, these actions would have negligible to no effect on park populations of these species.

Implementation-Related and Short-Term Effects

Staging and Access: The impacts of staging and access would be very similar to those discussed under Alternative B, although the intensity of impact may be slightly increased due to the fact heavy equipment would potentially be used for removal in wetland and organic pasture buffers. Staging and access may have negligible adverse effects on birds at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: The impacts of manual removal would be identical to those discussed under Alternative B, although the intensity may be reduced slightly due to the fact that manual removal would primarily be used for removal of iceplant and European beachgrass in wetland and buffers. Overall, these implementation-related impacts would be expected to be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Mechanical removal can injure or kill birds, although this is less likely with birds due to mobility. The slow speed at which mechanical removal takes place – 0.3 to 0.5 acre/day based on time required during Phase I at Abbotts Lagoon – would allow most birds to escape the work area before direct impacts occurred, although some animals may freeze in response to the noises and be injured or killed by equipment. Also, flushing of birds may increase the likelihood that they may be eaten by predators before they can reach other high cover areas.

As was discussed for mammals, mechanical removal can impact animals indirectly due to the noise of heavy equipment and UTVs. Based on analyses described in more detail under *Special Status Species* and summarized under mammal sub-sections, construction noise within dune restoration areas could reach 86 dBA at 50 feet. Based on noise attenuation, noise levels would drop to 78.5 dBA at 100 feet and 61 dBA at 500 feet. Using the EPA guidance on noise impacts relative to ambient noise conditions, bulldozer noise would dissipate to within 10 dBA of background noise or inconsequential levels within 500 to 900 feet when ambient noise levels are quiet (45 dBA) and 200 to 300 feet when conditions are windy (55 dBA; ICF 2010).

In a USFWS Biological Opinion issued for Washington Department of Transportation construction activities, the USFWS estimated the noise-only harassment/injury threshold for marbled murrelets and owls is approximately 92 dBA at nest sites (WSDOT 2013). Disturbance thresholds were estimated at 70 dBA, and detectability thresholds were estimated at 44 dBA. This would suggest that birds within 100 feet of the construction area would be disturbed; at 500 feet, the activity would still be detectable by birds, but not perceived as a disturbance. These numbers agree fairly well with snowy plover impact analyses for mechanical dune restoration efforts in Oregon that used the EPA ambient noise level guidance. Disturbance and detectability thresholds may be different for most predatory birds and passerines than marbled murrelets and owls, but it is likely that these are conservative thresholds.

Several species of raptors increased their home range size during military activity that included vehicle activity, human activity, and helicopter flights: red-tailed hawks shifted their activity away from the noise, but returned when training had ceased (FHWA 2004 *in* NPS 2009). Ellis et al (1991 *in* AMEC 2005 *in* NPS 2009) reported frequent and nearby jet aircraft passes noticeably alarmed peregrine falcons and sometimes caused a flight response, but never caused nest abandonment or reproductive failure. Fraser et al. (1985 *in* AMEC 2005 *in* NPS 2009) found that 10% of nesting bald eagles interrupted their incubation or brooding activities during overflights. Mexican spotted owls were observed to flush at noise levels of 92 dBA, but returned to pre-disturbance behavior within 10 to 15 minutes after the noise (Delaney et al. 1999 *in* AMEC 2005 *in* NPS 2009).

Waterfowl are considered particularly sensitive to noise, and construction noise in the 25 to 95 dBA range displaced up to 67% of nesting greater whitefronted geese in one study (Johnson et al. 2003 *in* AMEC 2005 *in* NPS 2009). Incubating waterfowl responses to aircraft include alert and concealment posture, interruption of foraging behavior, flight and decreases in nest attendance (Johnson et al. 2003 *in* AMEC 2005 *in* NPS 2009). Waterfowl and other waterbirds sometimes occur in ponded dune swale wetlands during the winter and spring (ARA 2012).

As noted under the discussion for Mammals, mechanical removal can have some benefits for species, as raptors will often take advantage of disturbance to prey populations and actually increase hunting efforts within construction sites, as was observed with white-tailed kites and the Giacomini Wetland Restoration Project.

Overall, use of mechanical removal in buffers would be expected to have negligible to possibly minor adverse impacts on bird species that frequent dune areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: Chemical control could also impact bird species. Most of these types of birds are unlikely to be affected by accidental spraying or drift onto individuals themselves, but more by ingestion of contaminated species. Most spraying would occur in the late summer or fall, when nesting is finished for the year. Should any spray operations be conducted prior to August 1 of the calendar year, nesting surveys would be conducted, and up to 100-foot no-work buffer would be established. No spraying would occur in that area until nesting is complete.

As was discussed in detail under *Special Status Species*, considerable research into glyphosate and its effect on birds has been conducted, with effects split between toxic and less toxic formulations. The type of glyphosate used by the Seashore is considered less toxic. For acute toxicity values for less toxic glyphosate formulations, the current USFS risk assessment uses a NOAEL of 1,500 mg a.e./kg/bw (SERA 2011a). For longer-term exposures to less toxic formulations, the USFS risk assessment uses an NOAEL of 58 mg a.e./kg bw (SERA 2011a).

Based on USFS risk assessment worksheets developed by SERA, at an application rate of 4 lbs a.e./acre of glyphosate, consumption of contaminated grass by a large bird could result in acute exposure to dosages ranging from 41.7 to 334 mg a.e./kg bw/day, while consumption of contaminated insects could expose small birds to acute dosages ranging from 50.3 to 452 mg/kg bw/day. Estimates of exposure from a small mammal being directly sprayed and then consumed by a carnivorous bird were 12.9 mg a.e./kg/bw/day. In terms of chronic exposure, consumption of contaminated grasses on-site could expose large birds to dosages ranging from 0.7 to 53.4 mg a.e./kg bw/day. All of these amounts fall either far below the acute NOAEL of 1,500 mg a.e./kg bw or just below the chronic NOAEL of approximately 58 mg a.e./kg bw.

As was discussed in more detail under *Special Status Species*, the available avian studies on imazapyr do not report any signs of toxicity (SERA 2011b). The current USFS risk assessment uses a NOAEL of 2,510 mg a.e./kg bw to characterize risks associated with acute exposures to imazapyr (SERA 2011b). For chronic toxicity, the current USFS risk assessment uses a NOAEL of 610 mg a.e./kg bw/day (SERA 2011b).

Based on USFS risk assessment worksheets developed by SERA, at an application rate of 1 lb a.e./acre of imazapyr, consumption of contaminated fruit by a small or large bird could result in acute exposure to dosages ranging from 0.5 to 127 mg a.e./kg bw/day, while consumption of contaminated grass could result in acute exposure to dosages ranging from 4.29 to 1,710 mg a.e./kg bw/day, with the highest end of the range being for small birds. Consumption of contaminated insects could expose small birds to acute dosages ranging from 4.38 to 224 mg/kg bw/day. Estimates of exposure from a small mammal being directly sprayed and then consumed by a carnivorous bird were 3.23 mg a.e./kg/bw/day. In terms of chronic exposure, consumption of contaminated fruits or grasses on-site could expose small or large birds to dosages ranging from 0.1 to 826 mg a.e./kg bw/day.

Almost all of these amounts fall far below the acute NOAEL of 2,510 mg a.e./kg bw or chronic NOAEL of 610 mg a.e./kg bw, except for the chronic exposure of small birds to contaminated grasses. The HQ for this exposure would be 1.4, which is just above the level of concern (1.0), however, SERA does not consider an exceedance of this magnitude to be of concern (SERA 2011b). Any consumption of grasses by small birds is unlikely to be that of the target species European beachgrass, which does not appear to be consumed by either wildlife or livestock, except for new vegetative growth or seed (deer mice; Department of Agriculture 1896; Pitts and Barbour 1979).

Under this alternative, mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have negligible effects on birds on a localized scale. Mowing would not be conducted until the fall, after nesting has been completed. By necessity, the rough terrain would keep the speed of the mowing unit down well below 10 mph, so birds within dense European beachgrass stands could flee prior to being struck or killed. However, there is a potential for some birds to freeze in response to disturbance.

Another pre-treatment measure that may be used is prescribed burning. As with mowing, prescribed burning would be conducted in the fall, after nesting is complete. Most birds would be able to escape a fire and would likely vacate the area when humans or UTVs approach. Impacts would be short-term, adverse and negligible for most species.

Based on these factors, including proposed impact avoidance and minimization measures, adverse impacts during and shortly following restoration would be negligible to possibly minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with minor impacts resulting from consumption of contaminated grasses by small birds, although the hazard quotient for this exposure is only slightly above the level of concern. Birds are unlikely to eat vegetative parts of the target grass species, European beachgrass.

Amphibians and Reptiles

Long-Term Effects

A more complete description of use of dune systems by amphibians and reptiles can be found under Alternative A. More information on the effect of restoration on amphibians and reptiles can be found under Alternative B. In general, Alternative C could have either beneficial or adverse effects on amphibians and reptiles, with the intensity of both types of effects increased relative to Alternative B. For certain reptiles, removal of European beachgrass and iceplant would appear to possibly benefit these species, while other amphibian and certain reptile species mainly occur in wetland and moist habitats and could be adversely affected by restoration over the long-term if restoration results in remobilization of sands.

Mechanical restoration often involves "flipping" of soil horizons, which decreases sand stability and can result in mobilization of sands into aquatic breeding and non-breeding habitat, upland habitat, and dispersal habitat. These impacts are not likely to direct impacts amphibians and garter snakes, because of the protracted timeframe over which sand movement occurs, but rather to result in loss of habitat over time, so impacts would be indirect. Where other restoration methods be used, impacts to amphibians and garter snakes would be expected to be much less (negligible at most) due to the fact that manual removal and chemical control tend to result in less destabilization of dune sands, and, therefore, wetland habitats within dunes and adjacent grasslands would be less directly impacted. Therefore, impacts of sand remobilization are more likely to occur under Alternative D than Alternative C, because mechanical removal is only used in buffer areas.

Overall, at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, there could be negligible adverse impacts for some of the more wetland-associated species, but other species may actually benefit over the long-term, with benefits ranging from negligible to minor. As these species occur in many habitats within the Seashore, there would either be no effect or very negligible impacts to park populations.

Implementation-Related and Short-Term Effects

Staging and Access: The impacts of staging and access would be very similar to those discussed under Alternative B, although the intensity of impact may be slightly increased due to the fact heavy equipment would potentially be used for removal in wetland and organic pasture buffer areas. Staging and access may have negligible adverse effects on amphibians and reptiles at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: The impacts of manual removal would be identical to those discussed under Alternative B, although the intensity may be reduced slightly due to the fact that manual removal would be primarily used for removal of iceplant and European beachgrass in wetland and buffer areas. Overall, these implementation-related impacts would be expected to be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: The largest implementation-related impacts to amphibians and reptiles would probably occur with mechanical removal due to use of heavy equipment and extensive turnover of soil horizons. Mechanical removal could result in death or injury to amphibians and reptiles, although those species that are more frequently found in wetlands would be less likely to be impacted, because no excavation would occur in wetlands, and stapled silt fence would be used to demarcate wetland boundaries. While not intended to prevent animal movement, the fence would likely help to keep amphibians and garter snakes out of mechanical work areas. For those animals in work areas, the slow speed at which mechanical removal takes place – 0.3 to 0.5 acre/day based on time required during Phase I at Abbotts Lagoon – would allow many of the reptiles and amphibians to escape the work area before direct impacts occurred, but they may be eaten by predators before they can reach new areas with high cover.

Few studies have found any impact on amphibians or reptiles from road noise, although vibrations are known to be used by some amphibian species to transmit social signals and avoid prey (Bowles 1995 *in* NPS 2009). Spadefoot toads in aestivation (warm weather hibernation) responded to motorcycles driving overhead by exiting their burrows during the wrong season of the year (FHWA 2004 *in* NPS 2009): Noise levels were very high (on the order of 94 dBA).

Overall, use of mechanical removal in buffers would be expected to have negligible to possibly minor adverse impacts on amphibian and reptile species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: Chemical control could also impact amphibians and reptiles. Similar to mechanical removal, chemical control would largely be used in European beachgrass stands and dense iceplant patches, both of which are unlikely to support amphibians and garter snakes. These areas constitute more non-breeding habitat, with most species using these areas for temporarily shelter, predator avoidance, and dispersal.

A very detailed description of the potential impacts of chemical control to California red-legged frog can be found in the *Special Status Species* section, and this discussion would be pertinent to potential impacts on others amphibian and garter snakes, as these species and red-legged frogs occupy similar habitat. Impact avoidance and minimization measures developed for red-legged frogs would also have benefits for these species. Measures include: establishment of no-spray buffers to both wetlands with red-legged frogs (60 feet) and wetlands without red-legged frogs (25 feet) and weather-related spray restrictions. Most of the spot spraying with herbicide would occur during the late summer and fall, when amphibians and other wetland-associated species are more likely to remain within moist wetland habitats and not be dispersing through drier dune areas. Some spraying could occur in the winter, but only if conditions are dry.

Due to the factors discussed above, including proposed impact avoidance and minimization measures, the potential for dune restoration to impact amphibians and reptiles would largely appear related to drift during spray operations and run-off from sprayed areas into adjacent wetlands. The potential for accidental contact to amphibians and garter snakes during spray operations appears extremely negligible due to the fact that sprayed areas are unlikely to be used by this species during the dry season, however, fence lizards may be inadvertently sprayed.

A more complete description of issues related to drift can be found under *Vegetation Resources*-Alternative C. In summary, based on USFS risk assessment worksheets developed by SERA, the proportion of glyphosate subject to drift drops dramatically even at 25 feet to 0.8% of total herbicide applied (0.03 lbs a.e./acre) and at 50 feet to 0.4% (0.017 lbs a.e./acre). Using similar worksheets for imazapyr (SERA 2011b), a similar proportion of this herbicide would drift with backpack application, but the volume was lower, ranging from 0.008 a.e./acre at 25 feet and 0.004 a.e./acre at 50 feet due to the lower total volume of imazapyr used. The potential for run-off would also be quite low due to the very sandy soils and moderate rainfall totals: "In areas with predominantly sandy soils, the runoff of imazapyr following foliar applications should be negligible" (SERA 2011b). The potential for impact associated with run-off would be further reduced by impact avoidance measures such as spraying during dry periods, not spraying 24 hours before a rainfall event with a 20% probability of occurrence, or 24 hours after a rainfall event. In addition, herbicide application methods emphasize avoidance of any drip of herbicide from foliage onto the ground.

Exposure of amphibians to herbicides has generated strong concerns in recent years due to a number of studies that have shown herbicide-associated adverse effects on frogs or reported observations of frogs in the field with various deformities. Use of glyphosate has been the cause of most of the concerns. Numerous studies address the acute lethal potency of glyphosate and glyphosate formulations to amphibians (SERA 2011a). For ecotoxicology purposes, glyphosate formulations are often separated into toxic and less toxic formulations. Most of the herbicide-related concerns for amphibians have revolved around use glyphosate formulations such as Round-Up® that incorporate the surfactant called POEA, which is considered to be more toxic than glyphosate itself (SERA 2011a). The park proposes to use aquatic-label glyphosate formulations such as AquaMaster® (now marketed as Round-Up Custom®), which is a less toxic glyphosate formulation known as glyphosate isopropylamine (IPA) that has no integrated surfactant.

In amphibians, the lesser toxicity of glyphosate IPA relative to other glyphosate formulations is well documented (SERA 2011a). Based on some of the available literature on glyphosate and its effects on amphibians and fish, the USEPA conducted an assessment is to evaluate potential direct and indirect effects on the red-legged frog arising from use of glyphosate and its salts on agricultural and non-agricultural sites (USEPA 2008). In general, most uses that would have resulted in "Likely to Adversely Affect" scenarios were those with higher application rates (e.g., 7.5 lbs a.e./acre in forestry settings); those using reduced application rates of particular formulations; and those where reduced application rates were applied via aerial spraying (~3.5 lbs a.e./acre; USEPA 2008). Use of glyphosate at application rates of 3.85 lb a.e./acre and below had no acute or chronic direct effects on aquatic or terrestrial habitats for red-legged frog (No Effect; USEPA 2008).

The USEPA also conducted a risk assessment on use of imazapyr and red-legged frogs (USEPA 2007). This risk assessment indicated that no direct effects wee expected on either the aquatic or terrestrial phase for red-legged frog, nor were there indirect effects expected for frogs through direct effects to either its terrestrial or aquatic food sources (No Effect; USEPA 2007). It did conclude that red-legged frogs might be adversely affected through direct effects on habitat or aquatic plant community and riparian vegetation (USEPA 2007). The assessment stated that these indirect risks exceeded the level of concern for non-listed, non-target aquatic plants (monocots and dicots) for all imazapyr uses (LAA; EPA 2007). However, some uses would not exceed the level of concern for terrestrial plants, including monocots and/or dicots exposed via spray drift following either ground and/or aerial application at ranges from 0.91 lbs a.e./acre to 1.5 lbs a.e./acre (USEPA 2007). As noted earlier, application rates proposed in terrestrial environments under this project would not exceed 1.0 lbs a.e./acre.

Terrestrial organisms or terrestrial phases of largely aquatic organisms such as amphibians would be the most likely to be affected by chemical control during dune restoration. The USEPA does not require standard toxicity studies on terrestrial phase amphibians or on reptiles (SERA 2011a). Typically, the USEPA and USFS risk assessments have characterized risks to terrestrial-phase amphibians as being similar to that for birds (SERA 2011a). As was discussed above under Birds, based on the proposed application rates for glyphosate and imazapyr, neither the acute or chronic NOAELs were exceeded for either small or large birds, except for chronic exposure of small birds to contaminated grasses, which resulted in a HQ of 1.4, which is slightly above the level of concern threshold (1.0).

For amphibians, there is very little information regarding the toxicity of surfactants that may be used with the less toxic formulations of glyphosate (SERA 2011a). One type of surfactant that would be used by the park, Competitor®, has only slight acute toxicity to aquatic organisms and is considered one of the least-toxic surfactants used as an herbicide adjuvant (PRI 2010). There is no information on the aquatic toxicity of the mixture of this surfactant with AquaMaster® (currently marketed as Round-Up Custom®), Garlon 4 Ultra®, or Transline® (PRI 2010).

Under this alternative, mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would be expected to have negligible to possibly minor effects on amphibians and reptiles, with higher intensity impacts occurring for reptile species such as fence lizards. Mowing would be conducted in the fall, when most amphibian and wetland-associated reptile species would likely remain in moister habitats that would not be mowed. By necessity, the rough terrain would keep the speed of the mowing unit down well below 10 mph, so amphibians and reptiles within dense European beachgrass stands could flee prior to being struck or killed. However, there is a potential for some animals to freeze in response to disturbance.

Another pre-treatment measure that may be used is prescribed burning. As with mowing, prescribed burning would be conducted in the fall, when most amphibian and wetland-associated reptile species would likely remain in moister habitats that would not be mowed. There would be a 20-foot buffer between wetlands and prescribed burning. Slower moving animals, such as crawling amphibians and reptiles, may be unable to outrun a prescribed fire and would be killed. Impacts would be short-term, adverse and minor for most species.

Based on these factors, including proposed impact avoidance and minimization measures, adverse impacts during and shortly following restoration would be negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with minor impacts resulting from mowing and prescribed burning activities.

Other Species

A more complete description of use of dune systems by terrestrial invertebrates and fish can be found under Alternative A. More information on the effect of restoration on use of these systems by terrestrial invertebrates and fish can be found under Alternative B.

In general, Alternative C could have negligible to possibly moderate benefits for terrestrial invertebrates on a localized scale, including at AT&T and B Ranch, with the intensity of benefits increased relative to Alternatives B, A, and possibly D. Overall, there could be negligible benefits to these species on a park-wide scale.

While mechanical removal would pose the most potential impact due to the extensive flipping of sand horizons where burrowing insects may live, arthropod communities, as noted above, are likely to be lower in dense European beachgrass stands and iceplant areas than in adjacent native dune vegetation communities, which would be off-limits to heavy equipment.

There is a detailed discussion on potential impacts of chemical control on terrestrial invertebrates under *Special Status Species*, Animal Species of Special Concern. The park would attempt to conduct operations as much as possible outside of the flight season for the Myrtle's silverspot butterfly, which extends from June 15 through August 31. This should also have benefits for other terrestrial invertebrates. Potential impacts to terrestrial invertebrates include accidental spraying of individuals; foliar spray onto food sources; and drift of herbicide onto food sources. European beachgrass or iceplant are not known food or nectar sources for any terrestrial invertebrates, but this has not been fully studied in California dune ecosystems or other ecosystems outside these plants' natural ranges. There is a potential for accidental over-spray or drift onto non-target nectar or host plant sources, although these impacts would not occur in the larger Dune Mat or Dune Scrub areas, where there is the highest density of nectar sources.

In summary, the USFS risk assessment study concluded that, "while risks to honeybees (surrogate organism for terrestrial invertebrates) from a direct spray cannot be excluded at the highest application rate (8 lbs a.e./acre of more toxic glyphosate formulation), the effects would not be substantial and probably would not be detectable" (SERA 2011a).

The same is not necessarily true of oral toxicity. Using proposed application rate of 4 lbs a.e./acre and the USFS worksheets developed by SERA, the acute risk from ingesting fruit contaminated by glyphosate would range from 7.68 to 132 mg a.e./kg bw, which is well below the level the NOAEL threshold of 860 mg a.e./kg bw. However, consumption by terrestrial invertebrates of contaminated insects or grasses lead to a much broader – and more elevated range – for acute exposure that ranged from 36.0 to 2,110 mg a.e./kg bw. The upper part of the range exceeds the NOAEL threshold, with the highest dosage numbers being for consumption of broadleaf plants, insects, and short grasses: the central value, however, did not exceed the NOAEL for any of these food sources. As was noted in SERA (2011a), application rates of as low as 1.4 and 1.7 lbs a.e./acre of glyphosate could pose concerns for invertebrates that consume broadleaf vegetation and long grass plant species, respectively (SERA 2011a). While one of the target species includes a grass (European beachgrass), it is unclear that any of the terrestrial invertebrates eat this species, so risks may come from primarily from accidental spraying of non-target plants or insects.

For imazapyr, the oral and contact toxicity threshold for worker bees corresponds to about 860 mg a.e./kg bw, which is comparable to the NOAEL values reported for experimental mammals and birds (SERA 2011b). Exposure levels for honeybees are typically far below

860 mg a.e./kg bw, both for contact with and ingestion of contaminated vegetation (SERA 2011b). This apparently low acute toxicity is consistent with the toxicity data on mammals and birds (SERA 2011b). Using the same modeling approach for imazapyr, the acute risk from ingesting contaminated fruit would range from 1.92 to 33 mg a.e./kg bw, which is also well below the level the NOAEL threshold of 860 mg a.e./kg bw.

Mowing may be used before and after chemical treatment. Mowing would be expected to have negligible to possibly minor effects on terrestrial invertebrates on a localized scale, with higher intensity impacts occurring for non-flying insects. In keeping with impact avoidance and minimization measures for Myrtle's silverspot, mowing would not be conducted within the butterfly's flight season, which should reduce impacts for other terrestrial invertebrates, as well. By necessity, the rough terrain would keep the speed of the mowing unit down well below 10 mph, so many invertebrates within dense European beachgrass stands could flee prior to being struck or killed. However, some invertebrates would be injured or killed. Prescribed burning may also be used as a pre-treatment measure and would also have possibly minor effects.

Based on these factors, adverse impacts from implementation would be characterized as negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Adverse impacts from staging and access would be negligible at these project areas.

Fish species would typically only occur in adjacent open water bodies such as Estero de Limantour or in marshes in adjacent wetlands due to the ephemeral nature of most Dune Swale wetlands. Implementation would be expected to have very negligible impacts on fish communities within adjacent water bodies at Limantour. Over the long-term, dune restoration would be expected to have no effect on the park's fish populations.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wildlife would be the same as described under Alternative A. From a regional perspective, based on the scale of projects conducted historically in the park and proposed outside the park, the proposed dune restoration efforts would likely have very negligible adverse and possibly even negligible beneficial effects on wildlife species within the region, as most of the species are common ones that occur in a diverse number of habitats.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, although it would also incorporate manual and mechanical removal potentially.

Under Alternative C, dune restoration could provide negligible to possibly moderate benefits for certain species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. These include certain small mammal, reptile, passerine bird, and sand-burrowing arthropod species. For other species, dune restoration may offer no benefit and could, for some, have negligible to minor adverse impacts. Higher intensity impacts result from the fact that European beachgrass and iceplant may provide more cover and habitat for certain species such as deer mice and brush rabbits, thereby artificially inflating populations of these and potentially other small and medium-sized mammal species. Larger populations of deer mice and rabbits would attract potentially higher numbers of predatory species such as raptors and mammals such as coyotes, fox, and bobcats. Negligible adverse impacts could also occur if sand remobilization impacts wetlands used seasonally by waterfowl or shorebirds. No long term effects would be expected on marine mammals such as California sea lion, harbor seals, and northern elephant seals, which may occur on beaches adjacent to project areas.

While possibly affecting abundance of these species on a localized scale, removal of European beachgrass and iceplant would restore more natural population dynamics and could possibly even benefit other species that have been preyed upon by higher than normal numbers of carnivores, including western snowy plovers and other bird species. In addition, as almost all of these wildlife species occurs in multiple habitats both within and outside the park, restoration efforts would be expected to have almost no effect to a very negligible effect on populations of these species within the Seashore and local region.

For some of the wetland-associated species such as amphibians, certain reptiles, and visiting waterfowl and shorebirds, dune restoration is unlikely to have measurable benefits for their wetland habitat, which occurs in the dunes themselves (Dune Swales) or in adjacent grasslands (Freshwater Marsh). Removal of invasives could destabilize the sand dunes surrounding Dune Swales or Freshwater Marshes, although the potential for this is reduced relative to Alternative D due to the fact that mechanical removal would not be the primary removal method. Under this alternative, there would be the potential for negligible adverse effects long-term on wetland-associated species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, but as these species occur in many habitats throughout the park, there would only a very negligible effect on a park-wide scale.

Implementation, staging, and access could have negligible to moderate adverse impacts on wildlife species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Higher intensity (minor) implementation-related and short-term impacts could result from injury or death to small and medium-sized mammals and amphibians and reptiles during mowing and prescribed burning activities and consumption of contaminated grasses by small birds, although the hazard quotient for this exposure is only slightly above the level of concern. Birds are unlikely to eat vegetative parts of the target grass species, European beachgrass.

Based on the scale of other dune restoration projects proposed within the region, cumulative adverse and beneficial effects of these projects with those that may be conducted under Alternative C would have no more than a very negligible beneficial or adverse impact to these wildlife species on a regional scale.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour by using primarily a mechanical approach to remove European beachgrass. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

As was discussed in the Affected Environment section of this document, species diversity and abundance of small terrestrial vertebrates and mammals within the Seashore's dunes is probably lower than that of other habitats within the park (Fellers and Pratt 2002). However, based on published and unpublished information, a range of species do use these habitats, including terrestrial invertebrates, small terrestrial vertebrates, mammals, birds, and, in adjacent open water habitats, fish.

Small Terrestrial Mammals

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on small terrestrial mammals can be found under Alternatives B and C. In general, with expanded removal of European beachgrass and iceplant and use of mechanical removal, there could be greater impact to deer mice populations, particularly relative to Alternative B and even possibly relative to Alternative C. Potential benefits for other small mammals would possibly be reduced relative to Alternative C due to the fact that increased costs of restoration using this method may reduce the amount of restoration performed. Also, mechanical removal – even at a smaller scale – would be more likely to impact small mammals due to the intensive disturbance associated with "flipping" sand horizons.

Based on these factors, Alternative D could have minor to possibly moderate long-term adverse effects for deer mice at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. There may also possibly be adverse effects for other small mammals, although removal of at least iceplant would provide negligible to possibly minor benefits for some of these species based on recent studies (Russell et al. 2009). Restoration may also restore a more natural dynamic to small mammal populations at these project areas, although benefits would be reduced relative to Alternative C. As these species occur in many other habitats at higher abundances, adverse impacts would have only very negligible to almost no effect on park populations of these species.

Implementation-Related and Short-Term Effects

Staging and Access: The impacts of staging and access would be very similar to those discussed under Alternative C, although the intensity of impact may be greater as mechanical removal would be the primary removal method, and more equipment would need to be transported to and staged at project areas. Staging and access may have negligible to minor adverse effects on small mammals at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: The impacts of manual removal would be identical to those discussed under Alternative B, although the intensity may be decreased due to the fact that manual removal would only be used for removal of iceplant and European beachgrass in buffers and wetlands. Overall, these implementation-related impacts would be expected to be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: The impacts of mechanical removal would be similar to those discussed under Alternative C, although the intensity may be increased considerably due to the fact that mechanical removal would be the primary removal method. Overall, use of mechanical removal would be expected to have minor to moderate adverse impacts on small mammal species that frequent dune areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: The impacts of chemical control would be very similar to those discussed under Alternative C, although the intensity may be reduced relative to that alternative. Under Alternative D, chemical control would primarily be used for re-treatment with spot spraying of re-growth in mechanical removal areas. Based on the factors discussed here and under Alternative C, adverse impacts during and shortly following restoration would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Large Mammals

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on large terrestrial mammals can be found under Alternatives B and C. In general, under Alternative D, there would be greater long-term adverse impacts to medium-sized mammals such as brush rabbits or carnivores that prey upon the unnaturally high densities of deer mice and possibly other small mammals within dense European beachgrass and iceplant stands than under Alternatives B and C. For other species such as mule deer, decreases -– or increases -- in invasive, non-native plants would not appear to impact their use of dune habitats. Marine mammals such as California sea lion, harbor seals, and northern elephant seals may also occur on beaches adjacent to project areas such as at Limantour, but no long-term effects would be expected from dune restoration efforts.

Based on these factors, Alternative D would be expected to have either no effect (large herbivores, marine mammals) or minor to possibly moderate long-term adverse effects (small herbivores, carnivores) at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. However, as these species occur in many other habitats at higher abundances, even adverse impacts would have only very negligible to almost no effect on park populations of these species.

Implementation-Related and Short-Term Effects

Staging and Access: The impacts of staging and access would be very similar to those discussed under Alternative C, although the intensity of impact may be greater as mechanical removal would be the primary removal method, and more equipment would need to be transported to and staged at project areas. Staging and access may have negligible to minor adverse effects on larger mammals at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: The impacts of manual removal would be identical to those discussed under Alternative B, although the intensity may be decreased due to the fact that manual removal would be used primarily for removal of iceplant and European beachgrass in wetlands and buffer areas. Overall, these implementation-related impacts would be expected to be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: The impacts of mechanical removal would be similar to those discussed under Alternative C, although the intensity may be increased considerably due to the fact that mechanical removal would be the primary removal method. Overall, use of mechanical removal would be expected to have minor to possibly moderate adverse impacts on large mammal species frequenting dune areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: The impacts of chemical control would be very similar to those discussed under Alternative C, although the intensity may be reduced relative to that alternative. Under Alternative D, chemical control would primarily be used for re-treatment with spot spraying of re-growth in mechanical removal areas. Based on these factors and those discussed under Alternative C, including proposed impact avoidance and minimization measures, adverse impacts during and shortly following restoration would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Birds

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on birds can be found under Alternatives B and C. In general, dune restoration could have both adverse and beneficial long-term effects on birds, although the intensity of both types of effects would be increased relative to Alternative B. Predatory bird species could be impacted more under this alternative than Alternative B and possibly even Alternative C by reductions in prey populations (e.g., small mammals such as deer mice) associated with extensive flipping of dune soils during mechanical removal, even though the total extent of restoration may be reduced relative to Alternative C.

Passerine birds could also be benefitted by increases in nesting habitat such as native Dune Mat and Dune Scrub vegetation, and shorebirds would benefit from higher quality foredune and nearshore habitats. However, these benefits would probably be reduced relative to Alternative C due to the reduction in area restored. In addition, over the long-term, mechanical removal of European beachgrass could adversely impact wetland communities that support waterbirds during wetter periods by increasing sand remobilization, although efforts would be made to actively revegetate backdune areas to minimize remobilization.

Therefore, depending on the species, this alternative could have either negligible to possibly minor beneficial effects or negligible to minor adverse effects over the long-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. As these species occur within many different areas of the park, these actions would have negligible to no effect on park populations of these species.

Implementation-Related and Short-Term Effects

Staging and Access: The impacts of staging and access would be very similar to those discussed under Alternative C, although the intensity of impact may be greater as mechanical removal would be the primary removal method, and more equipment would need to be transported to and staged at project areas. Staging and access may have negligible to possibly minor adverse effects on birds at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: The impacts of manual removal would be identical to those discussed under Alternative B, although the intensity may be reduced slightly due to the fact that manual removal would primarily be used for removal of iceplant and European beachgrass in wetland and buffers. Overall, these implementation-related impacts would be expected to be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: The impacts of mechanical removal would be very similar to those discussed under Alternative C, although the intensity may be increased considerably due to the fact that mechanical removal would be the primary removal method. Overall, use of mechanical removal in buffers would be expected to have minor adverse impacts on bird species frequenting dune areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: The impacts of chemical control would be very similar to those discussed under Alternative C, although the intensity may be reduced relative to that alternative. Under Alternative D, chemical control would primarily be used for re-treatment with spot spraying of re-growth in mechanical removal areas. Based on these factors, adverse impacts during and shortly following restoration would be negligible to possibly minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour with very minor impacts resulting from consumption of contaminated grasses by small birds, although the hazard quotient for this exposure is only slightly above the level of concern. Birds are unlikely to eat vegetative parts of the target grass species, European beachgrass. While the HQ is slightly above concern, the potential for impact would be reduced relative to Alternative C due to the fact that herbicide would only be used for re-treatment.

Amphibians and Reptiles

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on amphibians and reptiles can be found under Alternatives B and C. In general, Alternative D could have either beneficial or adverse effects on amphibians and reptiles, with the intensity of both types of effects increased relative to Alternative B and possibly Alternative C. For certain reptiles, removal of European beachgrass and iceplant would appear to possibly benefit these species, while other amphibian and certain reptile species mainly occur in wetland and moist habitats and could be adversely affected by restoration over the long-term if restoration results in remobilization of sands. This impact is more likely to occur under Alternative D than Alternative C, although efforts would be made to actively revegetate at least backdune areas to minimize sand remobilization.

Overall, at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, there could be negligible to minor adverse impacts for some of the more wetland-associated species, but other species may actually benefit over the long-term, with benefits ranging from negligible to possibly minor. As these species occur in many habitats within the Seashore, there would either be no effect or very negligible impacts to park populations.

Implementation-Related and Short-Term Effects

Staging and Access: The impacts of staging and access would be very similar to those discussed under Alternative C, although the intensity of impact may be greater as mechanical removal would be the primary removal method, and more equipment would need to be transported to and staged at project areas. Staging and access may have negligible to minor adverse effects on amphibians and reptiles at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: The impacts of manual removal would be identical to those discussed under Alternative B, although the intensity may be reduced slightly due to the fact that manual removal would be primarily used for removal of iceplant and European beachgrass in wetland and buffer areas. Overall, these implementation-related impacts would be expected to be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: The impacts of mechanical removal would be very similar to those discussed under Alternative C, although the intensity may be increased considerably due to the fact that mechanical removal would be the primary removal method. Overall, use of mechanical removal would be expected to have minor to possibly moderate adverse impacts on amphibians and reptiles at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: The impacts of chemical control would be very similar to those discussed under Alternative C, although the intensity may be reduced relative to that alternative. Under Alternative D, chemical control would primarily be used for re-treatment with spot spraying of re-growth in mechanical removal areas. Based on these factors and those discussed under Alternative C, adverse impacts during and shortly following restoration would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Other Species

A more complete description of the long-term impacts associated with restoration on terrestrial invertebrates and fish can be found under Alternatives B and C.

In general, Alternative D could have negligible to minor benefits for terrestrial invertebrates at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with the intensity of benefits increased relative to Alternative B.

Implementation-related and short-term impacts to terrestrial invertebrates could occur from chemical control and, to a lesser extent, staging, access, and manual and mechanical removal. Contact toxicity from herbicides does not appear to be a concern, but oral toxicity when contaminated broadleaf plants, grasses, and insects are consumed by terrestrial invertebrates does appear to be of some potential concern, at least for glyphosate, if not for imazapyr, at least under extreme circumstances. Based on these factors and others discussed under Alternative C, adverse impacts from implementation would be estimated at negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Minor impacts would result from extensive flipping of dune soils during mechanical removal, although arthropod communities are probably relatively depauperate in dense European beachgrass stands (Slobodchikoff and Doyen 1977). Adverse impacts from staging and access would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Fish species would typically only occur in adjacent open water bodies such as Estero de Limantour or in marshes in adjacent wetlands due to the ephemeral nature of most Dune Swale wetlands. Implementation would be expected to have negligible impacts on fish communities within adjacent water bodies at Limantour. Over the long-term, dune restoration would be expected to have no effect on the park's fish populations.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wildlife would be the same as described under Alternative A. From a regional perspective, based on the scale of projects conducted historically in the park and proposed outside the park, the proposed dune restoration efforts would likely have negligible adverse and beneficial effects on wildlife species within the region, as most of the species are common ones that occur in a diverse number of habitats.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Under Alternative D, dune restoration could provide negligible to possibly minor benefits for certain wildlife species within the project areas. These include certain small mammal, reptile, passerine bird, and sand-burrowing arthropod species. For other species, dune restoration may offer no benefit and could, for some, have negligible to possibly even moderate adverse impacts. Higher intensity impacts result from the fact that European beachgrass and iceplant may provide more cover and habitat for certain species such as deer mice and brush rabbits, thereby artificially inflating populations of these and potentially other small and medium-sized mammal species. Larger populations of deer mice and rabbits would attract potentially higher numbers of predatory species such as raptors and mammals such as coyotes, fox, and bobcats. Minor adverse impacts could also occur if sand remobilization impacts wetlands used seasonally by waterfowl or shorebirds. Marine mammals such as California sea lion, harbor seals, and northern elephant seals may also occur on beaches adjacent to project areas such as at Limantour, but no long-term effects would be expected from dune restoration efforts.

While possibly affecting local abundance of these species, removal of European beachgrass and iceplant at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would restore more natural population dynamics and could possibly even benefit other species that have been preyed upon by higher than normal numbers of carnivores, including western snowy plovers and other bird species. The intensity of this benefit under Alternative D would be reduced relative to Alternative C due to the fact that the scale of restoration would be smaller within the project areas. As almost all of these wildlife species occurs in multiple habitats both within and outside the park, restoration efforts would be expected to have almost no effect to a very negligible effect on populations of these species within the Seashore and local region.

For some of the wetland-associated species such as amphibians, certain reptiles, and visiting waterfowl and shorebirds, dune restoration is unlikely to have measurable benefits for their wetland habitat, which occurs in the dunes themselves (Dune Swales) or in adjacent grasslands (Freshwater Marsh). Removal of invasives could destabilize the sand dunes surrounding Dune Swales or Freshwater Marshes, and the potential for this is increased under Alternative D relative to Alternative C due to the fact that mechanical removal would be the primary removal method, although active revegetation would be conducted in backdune habitats to minimize sand remobilization. Under this alternative, there would be the potential for negligible to minor adverse effects long-term on wetland-associated species, but as these species occur in many habitats throughout the park, there would only a very negligible effect or no effect on a park-wide scale.

Implementation, staging, and access could have negligible to moderate adverse impacts on any of these wildlife species at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Higher intensity implementation-related and short-term impacts (moderate) could result from injury or death to small and medium-sized mammals and amphibians and reptiles during mechanical removal activities.

Based on the scale of other dune restoration projects proposed within the region, cumulative adverse and beneficial effects of these projects with those that may be conducted under

Alternative D would have no more than a very negligible beneficial or adverse impact to these wildlife species on a regional scale.

Natural Physical Processes and Soils

Policies and Regulations

Relevant sections of the Park Service *Management Policies 2006* regulate soils and shoreline processes. Shoreline processes, including erosion, deposition and dune formation are to be continued without interference. Where human activities have altered the nature or rate of a natural shoreline process, the Park Service is to investigate alternatives to mitigate the effects of those activities and to restore natural conditions (Section 4.8.1.1).

Assessment Methodology

An assessment of how the proposed alternatives would affect natural physical processes, response to climate change, and soils was performed by reviewing the available literature on effects of other dune restoration projects, as well as information on effects of projects conducted historically within the Seashore.

Potential changes in dune processes and the systems' ability to respond to pressure from climate change are only evaluated as long-term impacts. With the possible exception of continued expansion of European beachgrass and iceplant into uninvaded areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, while changes to soils can be either immediate, short-term (~3 years), or long-term.

Context, Duration and Impact Thresholds

The standardized definitions of each of these factors as described at the beginning of Chapter 4.0 was used to evaluate impacts to natural physical processes, response to climate change, and soils.

Impacts of dune restoration and sand movement on vegetation communities, wetlands, and adjacent ranchlands are also discussed under *Vegetation Resources*, *Water Resources*, and *Adjacent Land Use* sections, respectively.

Impact of Alternative A

Analysis

Under Alternative A, no near-term dune restoration projects would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Dune Processes and Response to Climate Change

As was discussed under Affected Environment, one of the primary differences between natural or native dunes and dunes heavily colonized by European beachgrass is the rate of sand movement, as species such as beachgrass and iceplant were planted to stabilize dunes and prevent encroachment into adjacent lands. In Humboldt, research found that natural parabolic dunes migrated on average 4.7 feet/year between 1939 and 1988, while some other parabolic dunes and transverse dunes moved as much as 15 to 21 feet/year (Wiedemann

1984; Pacific Watershed Associates 1991). Sand movement rates would be naturally lower in invaded dune, as these species were plant to stabilize these systems, although, somewhat surprisingly, there is not much quantitative information on dune movement rates in European beachgrass-dominated dunes. In England, where European beachgrass is native, rates of inland movement of the dunes varied between 5-10 feet/year on the more stable dune sections and up to 22 feet/year on the most mobile dune sections (Ranwell 1958).

While European beachgrass and iceplant were planted to stop movement of the dunes, the dunes have continued to migrate inland over the past 60- 70 years despite rapid expansion of these species based on results of aerial imagery review. Inland movement rates for dunes between 1943 and 2007 varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual inland expansion rates for coastal dunes during this period of 0.25% to 0.91% (Johnson 2013a). (A dune restoration project was recently conducted at Abbotts Lagoon adjacent to G Ranch, while AT&T and B Ranch dunes are two of the project areas proposed for potential future restoration.) Dune represents varying percentages of the total leased lands for different ranches, ranging from as low as 2% at G Ranch –- most of the dune system is outside the lease boundary at this ranch –- to 24% at AT&T, with B Ranch estimated at 22% (Johnson 2013a).

In fact, based on historic aerial imagery, the proportion of barren, sandy areas within the G Ranch leased/permit pastures appears actually lower in 2013 – even with sand remobilization from recent restoration – than in 1963 (Johnson 2013a). In general, sand movement since 2011 has tended to follow established historical sand deposition paths as evidenced by the fact that most of the ungrazeable areas buried were pre-existing dune "fingers" that extended into the pasture, which were already very sandy and dominated by dune and scrub type species. In the 1960s, two decades after European beachgrass was planted at Abbotts, these fingers are very distinguishable on aerial imagery as barren, sandy areas (Johnson 2013a). Over the next 30- to 40 years, these fingers remained within the pasture, but became sparsely vegetated by dune and dune scrub plant species, as can be seen in 2010 aerial imagery (Johnson 2013a). While there has been an inland creep from the perimeter of the mechanical removal area, this creep has largely been burying areas that have already been repeatedly buried by sand in the past, with some very minor (<1 acre) exceptions. Some of the movement post-restoration may have been influenced by the two successive dry winters and the fact that dry winters reduce establishment by stabilizing vegetation and are accompanied by higher winds that further discourage vegetation establishment (Baye 2008).

Sand movement rates can also be affected by differing physiology of European beachgrass in foredune and backdune areas. As active burial stimulates European beachgrass rhizome growth, rhizomes are deeper in the foredunes, where sand is more actively deposited, than in the reardunes (Baye 2008). Over decades, the internal fabric of interbedded European beachgrass roots and rhizomes in stabilized backdune areas begins to decay, particularly at lower depths, so backdune sands may be more susceptible to wind movement, although, because they are distant from the shore and are protected somewhat by the foredune, they are typically not subject to as high wind speeds or sand accretion as the foredune (Baye 2008).

The forces shaping dune spits are slightly different. Inland movement of sands on spits typically results in a series of hooked curves or "ends" that transgress into open water bodies or salt marshes that have established in the sheltered embayment.

Without restoration, European beachgrass and iceplant would be expected to continue to expand within the dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. With expansion, the natural structure of foredunes and backdunes would continue to be degraded by the soil-altering properties of these two invasive species. Monotypic stands of beachgrass and iceplant would also prevent the dunes from migrating in response to wind and wave pressure, and coastal dune acreage would likely decrease within these project areas as a result due to increased erosion: coastal erosion of dune terraces and cliffs is already noticeable at the Davis Property. Based on these factors, under Alternative A, there could be negligible to possibly minor adverse effects in the future to natural dune and spit physical processes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with the intensity of impact dependent on how much sand movement occurs even in areas where beachgrass and iceplant are present.

Soils

There would be no more than a very negligible adverse effect on soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour from the continued expansion of European beachgrass and iceplant, as these species already cover a large percentage of these project areas.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on natural physical dune processes, response to climate change, and soils would be restoration of coastal dunes at Bodega Marine Laboratory in Sonoma County, continued restoration of coastal dunes at Tom's Point in Marin County, possible dune restoration at Lawson's Landing, and small-scale dune restoration efforts being conducted as part of the Muir Beach Restoration Project at GGNRA. The Wildlife Protection and Habitat Improvement Plan proposed by MMWD would principally affect higher-elevation vegetation communities such as oak woodland and grassland habitat that have been invaded by non-native brooms or invasive species, so it would likely have no cumulative effect with this project. Actions in the park that may have cumulative effects on natural physical dune processes, response to climate change, and soils include other types of habitat restoration –- including those also using chemical control – and maintenance and upgrade of park facilities near coastal areas.

From a regional perspective, based on the scale of projects proposed outside the park, Alternative A would likely have very negligible to negligible adverse long-term effects on natural dune physical processes, soils, and the response of coastal areas to climate change within the region.

Conclusions

Under Alternative A, no near-term dune restoration projects would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Based on fact that European beachgrass and iceplant would continue to expand, over the long term, this alternative would have negligible to possibly minor adverse impacts on natural dune processes and the ability of the dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to respond positively to climate change impacts. Continued expansion of European beachgrass and iceplant would also adversely affect soils, but intensity of this impact within these projects would be very negligible due to highly invaded conditions already present.

From a regional perspective, based on the scale of projects proposed outside the park, Alternative A would likely have very negligible to negligible adverse long-term effects on natural dune physical processes, soils, and the response of coastal areas to climate change within the region.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Dune Processes and Response to Climate Change

A description of the long-term impacts associated with continued expansion of European beachgrass and iceplant in unrestored areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour on natural dune physical processes, response to climate change, and soils can be found under Alternative A.

In areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour where European beachgrass and iceplant are removed, the rate of inland sand movement should increase, which will help to maintain an intact coastal dune system in the face of increased coastal erosion pressure from sea level rise and higher intensity storm surge events. The intensity and immediacy of this inland progradation would be strongly dependent on many factors, including removal methods and weather conditions. As was discussed under Affected Environment, one of the primary differences between natural or native dunes and dunes heavily colonized by European beachgrass should be the rate of sand movement, although there is no definitive information available on movement rates in invaded and uninvaded systems. As was discussed under Alternative A in more detail, dunes within the Seashore have continued to migrate inland even after planting of European beachgrass and iceplant more than 60- to 70 years ago. Inland movement rates for dunes between 1943 and 2007 varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual inland expansion rates for coastal dunes during this period of 0.25% to 0.91% (Johnson 2013a).

Restoration can result in more sand movement, depending on the approach used. Most of the information available on inland migration after restoration comes from projects involving mechanical removal, with a Humboldt County project reporting rates of 2.5 feet per month (Vaughan and Fiori 2007). Monitoring of the recent mechanical removal project at Abbotts Lagoon showed that inland "creep" of dunes totaled approximately 7.3 acres, with 4.1 or approximately 75% of that creep occurring in areas that had already been previously buried by sand through dune migration (Johnson 2013a). More detail on these mechanical removal projects can be found under Alternative C. Information on sand movement after manual removal of European beachgrass and iceplant is scant: within the park, the only incident reported involved potential remobilization of sands following a iceplant hand removal project in the Point Reyes Headlands that may have caused burial of a portion of Sir Francis Drake Boulevard, but maintenance records show that removal of sands from the road occurred even prior to the restoration project and that frequency of removal has not necessarily increased since restoration was conducted.

Because of the vast amounts of sand stored in these vegetatively stabilized features, the Seashore's dunes may never totally evolve back towards a more natural dune structure, even with restoration, as the larger-than-natural volume of sand present may pose a challenge to development of a more natural structure with discontinuous, hummocky foredunes and strongly defined blow-outs and dune slacks. However, remobilized sands do increase the potential for dune systems at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to persist in the face of climate change pressures through inland migration at varying rates, although unrestored dunes within these projects (or in other dunes within the Seashore) could still be lost to increased erosion in the future.

Based on the extent of restoration that may be implemented under this alternative, over the long term, this alternative would have very negligible to negligible benefits on natural dune processes and the ability of dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to respond positively to climate change impacts. The emphasis on manual removal would result in fewer acres being restored within the project areas. Also, manual removal is particularly ineffective in restoring foredune areas dominated by European beachgrass due to the fact that only 1.5- to 3 feet can reasonably be excavated by hand, and rhizomes in these areas extend down as deep as 6 to 12 feet, leaving considerable material for re-establishment of beachgrass once treatment is complete. The degree of benefit to natural physical processes may be further reduced by the fact that active revegetation would be conducted in backdune area to minimize sand remobilization.

Soils

Restoration can also have long-term effects on soil nutrients and biota, and restoration method can affect the type and intensity of effect.

Staging and Access: More than half of the primary staging and access would occur in adjacent grasslands or scrub communities, some of which are used as pastures for cattle, or in asphalt parking lots or park access roads. In general, impact avoidance and minimization measures call for the preferential use of existing ranch and park roads before establishment of any new primary access roads. However, even use of existing ranch access roads can increase compaction of soils. Most of the adjacent lands fall on relatively sandy soil types such as Sirdrak Sand or other Sirdrak types. Due to the higher bulk density of sandy soils, these types of soils are less susceptible to compaction issues than loams or clay soils. In general, the degree of potential compaction may be strongly related to the type of removal method that would be used. Manual removal projects would lead to the least amount of soil compaction, as the only vehicles would be personal vehicles or trucks for crew transport. While compaction can be alleviated through ripping or other mechanical methods, the Seashore does not typically endorse use of these methods as they tend to result in rapid germination and establishment of disturbance-adapted weeds.

Additional impacts to soils may result from grading to create any necessary primary access roads and staging areas.

These same soils, including those along access routes, may be contaminated with fuel or oil in the case of an uncontained spill or leaking equipment. However, equipment would be regularly inspected, and the staging area would be managed using Best Management Practices, which includes requiring that fueling be conducted in areas with an impermeable lining or some other barrier to minimize contamination of fuels into the soils.

Potential long-term adverse impacts to soils from staging and access under this alternative would generally be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with no effect expected where asphalt parking lots and roads are used for staging and access.

Manual Removal: Manual removal would generally involve shallow turnover of soils, although the turnover would be deeper for areas where European beachgrass is removed (at least 1.5 feet) than areas where iceplant would be removed (~0.5 feet). This shallow excavation could increase nutrient turnover in soils, increasing organic nutrients, as well as inorganic nutrients that are eventually produced through breakdown of organic matter. In general, shallow excavation could have some impacts on soil biota, including mycorrhizal fungi, bacteria, pathogens, and other organisms that may aid or dissuade establishment of native dune plant species. A short-term pulse in organic nutrients could promote establishment of more weedy, annual species. Once established, these weedy annual exotics could create a labile litter that completely turns over organic matter and nitrogen, favoring persistence of weedy annuals (Zink et al. 1995). Conversely, over time, these species could give way to more native dune species if nutrient levels drop off.

No information readily exists on the impacts of European beachgrass on soil properties. However, there has been considerable research on the impacts of iceplant on soils. Iceplant-invaded soils appear to have higher organic matter content, and lower pH than uninvaded areas (D'Antonio and Mahall 1991, de la Peña et al. 2010, Santoro et al. 2011) and, in some areas, organic carbon (Vilà et al. 2006): this may be partially due to the much higher amounts of detritus produced by this species (Vilà et al. 2006). Iceplant leaves have high contents of tannin and antibacterial compounds that may reduce litter decomposition rates (Van der Watt & Pretorius 2001 *in* Vila et al. 2006) and leach into the soils. This leachate may acidify dune soils, which inhibits nitrification (conversion of ammonium to nitrate) and increases leaching of calcium and magnesium (D'Antonio and Haubensak 1998, D'Antonio and Mahall, unpub. *in* Conser and Connor 2009). Soil acidification occurs naturally with dune succession, but iceplant invasion speeds up this process (D'Antonio and Mahall, unpub. *in* Conser and Connor 2009). Changes in soil nutrient content appeared more variable, with some studies showing an increase in total nitrogen (Santoro et al. 2011), some showing a decrease (D'Antonio and Mahall, unpub. data *in* Conser and Connor 2009) and some showing no change at all (Vilà et al. 2006).

If dense iceplant patches are removed by hand, with the iceplant rolled up like a carpet, the thick duff layer may remain and continue to negatively affect soils. Even if the duff layer is removed, soils may still remain highly altered relative to native dune soils. Studies conducted in Spain suggested that success of removal efforts could be compromised by lingering allelopathic effects (Novoa et al. 2012). These soil changes may preclude re-establishment of certain types of native dune vegetation communities, such as primary or mid-successional ones, and ultimately favor later successional ones or even Dune Scrub. In areas where native dune exists with iceplant, the presence of iceplant appears to drive the successional status of native dune "pockets" towards a more mature, late successional community supporting species such as dune buckwheat, dune sagebrush, sea thrift, gumplant, sand mat, and woolly lotus.

Over the long-term, manual removal would be expected to have very negligible to possibly minor benefits for dune soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour relative to unrestored conditions, with more benefits expected at B Ranch, A

Ranch, and Davis Property due to the fact that iceplant is the dominant there and can be more successfully removed by hand. Even in restored iceplant areas, however,soils may not entirely revert back to uninvaded conditions that would support earlier successional Dune Mat vegetation communities.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on natural physical dune processes, response to climate change, and soils would be the same as described under Alternative A. From a regional perspective, based on the scale of projects proposed within and outside the park, Alternative B would likely have very negligible beneficial long-term effects on natural dune physical processes, soils, and the response of coastal areas to climate change within the region.

Conclusions

Restoration under this alternative would primarily use manual methods to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket and bush lupine at AT&T/North Beach, B Ranch/A Ranch/ Davis Property, and Limantour. Both initial treatment and re-treatment would be conducted using manual methods.

Over the long term, this alternative would have very negligible to negligible benefits on natural dune processes and the ability of dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to respond positively to climate change impacts. The emphasis of manual removal would result in less acres being restored. Also, manual removal is particularly ineffective in restoring foredune areas dominated by European beachgrass due to the fact that only 1.5- to 3 feet can reasonably be excavated by hand, and rhizomes in these areas extend down as deep as 6 to 12 feet, leaving considerable material for re-establishment of beachgrass once treatment is complete. The degree of benefit to natural physical processes may be further reduced by the fact that active revegetation would be conducted in backdune area to minimize sand remobilization.

Long-term effects on soils are also strongly determined by the scale and method of restoration. Manual removal would turn over soils, but not to the same extent as mechanical removal. Also, manual removal of iceplant –- particularly without removal of duff material –- may ultimately be less successful in restoring at least early successional dune vegetation communities, as iceplant has been shown to have strong effects on soil properties, including allelopathic impacts. Manual removal of iceplant could then result in rapid establishment of non-target plant species such as weedy native and non-native annuals and ultimately favor development of later successional or even Dune Scrub communities.

Over the long-term, then, manual removal would be expected to have negligible to possibly minor benefits on dune soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour particularly relative to unrestored conditions. Staging and access could result in disturbance to soils from grading and in compaction of soils in primary access routes and staging areas, although impacts would be minimized under this alternative (very negligible adverse) relative to other action alternatives, as no heavy equipment would need to be transported or staged. Also, no effect from primary access or staging would be expected where it occurs via an asphalt road or in an asphalt parking lot (e.g., North Beach, Limantour).

From a regional perspective, based on the scale of projects proposed within and outside the park, Alternative B would likely have very negligible beneficial long-term effects on natural dune physical processes, soils, and the response of coastal areas to climate change within the region.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Dune Processes and Response to Climate Change

A more complete description of the long-term impacts associated with continued expansion of invasive plant species and dune restoration on natural dune physical processes, response to climate change, and soils can be found under Alternatives A and B.

In areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour where European beachgrass and iceplant are removed, the rate of inland sand movement should increase, which will help to maintain an intact coastal dune system in the face of increased coastal erosion pressure from sea level rise and higher intensity storm surge events. The intensity and immediacy of this inland progradation would be strongly dependent on many factors, including removal methods and weather conditions. As was discussed under Affected Environment, one of the primary differences between natural or native dunes and dunes heavily colonized by European beachgrass should be the rate of sand movement, although there is no definitive information available on movement rates in invaded and uninvaded systems. As was discussed under Alternative A in more detail, dunes within the Seashore have continued to migrate inland even after planting of European beachgrass and iceplant more than 60- to 70 years ago. Inland movement rates for dunes between 1943 and 2007 varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual inland expansion rates for coastal dunes during this period of 0.25% to 0.91% (Johnson 2013a).

Restoration can result in more sand movement, depending on the approach used. Most of the information available on inland migration after restoration comes from projects involving mechanical removal. Under Alternative C, mechanical removal would not be the primary removal method as with Alternative D, but would be used potentially to remove European beachgrass in wetland and organic pasture buffers. A series of plots at Little River State Beach in Humboldt County where excavation had been conducted to remove European beachgrass experienced sand movement at a rate of 3.9 cubic feet for every 10 square feet per year (Transou et al. 2007). While the control plot lost sand over the two-year monitoring period, the plot treated with excavation had more than double the sand movement rate of other plots (0.11 cubic meters/square meter/year). During restoration, dunes moved, on average, 2.5 feet per month in a southeast or inland-trending direction, although the rate of inland dune movement may have been retarded by sand moving over existing European beachgrass stands (Vaughan and Fiori 2007).

Monitoring of the recent mechanical removal project at Abbotts Lagoon showed that acreage of open sand in areas within and adjacent to mechanical removal areas increased from 2011 to 2013 (Johnson 2013a). By spring 2013, approximately 10.1 acres of grassland, scrub, and wetland had been buried by newly remobilized sand (Johnson 2013a), which is equivalent to about 3% of the entire 300-acre restoration project area. Of the 10.1 acres, 7.3 acres involved inland "creep" of dunes, with the remainder being internal to the dune system (Johnson 2013a). Of those 7.3 acres, approximately 5.5 acres occurred within leased pastures, with 3.5 of those acres in areas characterized as "ungrazeable" due to being on Dune land soils that are very sandy and support largely dune mat and dune scrub species (Johnson 2013a).

Of these 5.5 acres, 4.1 acres or 75% occurred within areas that had already been buried previously by sand through dune migration (Johnson 2013a). In fact, based on historic aerial imagery, the proportion of barren, sandy areas within the G Ranch leased/permit pastures appears actually lower in 2013 – even with sand remobilization – than in 1963 (Johnson 2013a). In general, sand movement since 2011 has tended to follow established historical sand deposition paths as evidenced by the fact that most of the ungrazeable areas buried were pre-existing dune "fingers" that extended into the pasture, which were already very sandy and dominated by dune and scrub type species. Some of the movement post-restoration may have been influenced by the two successive dry winters and the fact that dry winters reduce establishment by stabilizing vegetation and are accompanied by higher winds that further discourage vegetation establishment (Baye 2008).

The intensity of sand movement, though, may strongly relate not only to weather conditions, but the type of removal method. While sands in dunes may appear somewhat homogenous, sand grain size varies both temporally and spatially in dunes: larger grain sands are more abundant in foredunes and more resistant to wind than smaller grain sands, which are blown inland (Johnson 2013a). Over time, many fine grain sizes are transported, leaving only larger grain sands on the soil surface. Mechanical removal essentially involves flipping of soil horizons, so larger grain sands are potentially buried deep, leaving finer grain sands on the surface that are more available for – and easier to – transport inland.

Sand movement rates are seemingly higher with mechanical removal, particularly over the near-term, than with chemical control, which would be the primary removal method under this alternative. In the same year that mechanical removal was performed at Abbotts Lagoon, some of the backdune and foredune areas immediately adjacent to these areas were treated with herbicide. Although European beachgrass was almost completely killed during the initial treatment effort (>99%), the dead aboveground biomass and presumably the rhizomes did not decompose rapidly. This delayed decomposition may have reduced the potential for sands in these areas to remobilize, as they are being held in place by the dead rhizomes. No migration of dune has occurred inland of these herbicide-treated areas in the one to two years since the treatment was initially performed (Johnson 2013a). While the propensity for dunes to migrate inland could increase as beachgrass decomposes, this potential could be countered to some degree by establishment of new vegetation or expansion of remnant native vegetation within treated areas: new plants are already colonizing these areas, although most of them, with the exception of wild cucumber, are annuals so far that would not contribute much to stabilization of dune soils. However, many of the intermixed dune shrubs that occurred there prior to treatment are still alive, so these may help stabilize soils until other shrubs can establish.

Because of the vast amounts of sand stored in these vegetatively stabilized features, the Seashore's dunes may never totally evolve back towards a more natural dune structure, even with restoration, as the larger-than-natural volume of sand present may pose a challenge to development of a more natural structure with discontinuous, hummocky foredunes and strongly defined blow-outs and dune slacks. However, remobilized sands do increase the potential for dune systems at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to persist in the face of climate change pressures through inland migration at varying rates, although unrestored dunes within these projects (or in other dunes within the Seashore) could still be lost to increased erosion in the future.

The combination of removal methods used under Alternative C could result in differing rates of sand movement, particularly between primary treatment areas and buffers where mechanical removal is conducted. However, overall, this alternative would have negligible to minor benefits for natural dune processes and the ability of the dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to respond positively to climate change impacts. More acres would potentially be restored under this alternative relative to Alternative B and possibly Alternative D, but benefits may be reduced relative to Alternative D due to the fact that chemical control would appear to have less potential for restoring natural dune physical processes than mechanical removal. The degree of benefit to natural physical processes may be further reduced by the fact that active revegetation would be conducted in backdune area to minimize sand remobilization.

Soils

Restoration can also have long-term effects on soil nutrients and biota, and restoration method can affect the type and intensity of effect.

Staging and Access: In general, access and staging impacts on soils would be identical to those under Alternative B, although the intensity of access and staging requirements – and impacts – may be slightly increased, as mechanical removal may be used in wetland and organic pasture buffer areas. In addition to fuels and oils, there would be use, transport, and storage of herbicides, however, all of the same impact avoidance and mitigation measures for spill prevention and response described under Alternative B for fuels would be employed for herbicides. Potential long-term adverse impacts to soils from staging and access under this alternative would generally be negligible to possibly minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with no effect expected at areas where primary and access and staging occurs via asphalt roads or in parking lots (e.g., North Beach and Limantour).

Manual Removal: Impacts of manual removal on soils are very similar to those discussed under Alternative B, although the intensity of impacts may decrease slightly as manual removal would be used primarily for removal of iceplant and European beachgrass in wetland and buffers. Over the long-term, manual removal would be expected to have very negligible to minor benefits for dune soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Minor benefits would be realized primarily in iceplant removal areas, where it can be more successfully removed by hand, although soils may not entirely revert back to uninvaded conditions that would support earlier successional Dune Mat vegetation communities.

Mechanical Removal: Mechanical removal essentially flips the soil horizons within 6 feet of the soil surface, resulting in the new, perhaps more fine-grained surface soils being relatively undeveloped from a nutrient and soil biota perspective. However, flipping may hinder immediate establishment of even native dune plant species due to the very low nutrient and biota levels present (and to the propensity for these soils to remobilized more by high winds).

Following Phase I of the Abbotts Lagoon project, the most prevalent species that germinated within the mechanically restored areas were all members of the pea or Legume (Fabaceae) family, which may be some of the most successful primary or early successional species due to the fact that they can fix atmospheric nitrogen through their roots. Bush lupines are tremendous nitrogen-fixers that derive 60% to 70% of their total nitrogen from atmospheric sources (Bentley and Johnson 1991). If nitrogen levels near these plants become high enough, they can tip the balance between establishment of native dune and non-native weedy species, typically favoring the latter (Maron and Connors 1996). Over a decade or more, these soils would be expected to continue to evolve and mature and develop soil nutrient and biota conditions more similar to those of native dune vegetation communities. In a recent experiment conducted at the Seashore, rare plants germinated more in "flipped" soils (30- 57.5%) than in soils where iceplant and duff had been removed (0- 6%), although germination was highest in native dune soils (57.5- 72.5%; Winsemius 2013). These results suggest that, although mechanical removal may reduce surface soil nutrient pools, plants can still establish, if climatic conditions such as precipitation and wind are favorable.

Under Alternative C, mechanical removal would be used primarily in wetland and organic pasture buffer areas. Over the long-term, mechanical removal would be expected to have negligible to minor benefits for dune soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, particularly relative to unrestored conditions. Under the short-term, minor impacts would be expected from mechanical removal activities in these project areas.

Chemical Control: With chemical control, soil horizons remain in place, at least over the short-term. As rhizomes and roots of European beachgrass and iceplant degrade, these soils may develop more potential for remobilization, although colonization by other plant species following treatment may counter this potential. As surface soils would not be turned over, any changes in soil nutrient and biota properties that occurred as a result of European beachgrass or iceplant establishment would persist. As was discussed under Manual Removal in Alternative B, while the effects on European beachgrass on soil properties are not well-known, the effects of iceplant area: iceplant increases organic matter and lowers pH and possibly organic carbon, all of which could affect which plant species establish following invasives removal.

Soil nutrient pools may be further altered by decomposition of dead European beachgrass and iceplant. While both of these species do appear to decompose slowly, perhaps decreasing the potential for a sharp pulse in influx of new nutrients into the soil pool, post-treatment mowing would accelerate breakdown of European beachgrass, so that also may cause a "flush" of organic and inorganic nutrients into the dune soils system that could affect which plant species establish after treatment and ultimately favor later successional dune or even Dune Scrub vegetation communities.

As discussed earlier, higher nutrients could tip the balance towards annual, weedy species, both native and non-native. Following herbicide treatment in Monterey, native annual plant species, early-successional woody shrubs such as bush lupine and European sea-rocket all readily invaded the treatment area (Hyland and Holloran 2005). One year after treatment and mowing at Abbotts, a number of native and non-native herbs had recruited strongly into sprayed areas, including groundsel, miner's lettuce, and coast cryptantha, a native dune species, particularly in areas that were mowed. Additional primary and later successional dune and other species present included sand mat, beach morning-glory, beach primrose, fiddleneck, and yarrow. Some individuals of beach layia and another CNPS-listed annual species, curlyleaf monardella, were also observed.

While nutrients are typically considered almost detrimental to native plant species, which are often adapted to lower nutrient levels than non-native ones, at Humboldt, recolonization efforts were actually characterized as being aided by "the relatively stable and nutrient-rich environment provided by the dead roots and rhizomes of Ammophila" (Pickart and Sawyer 1998). This environment also apparently promoted persistence of beneficial arbuscular mycorrhizal fungi (The Nature Conservancy, unpub. data *in* Pickart and Sawyer 1998).

Herbicides can also persist in soils, although it appears that this is less of an issue with glyphosate than imazapyr. As discussed in the *Alternatives* chapter, several herbicides are proposed for use: glyphosate, imazapyr, a non-ionic surfactant, and a dye. The lesser toxicity of glyphosate in soil exposures is probably attributable at least in part to the tight binding of glyphosate to some types of soils (e.g., Accinelli et al. 2005; Borggaard and Gimsing 2008; Caceres-Jensen et al. 2009; Glass 1987; Mamy and Barriuso 2005 in SERA 2011a).

Glyphosate appears to strongly adsorb to soils, more so than many other pesticides (PRI 2008a). Glyphosate adsorption is governed mainly by binding to the mineral components of soils rather than organic matter components (Vereecken 2005, Borggaard and Gimsing 2008 *in* PRI 2008a). This sorption can occur at low and high pH, but appears to be highest at low phosphate concentrations or with high availability of phosphate-binding sites such as multivalent cations (PRI 2008a). Penetration of glyphosate into soils depends on soil type, with this herbicide reaching depths of 4- to 12 inches in clay or loam soils and 8- to 18 inches in predominantly sandy soils depending on rainfall rates (SERA 2011a).

Once adsorbed, glyphosate breaks down through microbial degradation, hydrolysis, and photolysis, with minimal loss through evaporation (Hwang and Young 2011). Glyphosate degrades into primarily aminomethylphosphonic acid (AMPA), which then is transformed into its inorganic constituents, phosphate and carbon dioxide (Hwang and Young 2011). Depending on the soil type, temperature, microbial populations, and oxygen availability, half-lives for glyphosate and AMPA range from 1.5 days to 2 years (WHO *in* PRI 2008a). The average half-life span is approximately 1.5 – 2 months (PRI 2008a). The WHO (1994) quotes a differently different half-life range, spanning from 10 to 174 days depending on soil and climate conditions. Studies on degradation of glyphosate in the field for sandy clay loam soils encompass a range of 45 – 174 days (Monsanto 1983 *in* WHO 1994, Feng and Thompson 1990 *in* WHO 1994), while another study conducted on loamy sand soils found half-lives as low as 3 to 4 days (Monsanto 1983 *in* WHO 1994).

Imazapyr differs from glyphosate markedly in its potential belowground persistence rates, which appear to vary widely depending on the environment in which it is used. Because imazapyr is a weak acid herbicide, environmental pH will determine its chemical structure, which in turn determines its environmental persistence and mobility (Tu et al. 2004). Below pH 5, the adsorption capacity of imazapyr increases and limits its movement in soil; above pH 5, greater concentrations of imazapyr become negatively charged, fail to bind tightly with soils, and remain or become available for plant uptake and/or microbial breakdown (Tu et al. 2004). In soils, imazapyr is degraded primarily by microbial metabolism, unlike in water, where it is primarily broken down by photolysis in as little as a few hours (Mallipudi et al. 1991 *in* Tu et al. 2004).

Sorption of imazapyr is lower not only in soils with higher pH (Tu et al. 2004, Wehtje et al. 1987), but those with wetter soil conditions (Peoples 1984 *in* Tu et al. 2004, Wehtje et al. 1987), cooler temperatures (American Cyanamid 1986 *in* Tu et al. 2004), lower organic matter (Douglass 2012), and sandier substrates (American Cyanamid 1986 in Tu et al. 2004, Douglass 2012). Not all studies have found similar results: Vizantinopoulos and Lolos (1994) found that adsorption decreased with increasing soil temperature. Imazapyr adsorption is reportedly very weak in sandy soils, making imazapyr relatively more biologically available (Borjesson et al. 2004 *in* Douglass 2012). However, even in sandy soils, degradation rates can be slowed if lower organic matter, coupled with generally high sand content, reduces the water-holding capacity soils such that aerobic microbial degradation is inhibited (Douglass 2012).

Not surprisingly, the strong variation in sorption with different soil conditions has resulted in reporting of a very broad range of soil half-lives for anywhere from 1 to generally 7 months, although, in some cases, it can persist up to 50 months in loam and clay loam soils with pH 7-8 (American Cyanamid 1986 *in* Tu et al. 2004, Mangels 1991b *in* Tu et al. 2004, Vizantinopoulos and Lolos 1994, McDowell et al. 1997, Borjesson et al. 2004, Senseman 2007 *in* Douglass 2012). Lee et al. (1991 *in* Tu et al. 2004) reported that imazapyr residues in soil following post-emergent application increased eight days after initial application and continued to increase until day 231 post-treatment, however, the authors attributed these increases to runoff of residues from plant surfaces following rainfall and to the release of residues from decaying plant matter.

Microrganisms, like higher plants, use the shikimate pathway to produce aromatic amino acides, and, as glyphosate inhibits this pathway, it can be potentially toxic to microorganisms (Cox 2002, Issa 1999 *in* SERA 2011a). A number of laboratory studies have shown adverse effects on soil microorganisms exposed to glyphosate (SERA 2011a). For example, laboratory tests showed that 4% glyphosate application reduced abundance of photosymbiotic pink-pigmented facultative methylotrophic (PPFM) bacteria that occur in coastal sage scrub habitat (Irvine et al. 2013). However, field studies have been more equivocal, showing either no effect or even an enhancement of microorganisms (Busse et al. 2001; Wardle and Parkinson 1990a,b; Wardle and Parkinson 1991 *in* SERA 2011a). In some cases, application of glyphosate can even cause a transient increase in soil fungi that may adversely affect plants (Kremer 2002 *in* SERA 2011a). The mechanism for this apparent enhancement is unclear, however, some microorganisms may use glyphosate as a nutrient source, or glyphosate may increase nutrients in soil, secondary to plant damage (SERA 2011a). "In either case, glyphosate does not pose a clear hazard to soil microorganisms" (SERA 2011a).

Relatively little information is available on the toxicity of imazapyr to terrestrial microorganisms (SERA 2011b). Based on laboratory tests, effects on bacteria appear to be highly species specific with variations in sensitivity of up to a factor of 100 (SERA 2011b). The potential for longer-term effects on soil microorganisms seems possible where imazapyr persists in soils, although this effect has not been demonstrated in field studies (SERA 2011b). In a greenhouse study, Busse et al. (2004 *in* SERA 2011b) noted no effects on the infectivity of mycorrhizal fungi to pine seedlings following application of imazapyr at rates of 0.82 to 1.6 lb a.e./acre (i.e., rates that caused clear signs of 23 toxicity in the pine seedlings). The peak concentrations of imazapyr expected in the top 12 inches of soil are 0.32 (0.218 to 0.46) mg a.e./kg soil (SERA 2011b). These concentrations are far below the range of reported LC50 values for microorganisms (SERA 2011b). "Thus, there does not appear to be any basis for asserting that imazapyr is likely to affect soil microorganisms adversely" (SERA

2011b). The impact of herbicide persistence to vegetation is discussed under the *Vegetation Resources* section.

Half-life of these herbicides in dune soils is difficult to determine, as no previous studies have been conducted specifically in these systems. Taking imazapyr sorption characteristics as an example, characteristics would seem to both favor -- lower soil water content/more arid -- and not favor -- sandier, less organic matter, cooler temperature -- sorption to soils. Even though strong sorption is less likely for sandy soils such as those in the dunes, for the purposes of this analysis, a conservative estimate for both glyphosate and imazapyr is employed, and both herbicides are assumed to remain adsorbed to soils for at least 2 years.

Under this alternative, mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Pre-treatment mowing would be likely to have the same effects on soils as post-treatment mowing – which was discussed under Alternative A – although it may affect timing of nutrient influxes into soils from litter decomposition.

Another pre-treatment measure that may be used is prescribed burning. The impact of fire to soils varies with a number of factors, including vegetation and organic matter, soil moisture, soil type and steepness of slopes. Grass fires, such as would occur in European beachgrass, tend to burn quickly over an area and cause little or no soil heating (NPS 2004:FMP *in* NPS 2009). Grassland thatch even less than 1 inch thick can serve to insulate soils from heating in a typical fire. Even the heat generated by the heavier fuels in chaparral fires in southern California was found to be restricted largely to the surface soil layer (DeBano et al. 1998 *in* NPS 2004). The damage to soils at the site would likely be minimal, as prescribed burns would tend to move quickly through the European beachgrass-dominated vegetation, even if it contains some shrubs or heavier fuels. Fire can also convert nutrients in European beachgrass into ash deposits, making them readily available to native vegetation as it recolonizes treated areas. This is particularly true for nitrogen, which is responsible for the rapid growth that often takes place following a fire. Again, as dune plants are adapted to low nutrient regimes, it's possible that fire may have short-term adverse effect by stimulating growth of weedy annuals, but, ultimately, these nutrient pools should decrease over time.

Based on the factors discussed, over the short term, chemical control and associated pre- and post-treatment mowing and burning could have potentially minor to moderate adverse impacts to soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. There may also be minor to possibly moderate short-term adverse impacts to soil biota from both herbicide and burning: in this instance, adverse refers to changes that result in either in an increase or decrease of soil microorganisms relative to native dune vegetation communities. After a few years, however, impacts to soils from herbicide application and burning should dissipate, particularly as many plants need to be sprayed only once due to the proven efficacy of this combination of herbicides. This would eventually result in negligible to minor benefits to soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour over the long-term from the removal of soil-altering species such as European beachgrass and iceplant.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on natural physical dune processes, response to climate change, and soils would be the same as described under Alternative A. From a regional perspective, based on the scale of projects proposed inside and outside the park, the proposed dune restoration efforts would likely have negligible to possibly minor beneficial long-term effects on natural dune physical processes, soils, and the response of coastal areas to climate change within the region. There may be negligible adverse impacts over the short-term to soils within the region due to use of herbicides.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal potentially.

Based on the extent of restoration that may be implemented, over the long term, this alternative would have negligible to minor benefits on natural dune processes and the ability of dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to respond positively to climate change impacts. More acres would potentially be restored under this alternative relative to Alternative B, but benefits may be reduced relative to Alternative D due to the fact that chemical control would appear to have less potential for restoring natural dune physical processes than mechanical removal. The degree of benefit to natural physical processes may be further reduced by the fact that active revegetation would be conducted in backdune area to minimize sand remobilization.

Long-term effects on soils are also strongly determined by the scale and method of restoration. Chemical control would be the primary removal method under this alternative. Chemical control involves no turnover of soil horizons, such that restoration must proceed in an environment where invasive plants such as iceplant, bush lupine, and possibly even European beachgrass have artificially elevated nutrient levels or changed other soil properties relative to native dune areas. Death of European beachgrass and iceplant may simply exacerbate these nutrient issues through the slow decomposition of aboveground biomass. Both manual removal of iceplant and chemical control could then result in rapid establishment of non-target plant species such as weedy native and non-native annuals and ultimately preclude development of a primary successional dune community, favoring later successional ones or even Dune Scrub.

Mechanical removal involves "flipping" of soil horizons, which causes extensive change in sand grain size, nutrients, and soil biota, but this method would only be used in wetland and organic pasture buffer areas. Manual removal would also turn over soils, but not to the same extent: it would be used primarily for removal of iceplant and European beachgrass in wetlands and buffer areas. Manual removal of iceplant – particularly without removal of duff material – may ultimately be less successful in restoring at least early successional dune vegetation communities, as iceplant has been shown to have strong effects on soil properties, including allelopathic impacts. Over the long-term, then, the combination of restoration techniques implemented under this alternative would be expected to have negligible to minor benefits for dune soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, particularly relative to unrestored conditions.

Over the short-term, chemical control could have potentially minor to moderate adverse impacts to soils and soil biota from use of herbicides, although these impacts are expected to dissipate within a few years, particularly as the amount of re-treatment should be minimized by the efficacy of the combined herbicide approach.

Staging and access could result in disturbance to soils from grading and in compaction of soils in primary access routes and staging areas, although the intensity of access and staging requirements – and impacts – may be slightly reduced relative to Alternative D, as mechanical removal would only be used in buffer areas. Also, there would be no effect where primary access and staging occurs via asphalt roads or in parking lots (e.g., North Beach, Limantour).

From a regional perspective, based on the scale of projects proposed inside and outside the park, the proposed dune restoration efforts would likely have negligible to possibly minor beneficial long-term effects on natural dune physical processes, soils, and the response of coastal areas to climate change within the region. There may be negligible adverse impacts over the short-term to soils within the region due to use of herbicides.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Dune Processes and Response to Climate Change

A more complete description of the long-term impacts associated with continued expansion of European beachgrass and dune restoration on natural dune physical processes, response to climate change, and soils can be found under Alternatives A - C.

Based on the extent of restoration that may be implemented under this alternative, over the long term, this alternative would have negligible to moderate benefits on natural dune processes and the ability of dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to respond positively to climate change impacts. Fewer acres would potentially be restored under this alternative relative to Alternative C, but localized benefits may be increased relative to Alternatives B and C, because mechanical removal would appear to have more potential for restoring natural dune physical processes than either manual removal or chemical control. Some of this benefit may be offset by the fact that active revegetation would be conducted in backdune areas to minimize sand remobilization.

Soils

Restoration can also have long-term effects on soil nutrients and biota, and restoration method can affect the type and intensity of effect.

Staging and Access: In general, access and staging impacts on soils would be identical to those under Alternative C, although the intensity of access and staging requirements – and impacts – would be increased under this alternative, as mechanical removal would be the primary removal method. Potential long-term adverse impacts to soils from staging and access would generally be minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. There would be no effect on soils where primary access and staging would occur via asphalt roads or in parking lots (e.g., North Beach, Limantour).

Manual Removal: Impacts of manual removal on soils are very similar to those discussed under Alternative B, although the intensity of impacts may decrease as manual removal would be used primarily for removal of iceplant and European beachgrass in wetland and buffers. Over the long-term, manual removal would be expected to have very negligible to minor benefits for dune soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Minor benefits would be realized primarily in iceplant removal areas, where it can be more successfully removed by hand, although soils may not entirely revert back to uninvaded conditions that would support earlier successional Dune Mat vegetation communities.

Mechanical Removal: Potential impacts of mechanical removal on soils are similar to those discussed under Alternative C, although the intensity of impact would be increased relative to that alternative, as mechanical removal would be the primary removal method. Over the long-term, then, mechanical removal would be expected to have minor to moderate benefits for dune soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, particularly relative to unrestored conditions. While conditions may not favor dune plants over the short-term or even the more immediate long-term, these soils would be expected to evolve much as recently deposited foredune soils evolve such that they would eventually have the appropriate conditions to support native dune vegetation communities. Over the short-term, however, minor to moderate short-term impacts would potentially occur for dune soils in these project areas.

Chemical Control: Potential impacts of chemical control on soils are very similar to those discussed under Alternative C, although the intensity would be decreased relative to that alternative, because herbicide would only be used for spot-spraying of re-growth in mechanically treated areas. Within the project areas, then, chemical control could have potentially negligible adverse impacts to soils on a short-term basis. There may also be negligible short-term adverse impacts to soil biota from herbicide: in this instance, adverse refers to changes that result in either in an increase or decrease of soil microorganisms relative to native dune vegetation communities. After a few years, impacts to soils from herbicide application should dissipate, particularly as many plants need to be sprayed only once due to the proven efficacy of this combination of herbicides. This would eventually result in very negligible benefits to soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour over the long-term from removal of soil-altering species such as European beachgrass and iceplant.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on natural physical dune processes, response to climate change, and soils would be the same as described under Alternative A. From a regional perspective, based on the scale of projects proposed inside and outside the park, the proposed dune restoration efforts would likely have negligible to possibly minor beneficial long-term effects on natural dune physical processes, soils, and the response of coastal areas to climate change within the region. There may be almost no effect to very negligible adverse impacts over the short-term to soils within the region due to use of herbicides.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Over the long term, this alternative would have negligible to moderate benefits on natural dune processes and the ability of dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to respond positively to climate change impacts. Fewer acres would potentially be restored under this alternative relative to Alternative C, but localized benefits may be increased relative to Alternative C and certainly Alternative B due to the fact that mechanical removal would appear to have more potential for restoring natural dune physical processes than either chemical control or manual removal. Some of this benefit may be offset by the fact that active revegetation would be conducted in backdune areas to minimize sand remobilization.

Long-term effects on soils are also strongly determined by the scale and method of restoration. Mechanical removal would be the primary removal method under this alternative. Mechanical removal involves extensive "flipping" of soil horizons. Manual removal would also turn over soils, but not to the same extent: it would be used primarily for removal of iceplant and European beachgrass in wetlands and buffer areas. Manual removal of iceplant –- particularly without removal of duff material –- may ultimately be less successful in restoring at least early successional dune vegetation communities, as iceplant has been shown to have strong effects on soil properties, including allelopathic impacts. Chemical control involves no turnover of soil horizons, such that restoration must proceed in an environment where invasive plants such as iceplant, bush lupine, and possibly even European beachgrass have artificially elevated nutrient levels or changed other soil properties relative to native dune areas.

Over the long-term, then, the combination of restoration techniques implemented under this alternative would be expected to have very negligible to moderate benefits for dune soils at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, particularly relative to unrestored conditions. Over the short-term, chemical control could have potentially negligible adverse impacts to soils and soil biota from use of herbicides, although these impacts are expected to dissipate within a few years, particularly as the amount of re-treatment should be minimized by the efficacy of the combined herbicide approach. Staging and access could result in disturbance to soils from grading and in compaction of soils in primary access routes and staging areas, although the intensity of access and staging requirements -- and impacts (minor adverse) -- may be increased relative to Alternative C, as mechanical removal would be the primary restoration method. There would be no effect on soils where primary access and staging would occur via asphalt roads or in parking lots (e.g., North Beach, Limantour).

From a regional perspective, based on the scale of projects conducted historically in the park and proposed outside the park, the proposed dune restoration efforts would likely have negligible to possibly minor beneficial long-term effects on natural dune physical processes, soils, and the response of coastal areas to climate change within the region. There may be almost no effect to very negligible adverse impacts over the short-term to soils within the region due to use of herbicides.

Water Resources

Policies and Regulations

Increasing concern about polluted waters in the 1960s led to a number of federal and state efforts to improve water quality, some of which led to increasing protection for wetlands, which were recognized for their important role in improving water quality. A more detailed description of applicable policies and regulations can be found in Affected Environment. The most well-known legislation protecting the nation's waters is the Federal Water Pollution Control Act (Clean Water Act) and subsequent amendments of 1977 (33 USC §1251 et seq.). The Clean Water Act provides for the restoration and maintenance of the physical, chemical, and biological integrity of the nation's waters, primarily through three sections -- Section 404, Section 401, and Section 303(d).

The Park Service *Management Policies 2006* requires parks to avoid, whenever possible, the pollution of park waters by human activities occurring within and outside the parks (sec. 4.6.3). In addition, Director's Order #77-1 established Park Service policies, requirements, and standards for implementing Executive Order 11990, which directs federal agencies to avoid long- and short-term impacts to wetlands. The Park Service uses the Cowardin classification system (Cowardin et al. 1979) as the basis for creating a Park Service standard for defining, classifying, and inventorying wetlands that might be subject to adverse impacts and Park Service oversight.

Dunes are not considered "aquatic" ecosystems. Some dune systems are bounded by open waters, such as Abbotts Lagoon or Limantour Spit. However, in most cases, the only water-related features within the Seashore's dunes are Dunes Swales or dune slack wetlands. Potential impacts to unique wetland vegetation communities are discussed under *Vegetation Resources*, while potential impacts to special status plant and animal species that occur in wetlands are discussed either under *Special Status Species* or under *Wildlife*.

Assessment Methodology

Information from previous restoration projects, as well as from scientific literature, were used to assess potential impacts to water resources, including wetlands. In terms of assessment methodology, the previous methodology from the 2009 Abbotts Lagoon Coastal Dune Restoration project (NPS 2009) was amended to incorporate some of the methodologies from the Giacomini Wetland Restoration Project EIS/EIR (NPS 2007).

For evaluation purposes, the jurisdictional extent of wetlands subject to Corps' regulation under Section 404 of the Clean Water Act of the Clean Water Act is used as the wetland boundary to assess changes relative to existing conditions. ***However, this impact indicator does NOT analyze impacts to wetlands strictly on the basis on specific regulations issued by the Corps or other federal, state, and local agencies,*** although it does reference conditions in the Corps' Nationwide Permit #27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities) and Park Service policies (see below), particularly for setting impact thresholds for adverse impacts. Unlike regulations, however, these thresholds primarily evaluate change on the basis of whether the proposed project would either permanently impact existing wetlands such that wetlands would be eliminated or would no longer function as wetland or would cause only temporary disturbances that would not ultimately affect wetland characteristics or wetland functioning.

Federal policy requires proposed actions to result in no net loss of wetlands, and Park Service Management Policies push parks to strive for a net gain in wetland acreage. For this reason, impact thresholds reflect this mandate by establishing more stringent thresholds for adverse impacts. The Park Service requires a statement of finding and mitigation for any projects that may impact > 0.25 acres of "natural" wetlands except for those related to recreational facilities (e.g., overlooks, bike/foot trails, and signs) and minor stream crossings that completely span channel and wetlands (i.e., no pilings, fill, or other support structures).

Impact Thresholds

***Negligible*:** There would be no measurable chemical, physical, or biological changes to water bodies or wetlands within or adjacent to dune systems, or change would be barely detectable and often within the natural range of variability. There would be a negligible increase (≤ 0.05 acre) or decrease (≤ 0.1 acre) in the overall areal extent of jurisdictional wetlands (NPS 2007).

***Minor*:** There would be small, but detectable or measurable chemical, physical, or biological changes to water bodies or wetlands within or adjacent to dune systems changes, but no standard or criterion would be exceeded because of proposed actions. For beneficial impacts, there would be a minor increase (> 0.05 and ≤ 1 acre) in the overall areal extent of jurisdictional wetlands, or, for adverse impacts, there would be a minor decrease (> 0.1 acre and ≤ 0.25 acre) in the overall areal extent of jurisdictional wetlands (NPS 2007).

***Moderate*:** There would be apparent or appreciable chemical, physical, or biological changes to water bodies or wetlands, but no standard or criterion would be exceeded, except during implementation or on a short-term basis. There would be no long-term changes to water quality or hydrology. For beneficial impacts, there would be a moderate increase (> 1 and ≤ 5 acres) in the overall areal extent of jurisdictional wetlands, or, for adverse impacts, there would be a moderate decrease (> 0.25 acre and ≤ 1.0 acre) in the overall areal extent of jurisdictional wetlands. If the decrease in overall areal extent of jurisdictional wetlands is > 1.0, the loss must be for the purpose of Aquatic Habitat Restoration, Establishment, and Enhancement Activities as defined by conditions in the Corps' Nationwide Permit #27.

***Major*:** There would be striking or highly noticeable chemical, physical, or biological changes to water bodies or wetlands. Standards and criterions may be exceeded on a long-term basis. For beneficial impacts to wetlands, there would be a substantial and major increase (> 5 acres) in the overall areal extent of jurisdictional wetlands, or, for adverse impacts, there would be a substantial or major decrease (> 1.0 acre) in the overall areal extent of jurisdictional wetlands. If the decrease in overall areal extent of jurisdictional wetlands is > 1.0, the loss would be purposes other than those defined under the Aquatic Habitat Restoration, Establishment, and Enhancement Activities as defined by conditions in the Corps' Nationwide Permit #27.

Impact of Alternative A

Analysis

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Long-Term Effects

Most of the dune systems within the Seashore have either Dune Swale wetlands or do not necessarily incorporate wetlands, but fall adjacent to water bodies such as those at Limantour Spit. Dune swales and slacks often form in the so-called deflation plain behind the primary foredune or as narrow, linear basins between closely spaced successive ridges that are oriented roughly perpendicular to the shoreline (Wiedemann 1984). Most of the dune swale wetlands are only seasonally flooded during the winter, even if they are principally groundwater-fed, but a few wetlands sustain ponding throughout the year.

As natural dunes continue to migrate inland, wetlands features shift in adjustment, destroying and then re-creating features as ridges are re-established elsewhere with wetland vegetation establishment most pronounced during wet periods (P. Baye, *pers. comm*.). Ironically, European beachgrass may have facilitated the creation of more perennial wetlands by reducing sand flow and expanding deflation plains or stabilizing perpendicular ridges that support small wetland drainages. European beachgrass may have also played a role in preventing from encroaching upon the lower lobe of Abbotts Lagoon (NPS 2009), although, in general, the directional pattern of the wind, combined with dune topography upwind, would suggest that this may not be much of a factor in maintaining physical integrity of the lagoon.

Long-term effects to wetlands and water bodies would primarily result from continued expansion of European beachgrass and iceplant into the periphery of existing wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. These species will move into drier fringes of wetlands and water bodies, but they are not adapted to persisting in the wetter portions of these features, so occurrence there is only sporadic. Therefore, under this alternative, there may be negligible adverse impacts to wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour over the long-term from not conducting restoration. Scale of wetlands potentially impacted would probably be less than 0.1 acre within each of these project areas, although invasion does not cause loss of wetlands, but rather a decrease in habitat condition and function. No long-term adverse direct or indirect impacts would be expected to water quality of either wetlands or adjacent water bodies.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, because restoration would not be conducted in the near-term, except for previously permitted projects.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wetlands and water bodies would be restoration of coastal dunes at Bodega Marine Laboratory in Sonoma County, continued restoration of coastal dunes at Tom's Point in Marin County, possible wetland and dune restoration at Lawson's Landing, and wetland and small-scale dune restoration efforts being conducted as part of the Muir Beach Restoration Project at GGNRA. The Wildlife Protection and Habitat Improvement Plan proposed by MMWD would principally affect higher-elevation vegetation communities such as oak woodland and grassland habitat that have been invaded by non-native brooms or invasive species, so it would likely have no cumulative effect on wetlands with this project. Actions in the park that may have cumulative effects on wetlands include other types of habitat restoration – including use of herbicides to control other non-native, invasive plants – and maintenance and upgrade of park facilities near coastal areas, such as the Beaches Water System project, Federal Highways' Sir Francis Drake Boulevard and Limantour road maintenance project, and other smaller scale road and trail maintenance projects.

From a regional perspective, based on the scale of projects proposed outside the park, this alternative could cumulatively have very negligible adverse long-term effects on wetlands. There would be no cumulative effect on water quality within adjacent water bodies and wetlands.

Conclusions

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

To some extent, wetlands within dunes are naturally ephemeral or transitional features that are destroyed and re-formed as dunes naturally migrate inland: planting of non-native invasive species such as European beachgrass and iceplant prior to the park has made these features more "permanent" than they might have been otherwise.

Long-term effects to wetlands and water bodies would primarily result from continued expansion of European beachgrass and iceplant into the periphery of existing wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. These species will move into drier fringes of wetlands and water bodies, but they are not adapted to persisting in the wetter portions of these features, so occurrence there is only sporadic. Therefore, under this alternative, there may be negligible adverse impacts to wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour over the long-term from not conducting restoration. Scale of wetlands potentially impacted would probably be less than 0.1 acre within each of these project areas, although invasion would not cause loss of wetlands, but a decrease in habitat condition and function. No long-term adverse direct or indirect impacts would be expected to water quality of either wetlands or adjacent water bodies.

There would be no implementation-related or short-term effects on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, because restoration would not be conducted in the near-term, except for previously permitted projects.

From a regional perspective, based on the scale of projects proposed outside the park, this alternative could cumulatively have very negligible adverse long-term effects on wetlands. There would be no cumulative effect on water quality within adjacent water bodies and wetlands.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Long-Term Effects

Most of the dune systems within the Seashore have either Dune Swale wetlands or do not necessarily incorporate wetlands, but fall adjacent to water bodies such as those at Limantour. As natural dunes continue to migrate inland, wetlands features shift in adjustment, destroying and then re-creating features as ridges are re-established elsewhere with wetland vegetation establishment most pronounced during wet periods (P. Baye, *pers. comm*.). Ironically, European beachgrass may have facilitated the creation of more perennial wetlands by reducing sand flow and expanding deflation plains or stabilizing perpendicular ridges that support small wetland drainages.

Long-term effects to wetlands and water bodies would primarily result from direct and indirect effects of dune restoration. Indirect effects could result from remobilization of sand following restoration. A much more detailed description of this issue can be found under *Natural Physical Processes and Soils*. As was discussed under that section, the intensity of sand remobilization is directly related to the extent and type of restoration conducted. Manual removal would not be expected to result in much sand remobilization, as the depth of excavation is typically shallow (less than 1.5 feet) and would not result in turnover of soil horizons. However, there is some potential for manual removal in adjacent areas to cause transport of sands into wetland areas, resulting in more than negligible adverse impacts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Less than 0.25 acre of wetlands at each of the AT&T, North Beach, B Ranch, A Ranch, Davis Property, and Limantour project areas would be expected to be lost under this alternative due to long-term sand remobilization.

There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in most portions of the wetlands, particularly in wetter areas, these benefits would be negligible at best. Encroachment of European beachgrass and iceplant does not necessarily cause a loss of wetlands, but it does impact quality or condition of wetlands and their degree of functionality. Depending on the extent of removal performed within wetland and buffers, restoration could counteract some of the impacts from from encroachment of European beachgrass and iceplant into wetland fringes, thereby improving condition and function. However, the scale of restoration performed under this alternative is unlikely to result in substantial improvement of the condition or function of wetlands in invaded areas.

Therefore, under Alternative B, long-term impacts of dune restoration on interior and adjacent wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would be expected to range from either negligible adverse to negligible beneficial. No long-term adverse direct or indirect impacts would be expected on water quality of either wetlands or adjacent water bodies.

Implementation-Related and Short-Term Effects

Staging and Access: Most of the primary staging and access would occur in adjacent grasslands or scrub communities, some of which are used as pastures for cattle, or in paved parking lots and park roads. In general, impact avoidance and minimization measures call for the preferential use of existing ranch roads before establishment of any new primary access roads. No new primary access roads or staging areas would be established in or directly adjacent to wetlands: wetlands would either be mapped as part of this project, or information from past mapping efforts would be used to avoid impacts to wetlands. As part of the project, standard best management practices with regards to equipment fueling and herbicide mixing would be employed. No fueling would be conducted within 100 feet of a wetland or water body. Temporary fills or placement of soils or other materials in wetlands would probably not be required to construct access routes either to or within the dune site. However, if they were, these temporary fills would be removed at the end of the project, and the affected area would be returned to pre-construction contours.

Given these factors, including the proposed impact avoidance and minimization measures, staging and access would generally have no effect or very negligible adverse effects on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Manual Removal: Manual removal would have some impacts to wetlands due to excavation (1.5 feet) of European beachgrass rhizomes. While this would impact wetland plants in the vicinity of European beachgrass individuals, excavation areas are expected to be quickly recolonized by wetland species, particularly as many of them are rhizomatous. Given these factors, manual removal would have potentially very negligible adverse impacts on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour during and shortly after implementation.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wetlands would be the same as described under Alternative A. From a regional perspective, based on the scale of projects proposed inside and outside the park, this alternative could cumulatively have no effect to very negligible adverse long-term effects on wetlands. These projects would be expected to have no cumulative effect on water quality within adjacent water bodies.

Conclusions

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Long-term effects to wetlands and water bodies would primarily result from direct and indirect effects of dune restoration. Indirect effects could result from remobilization of sand following restoration. The intensity of sand remobilization is directly related to the extent and type of restoration conducted. Manual removal would not be expected to result in much sand remobilization, as the depth of excavation is typically shallow (less than 1.5 feet) and would not result in turnover of soil horizons. However, there is some potential for manual removal in adjacent areas to cause transport of sands into wetland areas, resulting in more than negligible adverse impacts at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Less than 0.25 acre of wetlands at each of the AT&T, North Beach, B Ranch, A Ranch, Davis Property, and Limantour project areas would be expected to be lost under this alternative due to long-term sand remobilization.

There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in most portions of the wetlands, particularly in wetter areas, these benefits would be negligible at best. Encroachment of European beachgrass and iceplant does not necessarily cause a loss of wetlands, but it does impact quality or condition of wetlands and their degree of functionality. Depending on the extent of removal performed within wetland and buffers, restoration could counteract some of the impacts from from encroachment of European beachgrass and iceplant into wetland fringes, thereby improving condition and function. However, the scale of restoration performed under this alternative is unlikely to result in substantial improvement of the condition or function of wetlands in invaded areas.

Therefore, under Alternative B, long-term impacts of dune restoration on interior and adjacent wetlands at AT&T/North, B Ranch/A Ranch/Davis Property, and Limantour would be expected to range from either negligible adverse to negligible beneficial. No long-term adverse direct or indirect impacts would be expected on water quality of either wetlands or adjacent water bodies.

Potential impacts to wetlands and water bodies during or shortly after restoration would result primarily from staging and primary access. There would be either no effect or a very negligible adverse impact from access and staging at AT&T/North Beach, B Ranch/A Ranch/ Davis Property and Limantour, as no temporary fills would probably be required as they might be if heavy equipment were needed.

From a regional perspective, based on the scale of projects proposed inside and outside the park, this project could cumulatively have no effect to very negligible adverse long-term effects on wetlands and adjacent water bodies within the region.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Long-Term Effects

A more complete description of the long-term impacts associated with continued expansion of European beachgrass and iceplant and dune restoration on wetlands can be found under Alternatives A and B.

Long-term effects to wetlands and water bodies would primarily result from direct and indirect effects of dune restoration and, to a lesser degree, continued encroachment by invasive species. Some of the direct long-term impacts would come from excavation in and adjacent to Dune Swale wetlands. Under Alternative C, mechanical removal would not be the primary control method, but would be used in wetland and organic pasture buffer areas. As excavation would occur on wetland perimeters, there is potential to impact wetlands either due to accidental over-excavation into wetlands or due to "sloughing" or incidental fallback of adjacent excavated dune soils into the wetland. The potential for this long-term impact would be greatly minimized through installation of the required silt fencing along the wetland perimeter, which not only helps to demarcate the wetland, but, as it's stapled to the ground, minimizes fallback of dune sands into the wetland.

Indirect effects could result from remobilization of sand following restoration. A much more detailed description of this issue can be found under *Natural Physical Processes and Soils*. As was discussed under that section, the intensity of sand remobilization is directly related to the extent and type of restoration conducted. Projects primarily using mechanical removal could potentially have more long-term impacts, particularly as European beachgrass has resulted in storage of very large volumes of sand deposited over the decades. Under more natural conditions, less sand would be stored in dunes, because sands would have gradually moved inland over time.

The 2011 Abbotts Lagoon dune restoration project, which primarily used mechanical removal, has already affected wetland morphology within this area by burying a few smaller wetland features within the interior of the dunes, as well as wetland swales immediately inland of the dunes. Estimated acreage of jurisdictional wetlands impacted totaled at least 2.5 acres as of spring 2013 (Johnson 2013a). The mechanical removal also inadvertently expanded some wetlands by simply removing contaminated sands on the perimeter of wetlands without "capping" them, which enabled waters from these wetlands to flow into these areas and create more open water edges. In addition, over time, as these excess sands migrate inland, wetlands may re-develop in the trough between foredune and elevated areas behind the foredunes where the water table is low enough to sustain seasonal ponding (Pickart and Sawyer 1998).

Projects primarily relying on chemical control would not be expected to remobilize as much sand as mechanical removal, because European beachgrass rhizomes decay very slowly and seemingly help to stabilize sands. While the propensity for dunes to migrate inland could increase as beachgrass decomposes, this potential could be countered to some degree by establishment of new vegetation or expansion of remnant native vegetation within treated areas: new plants are already colonizing treated areas near Abbotts Lagoon, although most of them, with the exception of wild cucumber, are annuals so far that would not contribute much to stabilization of dune soils. However, many of the intermixed dune shrubs that occurred there prior to treatment are still alive, so these may help hold soils until other shrubs can establish. Based on monitoring, no migration of dune occurred inland of these herbicide-treated areas in 2013: any impacts to wetlands that have occurred within this area resulted from use of mechanical removal in wetland buffers (Johnson 2013a).

As discussed in more detail under Alternative B, manual removal would also not be expected to have more than negligible adverse long-term indirect impacts on wetlands from remobilization of sands, as the depth of excavation is relatively shallow (less than 1.5 feet) and would not result in turnover of soil horizons. There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in wetlands, particularly in the wetter ones, these benefits would be negligible at best and would not offset any potential adverse effects associated with manual or mechanical removal.

Remobilized sand or incidental fallback of sands into wetlands would not be expected to have long-term impacts on water quality of adjacent open water bodies such as Abbotts Lagoon or Estero de Limantour, because sand is heavy and would quickly fall to the bottom of the wetlands and other open water bodies.

Under Alternative C, the scale of long-term impacts from sand remobilization would be reduced relative to Alternative D, because mechanical removal would not be the primary restoration method, and backdune areas would be actively revegetated. While some sand remobilization could occur in chemically treated once European beachgrass and iceplant decompose, by that time, native vegetation from plantings and natural recruitment should have established, thereby helping to stabilize soils. In addition, at AT&T, special impact avoidance and minimization measures, including selective retention of some European beachgrass-dominated wetland buffers, regrading of steep slopes, and active revegetation, may be employed to reduce impacts: See Possible Additional Mitigation Measures below for more information.

Based on the extent of restoration that may be implemented under this alternative, this alternative could have negligible to possibly moderate adverse long-term effects on interior and adjacent wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Within these project areas, more than 0.25 acre of wetlands might be lost due to long-term sand remobilization, with losses at some sites with more accumulated sands (or larger dunes) exceeding 1 acre: however, losses would be associated with restoration purposes. For these reasons, higher intensity impacts may be expected at project areas such as AT&T, but, as discussed earlier, these impacts would potentially be mitigated through a number special impact avoidance and minimization measures. There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in wetlands, particularly in the wetter ones, these benefits would be negligible at best.

No long-term adverse direct or indirect impacts would be expected to water quality of either wetlands or adjacent water bodies.

Implementation-Related and Short-Term Impacts

Staging and Access: In general, access and staging impacts on soils would be identical to those under Alternative A, although the intensity of access and staging requirements – and impacts – may slightly increase, as mechanical removal would be used in wetland and organic pasture buffer areas. Staging and access would generally have no effect or negligible to minor short-term adverse effects on wetlands at AT&T/North Beach, B Ranch/A Ranch/ Davis Property, and Limantour, with the latter occurring at AT&T if temporary fills in wetlands are required for access.

Manual Removal: Potential implementation-related and short-term impacts of manual removal on wetlands are very similar to those discussed under Alternative B, although the intensity of impact may be slightly less than under Alternative B, as manual removal would only be used for removal of iceplant and European beachgrass in wetland and buffer areas. Given these factors, potential adverse impacts to wetlands during and shortly after implementation from manual removal would be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Most of the potential impacts associated with mechanical removal would be long-term direct or indirect ones, such as incidental fallback or burial of wetland features with sand remobilization. However, there is some potential for short-term impacts associated with secondary access within dune restoration areas. As with adjacent grasslands, no secondary access would be allowed within or through wetlands to the maximum extent practicable. If no other access route for heavy equipment exists, access may be temporarily allowed through wetlands, but only within pre-established routes that result in the least impact to these features. Every effort would be made to not alter these features to improve accessibility conditions, but if they are altered, temporary fill would be removed at the end of the project, and the area would be brought back to pre-construction contours. Potential adverse impacts to wetlands during implementation of mechanical removal in wetland buffers would most likely have no effect or negligible effects on wetlands at AT&T/ North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Long-term effects from sand remobilization are addressed under Long-Term Effects.

Chemical Control: As herbicide would not be applied to the sparse European beachgrass that occurs in wetlands, there would be no direct impacts of chemical control and wetlands and water bodies. However, wetlands and water bodies can be affected by herbicide drift, run-off, and wind erosion. Drift results when herbicide application extends beyond the intended application area and can be influenced by many factors, including the method of application (e.g., aerial or broadcast versus ground), topography, wind speed, humidity, type of herbicide, and droplet size. Some of the potential for these impacts would be reduced considerably through measures such as requiring at least a 25-foot buffer between spray activities and wetlands. In addition, wetlands supporting federally threatened California red-legged frog would have a 60-foot buffer. The potential for drift and run-off is also reduced by use of backpack sprayers with calibrated nozzles and discontinuation of spraying when wind speeds reach an average or consistent gusts of 10 mph at plant level or when conditions are very foggy. Labels for both AquaMaster® (currently marketed as Round-Up Custom®) and Habitat® recommend spraying between 2 or 3 to 10 mph to minimize drift. In addition, wicking of herbicide onto vegetation or drift shields may also be used to minimize the potential for herbicide drift.

The issue of drift is discussed in detail under *Vegetation Resources*-Alternative C. Most studies on herbicide drift are focused on either aerial application or boom sprayer-type application methods used in agricultural operations (Salyani and Cromwell 1992, Holterman et al. 1997 *in* SERA 2011a). However, these studies greatly overestimate the potential for drift for more focused backpack-specific application methods (SERA 2011a). For the 2011 update of the USFS risk assessment, which uses the EPA's AgDRIFT Tier 1 model (Teske et al. 2002 in SERA 2011a), estimates of drift from backpack applications were based on adjusting the droplet size from very fine/fine to medium coarse and reducing drift estimates from 90 to 50 percentile (SERA 2011a). Even so, as cautioned in SERA (2011b), "the drift estimates for backpack applications, which are based on a modified set of assumptions for low-boom ground applications, are likely to overestimate drift associated with carefully conducted backpack applications under conditions that do not favor drift."

Based on USFS risk assessment worksheets developed by SERA, use of the proposed 4.0 pounds a.e./acre of glyphosate could result in drift of 0.8% (0.033 lbs a.e./acre) of the applied solution within 25 feet of the application area, 0.4% (0.017 lbs a.e./acre) within 50 feet, and 0.03% (0.001 lbs a.e./acre) within 900 feet. As was discussed under *Vegetation Resources*-Alternative A, the no-observed-adverse-effect levels (NOAEL) for the less toxic glyphosate isopropylamine (IPA) formulation for non-target plant species has been shown to vary in studies from 0.035 to 0.56 lbs a.e./acre depending largely on type of species (monocot, dicot), with the wetland facultative perennial ryegrass (*Festuca perennis*) being at the higher end of the scale (Chetram and Lucash 1994 *in* SERA 2011a). These numbers would suggest that no to very negligible effect should occur for species at least 25 feet away if the less toxic formulation of glyphosate is used. The park not only uses a less toxic formulation, but uses one labeled for aquatic uses (AquaMaster®; currently marketed as Round-Up Custom®), which should further minimize impacts.

Based on USFS risk assessment worksheets developed by SERA for imazapyr, the proportion of herbicide subject to drift shows the same relationship with distance from application area as glyphosate, however, the volume of herbicide delivered downstream with drift would differ. Use of the park's maximum application rate of 1.0 pounds a.e./acre of imazapyr could result in drift of 0.008 lbs a.e./acre of the applied solution within 25 feet of the application area, 0.004 lbs a.e./acre within 50 feet, and 0.0003 lbs a.e./acre within 900 feet. Similar to glyphosate, certain species are more tolerant to imazapyr than others, and this would affect susceptibility to drift, as well, with NOAEL rates varying from 0.000064 lbs a.e./acre to 0.4 lbs a.e./acre for certain types of imazapyr formulations (SERA 2011b). The IPA formulations of imazapyr (such as Habitat®) have shown less toxicity in tests, ranging from 0.001 lbs a.e./acre to 0.008 lbs a.e./acre (Christensen et al. 1995, Feutz and Canez 1995 *in* EPA 2005b *in* SERA 2011b). Similar to glyphosate, these numbers would suggest that some effect may occur between 25 and 300 feet from point of spraying depending on species sensitivity. As with glyphosate, the park not only uses a less toxic formulation of imazapyr, but uses one labeled for aquatic uses (Habitat®), which should further minimize impacts to wetlands.

One other form of "drift" that may affect non-target vegetation is wind erosion (SERA 2011a). Wind erosion leading to off-site movement of pesticides is highly site-specific and depends on several factors, including application rate, depth of incorporation into the soil, persistence in the soil, wind speed, and topographical and surface conditions of the soil (SERA 2011a). The earlier USFS risk assessment (2003) calculated that for a reasonable worst case scenario – a sandy surface with high wind speeds and arid conditions – approximately 0.54% of the glyphosate applied to an application area would be lost due to wind erosion. For an application rate of 4 lbs a.e./acre, this would result in loss of 0.02 lbs a.e./acre of glyphosate, which is below the NOAEL for glyphosate IPAs discussed above. While dune systems meet most of these conditions – sandy, high winds, arid conditions – areas where spraying would be conducted would be less likely to have wind erosion due to the very low rates of sand remobilization in these areas due to the slow decomposition rates for European beachgrass (See *Natural Physical Processes and Soils* for more detailed discussion).

In addition to drift and erosion, herbicides can also exert effects on non-target vegetation through surface water run-off or percolation into groundwater tables. The proportion of run-off as a fraction of application rate varies with soils, as well as climate, specifically temperature and rainfall. For the 2011 USFS risk assessment, a number of 0.089 lbs a.e./acre of glyphosate was calculated as the maximum run-off herbicide proportion in 100 individual simulations for an area with predominantly clay soils, cool temperatures, and high rainfall (SERA 2011a). The lower value of 0.0000001 lbs a.e./acre of the glyphosate application rate would be expected in arid areas with predominantly loam or sandy soils (SERA 2011a). Based on climate and soils, coastal dunes within the Seashore would tend towards the lower value due to the very sandy soils, and moderate rainfall. One recent study conducted for MMWD found that glyphosate and its breakdown product, AMPA, were not found either in dissolved or particulate phases of stormwater run-off collected from an application area, probably due to strong soil and litter adsorption (Hwang and Young 2011).

The same is true for imazapyr: "In areas with predominantly sandy soils, the runoff of imazapyr following foliar applications should be negligible, and risks to non-target plants should also be negligible" (SERA 2011b). The potential for impact would be further reduced by impact avoidance and mitigation measures such as spraying only during dry periods, not spraying 24 hours before a rainfall event with a 20% probability of occurrence, or 24 hours after a rainfall event. In addition, herbicide application methods emphasize avoidance of any drip of herbicide from foliage onto the ground.

Percolation represents the amount of the herbicide that is transported below the root zone: it can be transported off-site through movement of groundwater. Groundwater infiltration rates depend on soil adsorption rates, depth to groundwater, and fate of chemicals once in soils or in groundwater. In general, glyphosate strongly adsorbs to soils (SERA 2011a). Penetration of glyphosate into clay or loam soils is an estimated 4-12 inches, with the depth of penetration increasing as rainfall rates increase (SERA 2011a). In predominantly sand soils, glyphosate may penetrate to a depth of about 8-18 inches, depending on rainfall rates (SERA 2011a). Once adsorbed, it breaks down through microbial degradation, hydrolysis, and photolysis (Hwang and Young 2011). Soil adsorption characteristics of imazapyr are more complex, with sorption strongly dependent on pH and texture: imazapyr adsorption in sandy soils is reportedly very weak (Borjesson et al. 2004 *in* Douglass 2012). However, some field studies have indicated that imazapyr remains typically within the top 20 inches of the soil surface (USFS 2007). Based on this information, imazapyr would be more likely to percolate downwards towards the groundwater table than glyphosate, but the depth of percolation is considerably more shallow than the groundwater table in treatment areas, which is probably typically deeper than 2- to 3 feet. Also, the groundwater table within dunes typically flows in an oceanward direction rather than an inland direction, which would minimize potential for impacts to adjacent wetlands within grasslands.

Mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would not have any effects on wetlands, because wetlands would be strictly off-limits to mowing equipment, and the same buffer that applies to herbicide application would also apply to mowing.

Another pre-treatment measure that may be used is prescribed burning. A 25-foot fire break would be established between prescribed burning activities and wetlands, and no fire breaks would be established in wetlands. Although fire would not affect wetlands directly, ash generated from burning European beachgrass could be carried by wind or runoff to wetlands or adjacent water bodies. Ash generated by fires is usually rich in nitrogen (NPS 2004 *in* NPS 2009), a nutrient essential to plant growth. Excess nitrogen in wetlands and water bodies can increase production of algae or macrophytic vegetation and possibly lead to hypoxic or anoxic episodes. An increase in nutrients could also stimulate growth of non-native plant species at the expense of native ones. Based on scale of potential prescribed burning activities, this impact to project areas would be considered short-term, adverse, and negligible to minor in intensity.

Based on these factors, including the proposed impact avoidance and minimization measures, chemical control and its associated pre- and post-treatment measures could have very negligible to potentially minor impacts on interior and adjacent wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Minor impacts may occur in systems with more wetlands from indirect impacts of imazapyr drift, although use of strict weather restriction guidelines should minimize impacts from drift even more so than is reflected by the estimates from the USFS worksheets, which are adjusted for backpack applications from ground-based-boom style application. Even if impacts occurred, wetland plants, which often reproduce vegetatively from rhizomes, would be expected to quickly recolonize.

Possible Additional Mitigation Measures: As was discussed in much more detail under *Special Status Species* sections for Sonoma alopecurus and California red-legged frog, to reduce potential localized adverse impacts to wetlands and special status species, sands adjacent to the swale in which Sonoma alopecurus occurs at AT&T could be reshaped using heavy equipment to a lower elevation to minimize the amount of sand movement that would occur during spring winds, as well as actively revegetated. In addition, there may be selective retention of some European beachgrass-dominated wetland buffers.

Effectiveness of Possible Additional Mitigation Measures: In addition to reducing impacts to Sonoma alopecurus and California red-legged frog, this would reduce the potential adverse long-term impacts to some of the AT&T wetlands from possibly moderate to negligible or minor.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wetlands and water bodies would be the same as those discussed under Alternative A. From a regional perspective, based on the scale of projects proposed inside and outside the park, these projects could cumulatively have very negligible adverse long-term effects on wetlands. No cumulative effect on water quality within wetlands or adjacent water bodies is expected under this alternative.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal potentially.

This alternative would have less potential long-term impacts on wetlands than Alternative D, because mechanical removal would not be the primary removal method and would only be potentially used in wetland and organic pasture buffers. Mechanical removal can impact wetlands by remobilizing sands and causing burial of some of the interior and adjacent wetlands. In this alternative, burial potential would be reduced and commensurate with the amount of buffer subject to excavation. Some sand remobilization could occur once European beachgrass and iceplant decompose, but, by that time, native vegetation should have established, thereby helping to stabilize soils. In addition, active revegetation would be conducted in backdune areas, which would help to minimize the potential for remobilization after decomposition of European beachgrass to negatively impact adjacent wetlands. Less than 0.25 acre of wetlands at each of the North Beach, B Ranch, A Ranch, Davis Property, and Limantour project areas would be expected to be lost under this alternative due to long-term sand remobilization, while losses at some sites with more wetlands or accumulated sands (or larger dunes) such as AT&T could potentially exceed 1 acre. There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in wetlands, particularly in the wetter ones, these benefits would be negligible at best.

Based on these factors, restoration could have either negligible to possibly moderate long-term adverse impacts at AT&T, B Ranch, and Limantour, with moderate impacts potentially expected at AT&T. While losses would be associated with restoration purposes, special impact avoidance and minimization measures may be employed at AT&T to reduce impacts from possibly moderate to negligible or minor. These include selective retention of some European beachgrass-dominated wetland buffers or regrading of steep slopes: See Possible Additional Mitigation Measures section for more information. No long-term impacts would be expected on adjacent water bodies or water quality within these water bodies.

Potential impacts to wetlands and water bodies at AT&T, B Ranch, and Limantour during or shortly after restoration would result primarily from staging, primary and secondary access, and chemical control. These impacts would range from no effect to minor. In general, staging and access would have no impact, as wetlands would be avoided during siting of primary and secondary access roads and staging areas, but, if temporary access or fills are required, there may be negligible to minor short-term impacts to wetlands. Chemical control may have very negligible to minor adverse impacts, with minor adverse impacts potentially from drift of imazapyr onto non-target wetland plant species. However, these impacts would be very short-term in nature, and wetland plants would be expected to quickly recolonize any areas impacted due to the fact that many species reproduce vegetatively. Mechanical removal in wetland buffers would most likely have no effect or negligible short-term effects on wetlands within the project areas.

From a regional perspective, based on the scale of projects proposed inside and outside the park, these projects could cumulatively have very negligible adverse long-term effects on wetlands. No cumulative effect on water quality within wetlands or adjacent water bodies is expected under this alternative.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Long-Term Effects

A more complete description of the long-term impacts associated with continued expansion of European beachgrass and iceplant and dune restoration on wetlands can be found under Alternatives A, B, and C.

Based on the scale of restoration that may be implemented under this alternative, this alternative could have negligible to moderate adverse long-term effects on interior and adjacent wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with higher intensity impacts potentially occurring in sites with more wetlands and larger dunes such as AT&T. The intensity of long-term impacts to these project areas would probably be higher under Alternative D than under Alternatives C and B, because mechanical removal would be the primary restoration method, and mechanical removal can result in more sand remobilization than other removal methods. Sand remobilization impacts would be minimized under this and other action alternatives, because active revegetation would be conducted in backdune areas, which would help to stabilize sands. More than 0.25 acre of wetlands might be lost due to long-term sand remobilization within each of these project areas, with losses at some sites such as AT&T exceeding 1 acre due to the fact that dunes are larger with more accumulated sands, and more wetlands are present. While these losses would be associated with restoration purposes, special impact avoidance and minimization measures may be employed at AT&T to reduce impacts from moderate to minor. These include selective retention of some European beachgrass-dominated wetland buffers, regrading of steep slopes, and active revegetation, may be employed to reduce impacts: See Possible Additional Mitigation Measures section for more information.

There may be some long-term benefits from manual removal of European beachgrass from wetlands, but, as this species is not very common in wetlands, particularly in the wetter ones, these benefits would be negligible at best.

No long-term adverse direct or indirect impacts would be expected to water quality of either wetlands or adjacent water bodies.

Implementation-Related and Short-Term Impacts

Staging and Access: In general, access and staging impacts on soils would be identical to those under Alternative B, although the intensity of access and staging requirements – and impacts – may increase, as mechanical removal would be the primary removal method. Staging and access would generally have negligible to minor short-term adverse effect on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with minor effects occurring at AT&T if temporary fills are required for access.

Manual Removal: Potential short-term impacts would be the same as discussed under Alternative C. Given these factors, potential adverse impacts to wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour from manual removal would be very negligible.

Mechanical Removal: Potential short-term impacts of mechanical removal on wetlands are similar to those discussed under Alternative C, although the intensity of impact may be increased relative to that alternative, as mechanical removal would be the primary removal method. Mechanical removal would most likely have either no short-term effects on wetlands or water bodies at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour or, should temporary secondary access through wetlands be required, negligible to minor adverse short-term effects.

Chemical Control: Potential short-term impacts of chemical control on wetlands are similar to those discussed under Alternative C, although the intensity of impact would be greatly reduced as herbicide would be primarily used for spot-spraying of re-sprouts in mechanical removal areas. Based on factors discussed under Alternative C, including proposed impact avoidance and minimization measures, selective spot-spraying in non-wetland areas would be likely to have no effect or very negligible effects on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Possible Additional Mitigation Measures: As was discussed in much more detail under *Special Status Species* sections for Sonoma alopecurus and California red-legged frog and under *Water Resources*-Alternative C, to reduce potential localized adverse impacts to Sonoma alopecurus and wetlands, to reduce potential localized adverse impacts to wetlands and special status species, sands adjacent to the swale in which Sonoma alopecurus occurs at AT&T could be reshaped using heavy equipment to a lower elevation to minimize the amount of sand movement that would occur during spring winds, as well as actively revegetated. In addition, there may be selective retention of some European beachgrass-dominated wetland buffers.

Effectiveness of Possible Additional Mitigation Measures: In addition to reducing impacts to Sonoma alopecurus and California red-legged frog, this would reduce the potential adverse long-term impacts at some of the AT&T wetlands from moderate to minor.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on wetlands and water bodies would be the same as those discussed under Alternative A. From a regional perspective, based on the scale of projects proposed inside and outside the park, this alternative could cumulatively have very negligible adverse long-term effects on wetlands. No cumulative effect on water quality within wetlands or adjacent water bodies would be expected with any of the proposed or potential projects.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

This alternative would potentially have more long-term impacts on wetlands at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour than Alternatives C and B, because mechanical removal would be the primary removal method, and mechanical removal can result in more sand remobilization that can bury wetlands. However, active revegetation would be conducted in backdune areas, which would help reduce remobilization of sand after European beachgrass decomposes and, therefore, reduce negative impacts on interior and adjacent wetlands.

Based on the scale of restoration that may be implemented under this alternative, this alternative could have negligible to moderate long-term adverse effects on interior and adjacent wetlands within the project areas, with minor to moderate impacts potentially occurring at AT&T/North Beach and B Ranch/A Ranch/Davis Property. More than 0.25 acre of wetlands might be lost within each of the project areas due to long-term sand remobilization, with losses at some sites such as AT&T potentially exceeding 1 acre due to the fact that the dunes are larger with more accumulated sands, and more wetlands are present. While these losses would be associated with restoration purposes, special impact avoidance and minimization measures may be employed at AT&T to reduce impacts from moderate to minor. These include selective retention of some European beachgrass-dominated wetland buffers, regrading of steep slopes, and active revegetation, may be employed to reduce impacts: See Possible Additional Mitigation Measures section for more information. No long-term impacts would be expected on adjacent water bodies or water quality within these water bodies.

Under this alternative, potential impacts to wetlands and water bodies at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour during or shortly after restoration would result primarily from staging and primary and secondary access. These impacts would range from no effect to minor. In general, staging and access would have no impact as wetlands would be avoided during siting of primary and secondary access roads and staging areas, but, if temporary access or fills are required, there may be negligible to minor short-term impacts to wetlands. Chemical control would have no more than very negligible effects on wetlands on a localized scale, as herbicide would only be used for spot-spraying of resprouts. Mechanical removal would most likely have either no short-term effects on wetlands or water bodies at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour or, should temporary secondary access through wetlands be required, negligible to minor adverse short-term effects.

From a regional perspective, based on the scale of projects proposed inside and outside the park, this alternative could cumulatively have very negligible adverse long-term effects on wetlands. No cumulative effect on water quality within wetlands or adjacent water bodies would be expected with any of the proposed or potential projects.

Wilderness

The Seashore contains both designated and proposed wilderness areas that must be managed differently from other lands within the park. Along beaches and dunes of the Seashore, wilderness is restricted to beach areas adjacent to the ocean and certain portions of the coastal dune system, including near the mouth of Abbotts Lagoon, portions of A and B Ranches, North Beach, and Limantour Beach. Acreage of wilderness within potential project areas is as follows: AT&T (0 acres), North Beach (~42 acres), Davis (0 acres), B Ranch (~90 acres), A Ranch (~41 acres), and Limantour (~190 acres). Of the roughly 2,200 acres of coastal dune, bluff, and scrub within the Seashore, approximately 30% or 660 acres fall within designated wilderness.

Policies and Regulations

The Wilderness Act establishes the national wilderness preservation system, consisting of federal lands designated by Congress as wilderness. According to Section 4(c) of the Wilderness Act, there shall be no commercial enterprise and no permanent road within any wilderness area and, except as necessary to meet minimum requirements for the administration of the area (including measures required in emergencies involving the health and safety of people within the area), there shall be no temporary road; no use of motor vehicles, motorized equipment, or motorboats; no landing of aircraft; no other form of mechanical transport; and no structure or installation within any such area.

The evaluation of whether certain uses or activities can be conducted in wilderness areas occurs as part of a two-step process. The first step, the minimum requirement analysis, is used to determine which administration approach impacts wilderness the least. This step is used to scrutinize the project or activity and make the best decision for wilderness in the long term (BLM 2004). If, after completing step one, the proposal is found to be the minimum required action for administration of the area as wilderness, a minimum tool analysis is completed, which helps determine which method of implementing the proposal would have the least impact on the wilderness resource while still allowing the project to be completed safely and successfully (BLM 2004).

Assessment Methodology

The Interagency Wilderness Character Monitoring Team, which represents the Bureau of Land Management, USFWS, PS, U.S. Geological Survey, and U.S. Forest Service, offers an interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System in then handbook, "Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character across the National Wilderness Preservation System" (Landres et al. 2008 *in* NPS 2012: Drakes EIS). Based on the statutory language of the Wilderness Act, the interagency team has identified four qualities of wilderness character that should be used in wilderness planning, stewardship, and monitoring:

Untrammeled- Wilderness is essentially unhindered and free from modern human control or manipulation

Natural – Wilderness ecological systems are substantially free from the effects of modern civilization.

Undeveloped-Wilderness retains its primeval character and influence and is essentially without permanent improvement or modern human occupation.

Solitude or a primitive and unconfined type of recreation-Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation (Landres et al. 2008).

These four qualities are used in this EA to evaluate the extent to which wilderness values are either preserved, restored, or diminished under each alternative.

Impact Thresholds

Negligible: There is no measurable change to qualities of wilderness character or change is barely detectable and often within the range of natural variability.

Minor: There would be small, but detectable or measurable changes in qualities of wilderness character.

Moderate: There would be apparent or appreciable change in qualities of wilderness character.

Major: There would be striking, highly noticeable change in qualities of wilderness character.

Impact of Alternative A

Analysis

Under Alternative A, near-term dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Long-Term Effects

Under Alternative A, European beachgrass and iceplant would continue to expand in both wilderness and non-wilderness portions of dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Wilderness represents a portion of the dune systems at AT&T/North Beach and B Ranch/A Ranch/Davis Property, while all of the dunes at Limantour fall inside wilderness boundaries. By 2010, more than 60% (1,400 acres) of the park's roughly 2,200 acres of coastal dune, bluff, and scrub habitat was estimated to be dominated by European beachgrass and iceplant, and these species have continued during recent decades to rapidly spread to other areas. These species create dense monocultures that directly displace native coastal dune vegetation communities and associated rare plants such as Tidestrom's lupine (FE) and beach layia (FE). Many of these native dune species act as nectar sources for the federally endangered Myrtle's silverspot butterfly. The invasive species can also expand into beach areas, eliminating potential nesting areas for western snowy plover (FT). In addition to direct effects, these species have indirect effects by creating dense stands that provide cover to predators of western snowy plover and seeds of

Tidestrom's lupine, with at least the latter being scientifically linked to probable extinction of Tidestrom's lupine unless action is taken.

Continued encroachment by these invasive plant species would detract from the untrammeled nature of the wilderness by removing plants: these species were planted by humans to manipulate the dune environment. It would also decrease outstanding opportunities for solitude and an unconfined type of recreation, as dense stands of European beachgrass and iceplant discourage visitation and enjoyment of the dunes. Highly invaded dunes may also be considered less scenic from the perspective of passers-by walking along the beach.

Expansion of European beachgrass and iceplant could cause negligible to possibly minor adverse impacts on wilderness at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with intensity of impacts dependent on the extent of wilderness present and the amount of area currently uninvaded by these species. Higher intensity impacts (possibly minor) would occur where more of the dune systems fall within wilderness, and there is more native or open habitat available for invasion. Based on these factors, the highest level of impacts from the lack of restoration would potentially take place at Limantour, followed by B Ranch/A Ranch/Davis Property, North Beach, and then AT&T.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects, as near-term dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

On a regional scale, there would be no potential for cumulative impacts as Congressionally designated wilderness does not occur outside the Seashore within this region.

Conclusions

Under Alternative A, near-term dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Continued expansion of European beachgrass and iceplant could cause negligible to possibly minor adverse impacts on wilderness at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with expansion detracting from the naturalness of dunes within wilderness. The intensity of impacts would be dependent on the extent of wilderness present and the amount of area currently uninvaded by these species. Higher intensity impacts (possibly minor) would occur where more of the dune systems fall within wilderness and there is more native or open habitat available for invasion. Based on these factors, the highest level of impacts from the lack of restoration would potentially take place at Limantour, followed by B Ranch/A Ranch/Davis Property, North Beach, and then AT&T.

There would be no implementation-related or short-term effects, as dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

On a regional scale, there would be no potential for cumulative impacts as Congressionally designated wilderness does not occur outside the Seashore within this region.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

In addition to NEPA and other permitting and consultation needs, the Seashore requires projects that occur in the wilderness to undergo a minimum requirement/minimum tool analysis, which evaluates need of and proposed tools used to implement projects.

Long-Term Effects

Current impacts to wilderness character at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour have arisen from human manipulation of the natural dune environment by planting of non-native, invasive plants species that, through rapid expansion, have come to detract from the natural and untrammeled nature of wilderness within dunes. These species create dense monocultures that directly displace native coastal dune vegetation communities and associated rare plants such as Tidestrom's lupine (FE) and beach layia (FE), as well as indirectly impacting special status wildlife species such as western snowy plover (FT) and Myrtle's silverspot butterfly (FE).

By removing non-native, invasive plant species from wilderness portions of dunes, Alternative B would have very negligible to negligible beneficial effects on wilderness character at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with intensity dependent on the extent of wilderness restored. Wilderness areas at AT&T include primarily the beach, although they may extend into the southern portion of the dune system and do include a portion of North Beach. At B Ranch/A Ranch/Davis Property, they include most of the foredunes and extend some distance into the backdune area, so potential benefits would be higher at this project area. All of the Limantour Spit dunes fall within wilderness boundaries.

Following restoration, these impacts would end within restored areas, and, in fact, restoration should actually improve the untrammeled nature of the wilderness by removing plants that were installed by humans to manipulate the dune environment. Restoration would also increase outstanding opportunities for solitude and an unconfined type of recreation by removing dense stands of European beachgrass and iceplant that discourage visitation and enjoyment of the dunes. The dunes may also be considered more scenic from the perspective of passers-by walking along the beach.

There would be no long-term adverse effects on wilderness character within these project areas, nor would dune restoration conducted in adjacent non-wilderness areas be expected to have long-term adverse effects on wilderness character.

Implementation-Related and Short-Term Effects

Staging and Access: At AT&T and B Ranch/A Ranch, staging and access would occur primarily in adjacent grasslands or coastal scrub, which are typically outside wilderness and thereby substantially reduce or even eliminate the potential for impacts on wilderness (No Effect). Some of the staging and access at North Beach could take place on paved roads and parking lots that are not in wilderness. Staging and primary access at Limantour would also take place in non-wilderness areas associated with Limantour Road road corridor, parking lots near the beach, and the beach access road south of Limantour Pond. At Limantour, there could be some indirect impacts of staging and access on adjacent wilderness areas. Therefore, staging and access would either have no effect or very negligible adverse effects on wilderness character, including solitude and natural systems, at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with higher intensity effects potentially occurring at Limantour.

Manual Removal: Manual removal of invasive plant species could have adverse impacts on wilderness character due to the presence of crews and use of all-terrain vehicles such as UTVs. Specific wilderness characteristics that would be potentially impacted would be solitude and natural systems. UTVs are used not only to transport crews, but, in certain circumstances, to transport biomass. Without use of UTVs, crews would be required to walk in carrying appropriate supplies and transport by hand removed biomass. Ultimately, the sheer volume of materials and distance that would need to be travelled would greatly decrease efficiency and ultimately result in more contractor cost and less acreage being restored. In addition, disposal of material on-site can sometimes pose a risk to reestablishment of removed species, as well as result in unsightly "piles" within wilderness areas.

Therefore, under Alternative B, the minimum tool necessary to accomplish restoration objectives would include UTVs, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable. Potential impacts would be minimized by limiting UTV access as much as possible to the minimum number of vehicles needed and potentially requiring crews to park UTVs outside the wilderness boundaries when not in use. Based on these factors, including proposed impact avoidance and minimization measures, adverse impacts during implementation on wilderness character would range from negligible (Limantour, B Ranch/A Ranch, North Beach) to very negligible (effects on adjacent beach; AT&T). Manual removal may have some, albeit much less, effect on wilderness when these actions are conducted in areas adjacent to wilderness.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

On a regional scale, there would be no potential for cumulative impacts as Congressionally designated wilderness does not occur outside the Seashore within this region.

Conclusions

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket and bush lupine.

Current impacts to wilderness character at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour have arisen from human manipulation of the natural dune environment by planting of non-native, invasive plants species that, through rapid expansion, have come to detract from the natural and untrammeled nature of wilderness within dunes. By removing non-native, invasive plant species from wilderness portions of dunes, Alternative B would have very negligible to negligible beneficial effects on wilderness character at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with intensity dependent on the extent of wilderness restored. Wilderness areas at AT&T include primarily the beach, although they may extend into the southern portion of the dune system and include some of the dune system at North Beach. At B Ranch/A Ranch/Davis Property, they include most of the foredunes and extend some distance into the backdune area, so potential benefits would be higher at this project area. Almost all of the Limantour Spit dunes fall within wilderness boundaries. There would be no long-term adverse impacts to wilderness character.

During implementation, the presence of crews and UTVs could have either no effect if activities are conducted outside wilderness or have up to negligible adverse impacts if activities are conducted inside wilderness. Staging and access would either have no effect or very negligible adverse effects on wilderness character, including solitude and natural systems, at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with higher intensity effects potentially occurring at Limantour. In addition to NEPA and other permitting and consultation needs, the Seashore requires projects that occur in the wilderness to undergo a minimum requirement/minimum tool analysis, which evaluates need of and proposed tools used to implement projects. Under Alternative B, the minimum tool necessary to accomplish restoration objectives would include UTVs, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable. On a regional scale, there would be no potential for cumulative impacts as Congressionally designated wilderness does not occur outside the Seashore within this region.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

In addition to NEPA and other permitting and consultation needs, the Seashore requires projects that occur in the wilderness to undergo a minimum requirement/minimum tool analysis, which evaluates need of and proposed tools used to implement projects.

Long-Term Effects

A complete description of the potential benefits to wilderness character, including solitude and natural systems, associated with restoration can be found under Alternative B. Alternative C would result in very negligible (impacts to adjacent beach; AT&T), minor (B Ranch, A Ranch, North Beach), or moderate (Limantour) beneficial effects on wilderness character, with higher intensity benefits anticipated for areas where more of the dunes fall under wilderness designation (North Beach, B Ranch/A Ranch/Davis Property, and Limantour). There would be no long-term adverse effects on wilderness character.

Implementation-Related and Short-Term Effects

Staging and Access: In general, access and staging impacts on wilderness would be identical to those under Alternative B, although the intensity of access and staging requirements – and impacts – may increase slightly, as mechanical removal would only be used in wetland and organic pasture buffer areas. Staging and primary access would have no effect or possibly negligible adverse impacts on wilderness character, including solitude and natural systems, at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Higher intensity impacts could result from indirect impacts of staging and access by heavy equipment in non-wilderness areas at Limantour (Limantour road, parking lots, and access road south of Limantour Pond) on adjacent wilderness areas. Primary access and staging at AT&T/North Beach and B Ranch/A Ranch/Davis Property would occur at some distance from wilderness areas.

Manual Removal: Impacts of manual removal on wilderness are similar to those discussed under Alternative B, although the scale of manual removal would be reduced under this alternative to removal of iceplant and European beachgrass from wetlands and potentially buffers. Based on factors discussed, impacts from manual removal at AT&T and B Ranch would range from very negligible (impacts to adjacent beach; AT&T) to negligible (North Beach, B Ranch/A Ranch/Davis Property, Limantour) due to the fact that more of the dunes at North Beach, B Ranch/A Ranch/Davis Property, and Limantour fall within wilderness boundaries.

Mechanical Removal: Mechanical removal of European beachgrass could have adverse impacts on wilderness character due to the presence of heavy equipment, crews, and UTVs. Specific wilderness characteristics that would be potentially impacted would be solitude and natural systems. Under Alternative C, the minimum tool necessary to accomplish restoration objectives would include UTVs and excavators, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable. These potential impacts would be minimized by limiting UTV access as much as possible to the minimum number of vehicles needed and potentially requiring crews to park UTVs outside the wilderness boundaries when not in use. However, these same measures are not feasible for heavy equipment, however, the amount of heavy equipment and duration of use would be greatly reduced under Alternative C relative to Alternative D.

Based on these factors, including proposed impact avoidance and minimization measures, adverse impacts from mechanical removal within wetland and organic pasture buffer areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would range from negligible (AT&T, Limantour) to minor (North Beach, B Ranch/A Ranch/Davis Property) due to the fact that more of the dunes within the latter project areas fall within wilderness boundaries. While adjacent to Estero de Limantour, European beachgrass and iceplant stands on the Limantour Spit are largely more than 25 feet away from wetlands associated with the Estero, which limits the amount of mechanical removal necessary in wetland buffer areas, and there are no nearby organic pastures. Mechanical removal within non-wilderness areas could still have some effect on wilderness, if construction occurs immediately adjacent to wilderness, although impacts would be expected to be no more than minor and decrease with distance.

Chemical Control: Chemical control of invasive plants could have adverse impacts on wilderness character due to the presence of crews and UTVs. In addition, in certain project areas, post-treatment mowing would be conducted. Specific wilderness characteristics that would be potentially impacted would be solitude and natural systems. UTVs are used to transport crews and supplies. Without use of UTVs, crews would be required to walk in carrying appropriate supplies such as backpacks, water, safety gear, and other items. Ultimately, the sheer volume of materials and distance that would need to be travelled would greatly decrease efficiency and ultimately result in more contractor cost and less acreage being restored.Under Alternative C, the minimum tool necessary to accomplish restoration objectives would include, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable. Mowing and prescribed burning proposed as potential pre-treatment measures may ultimately not be conducted within wilderness, as they are not actions that are essential for successful implementation of dune restoration.

Given the emphasis on using the minimum tools, otential impacts to wilderness from use of mechanical equipment would be minimized by limiting UTV access as much as possible to the minimum number of vehicles needed and potentially requiring crews to park UTVs and mowing equipment outside the wilderness boundaries when not in use. Based on these factors, including proposed impact minimization measures, adverse impacts during implementation from chemical control would range from no effect to possibly moderate at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with higher intensity impacts occurring within areas such as Limantour where more of the dunes fall within wilderness boundaries. Chemical control activities would have negligible effects on wilderness when activities are conducted outside, but immediately adjacent to, wilderness.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

On a regional scale, there would be no potential for cumulative impacts as Congressionally designated wilderness does not occur outside the Seashore within this region.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal potentially. In addition to NEPA and other permitting and consultation needs, the Seashore requires projects that occur in the wilderness to undergo a minimum requirement/minimum tool analysis, which evaluates need of and proposed tools used to implement projects. Therefore, under Alternative C, the minimum tool necessary to accomplish restoration objectives would include UTVs and excavators, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable. Mowing and prescribed burning proposed as potential pre-treatment measures may not be conducted within wilderness, as they are not actions that are essential for successful implementation of dune restoration.

Alternative C would result in very negligible (AT&T), minor (North Beach, B Ranch/A Ranch/Davis Property), or moderate (Limantour) beneficial effects on wilderness character, with higher intensity benefits anticipated for areas where more of the dunes fall under wilderness designation (North Beach, B Ranch/A Ranch/Davis Property, and Limantour). There would be no long-term adverse effects on wilderness character.

During implementation, the presence of crews, UTVs, and potentially heavy equipment could have either no effect if activities are conducted outside wilderness or up to moderate adverse impacts on if activities are conducted inside wilderness, with higher intensity short-term impacts potentially expected for mechanical removal in buffers at North Beach and B Ranch/A Ranch/Davis Property and chemical control activities at Limantour. On a regional scale, there would be no potential for cumulative impacts as Congressionally designated wilderness does not occur outside the Seashore within this region.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

In addition to NEPA and other permitting and consultation needs, the Seashore requires projects that occur in the wilderness to undergo a minimum requirement/minimum tool analysis, which evaluates need of and proposed tools used to implement projects.

Long-Term Effects

A complete description of the potential benefits to wilderness character, including solitude and natural systems, associated with restoration can be found under Alternative B. Alternative D would result in very negligible (AT&T) to minor beneficial effects (North Beach, B Ranch/A Ranch/Davis Property, Limantour), with higher intensity benefits anticipated for areas where more of the dunes fall under wilderness designation (North Beach, B Ranch/A Ranch/Davis Property, and Limantour). Relative to Alternative C, fewer acres may be potentially restored, so benefits to wilderness character are reduced accordingly. There would be no long-term adverse effects on wilderness character.

Implementation-Related and Short-Term Effects

Staging and Access: In general, access and staging impacts on wilderness would be identical to those under Alternative C, although the intensity of access and staging requirements – and impacts – may increase, as mechanical removal would be the primary removal method. Staging and primary access would have either no effect or possibly minor short-term adverse impacts on wilderness character, including solitude and natural systems, at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Higher intensity impacts (possibly minor) could result from indirect impacts of staging and access by heavy equipment in non-wilderness areas at Limantour (Limantour road, parking lots, and access road south of Limantour Pond) on adjacent wilderness areas. Primary access and staging at AT&T/North Beach and B Ranch/A Ranch/Davis Property would occur at some distance from wilderness areas.

Manual Removal: Impacts of manual removal on wilderness are very similar to those discussed under Alternative B, although the intensity of impacts would be reduced, because manual removal would only be used for iceplant and European beachgrass re-sprouts and removal in buffer areas. Based on factors discussed, adverse impacts during implementation from manual removal would range from very negligible (impacts on adjacent beach; AT&T)

to negligible (North Beach, B Ranch/A Ranch/Davis Property, Limantour) due to the fact that more of the dunes within these latter project areas fall within wilderness boundaries.

Mechanical Removal: Impacts of mechanical removal on wilderness are very similar to those discussed under Alternative C, although the intensity of impact would increase, because mechanical removal would be the primary removal method. Under Alternative D, the minimum tool necessary to accomplish restoration objectives would include excavators, bulldozers, and other heavy and light equipment, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable. Based on factors discussed, adverse impacts during implementation from mechanical removal would range from negligible (AT&T) to moderate (North Beach, Limantour, B Ranch/A Ranch/Davis Property) due to the fact that more of the dunes within these latter project areas fall within wilderness boundaries.

Chemical Control: Impacts of chemical control on wilderness are very similar to those discussed under Alternative C, although the intensity of impact would decrease considerably, as spot-spraying with herbicide would only be used to re-treat re-sprouts within mechanical removal areas. Manual removal would be the primary option for re-treatment in wilderness areas, unless the extent of reestablishment warranted chemical control. Based on factors discussed, adverse impacts during implementation from chemical control would range from very negligible (AT&T) to minor (North Beach, B Ranch/A Ranch/Davis Property, Limantour) due to the fact that more of the dunes within these latter project areas fall within wilderness boundaries.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

On a regional scale, there would be no potential for cumulative impacts as Congressionally designated wilderness does not occur outside the Seashore within this region.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant. In addition to NEPA and other permitting and consultation needs, the Seashore requires projects that occur in the wilderness to undergo a minimum requirement/minimum tool analysis, which evaluates need of and proposed tools used to implement projects. Under Alternative D, the minimum tool necessary to accomplish restoration objectives would include excavators, bulldozers, and other heavy and light equipment, but the extent and duration of use within wilderness would be minimized to the maximum extent practicable.

Alternative D would result in very negligible (impacts on adjacent beach; AT&T) to minor (North Beach, B Ranch/A Ranch/Davis Property, Limantour) beneficial effects, with higher intensity benefits anticipated for areas where more of the dunes fall under wilderness designation (North Beach, B Ranch/A Ranch/Davis Property, and Limantour). Relative to Alternative C, fewer acres may be potentially restored, so benefits to wilderness character are reduced accordingly. There would be no long-term adverse effects on wilderness character.

During implementation, the presence of crews, UTVs, and heavy equipment could have either no effect on wilderness character if activities such as staging and primary access are conducted outside wilderness or up to moderate adverse impacts on if activities such as mechanical removal are conducted inside wilderness. On a regional scale, there would be no potential for cumulative impacts as Congressionally designated wilderness does not occur outside the Seashore within this region.

Soundscapes

While noise often has a negative connotation, one of the intrinsic values of national parks remains the potential for hearing "natural" noises such as crashing waves, running streams, thunder, or singing birds. A combination of noises that is intrinsic to a natural landscape is often characterized as a soundscape.

Unlike more urban parks, the Seashore and north district of GGNRA are located in a rural portion of western Marin County and must contend less with the intrusive influences of urbanization than the southern portions of GGNRA. Regardless of location, however, the Park Service is directed to preserve, to the greatest extent possible, the natural soundscapes of parks and to restore soundscapes that have become degraded due to "unnatural sounds" (noise; NPS 2006, Section 4.9).

In areas of the Seashore near the dunes, the predominant human-related source of noise is car and truck traffic on Sir Francis Drake Boulevard or other arterial roads, traffic in parking lots, and car, truck, farm equipment, and motorized all-terrain vehicle (e.g., ATV) activity on ranches. There may also be noise generated on occasion by park road or facility maintenance activities such as roadwork. Typical natural sources of sound include the sound of waves crashing on the beach, wind, and the call of birds. The FAA study estimated ambient levels along the Great Beach and adjacent coastal dunes, scrub, and grasslands as ranging between 30 to <40 dBA-LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011).

Manual, mechanical, and chemical removal of European beachgrass and iceplant can both directly and indirectly soundscapes. Direct impacts would relate mostly use of heavy equipment in mechanical removal or motorized equipment such as UTVs and presence of crews in other types of restoration efforts. Measures that could avoid or minimize these impacts include including requiring vehicles to have received recent maintenance and be in good operating condition, restricting equipment idling time, and reducing the number of concurrently operating pieces of equipment.

Policies and Regulations

The NPS Organic Act (16 USC section 1) establishes and authorizes NPS "to conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." An important aspect of the natural communities that NPS is directed to preserve in the national park system is the natural soundscape, which enhances visitor experience and reduces disturbances of wildlife.

NPS Management Policies 2006, section 4.9, "Soundscape Management," requires that NPS "preserve, to the greatest extent possible, the natural soundscapes of parks." Additionally, the Park Service "will restore to the natural condition wherever possible those park soundscapes that have become degraded by the unnatural sounds (noise) and will protect natural soundscapes from unacceptable impacts" (NPS 2006).

Director's Order 47 (Soundscape Preservation and Noise Management) was developed to emphasize Park Service policies "that will require, to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources." This Director's Order also directs park managers to measure acoustic conditions, differentiate existing or proposed human-made sounds that are consistent with park purposes, set acoustic goals based on the sounds deemed consistent with the park purpose, and determine which noise sources are impacting the parks (NPS 2000).

Additionally, NPS Management Policies 2006, Section 8.2.3, "Use of Motorized Equipment," acknowledges that motorized equipment operating in national parks could adversely impact the park's natural soundscape. To preserve the natural soundscape, park superintendents will manage when and where motorized equipment is used, evaluating effects on the natural soundscape against the natural ambient sound level (that which exists in the absence of human-induced sounds; NPS 2006d).

The Code of Federal Regulations recognizes concerns for preserving natural soundscapes; 36 CFR 2.12 (Audio Disturbances) restricts the use of certain types of motorized equipment or machinery in units of the park system (e.g., power saws) and places sound level limitations on others (e.g., motor vehicle, generating plant). Noise levels that exceed 60 dBA at 50 feet from the source, noise that is unreasonable given the location or time of day, and noise that is not in keeping with the purpose for which the area was established are conditions that are usually inappropriate or excessive.

Park Service standards are stricter than the 24-hour noise thresholds of 60 dB-Ldn established by the County of Marin. The County of Marin has established 24-hour noise thresholds of 60 dB-Ldn associated with operation of a completed project. This threshold pertains to a 24-hour average noise level, including the assignment of a 10dB penalty for noise occurring at night between 10 p.m. and 7 a.m. It should be noted that the 24-hour noise threshold for agricultural and industrial areas is 70 dB-Ldn.

Most of the Park Service regulations are focused on noise associated with long-term operations or consistent park use or activities such as noise in developed campgrounds. The noise associated with construction is different from operational noises, because it is louder, but usually short-term or more intermittent and does not occur in the evening or nighttime hours. For this reason, some counties such as Napa and Solano County have established separate thresholds of 75 dBA on construction activities at 50 feet. Neither the Park Service nor the County of Marin have an established construction noise ordinance. However, construction-related noise that does not exceed 75 dBA during the hours of 7:00 a.m. to 6:00 p.m., Monday through Friday, would meet the 24-hour noise thresholds of 60 dB-Ldn established by the County of Marin.

Following construction, implemented projects can exert long-term effects on soundscapes, effectively changing ambient noise levels. Changes in ambient noise of less than 3 dBA are assumed to be negligible due to the fact that human ear can barely detect changes of this magnitude. USEPA guidance suggested that long-term noise increase of 5 to 10 dBA (frequency weighted sound decibels) above background noise should be considered to have a noticeable effect (USEPA 1980 *in* ICF 2010).

Assessment Methodology

As described in chapter 3, the magnitude of noise is usually described by its sound pressure. Sound pressures described in decibels are often defined in terms of frequency-weighted scales. Sound levels measured using an A-weighted decibel scale are generally expressed as dBA. Throughout this section, all noise levels are expressed in dBA. A-weighting is based on human hearing capabilities. Comparative studies of vertebrate hearing suggest that dBA values are likely to overstate the perceived loudness of noise for all terrestrial vertebrates at Point Reyes.

Impacts on soundscapes are judged primarily by the contribution of human-caused sound to the natural soundscape, based on the assumptions described in the *Affected Environment* section. Assumptions include the following:

-- Ambient noise levels along the Great Beach and adjacent coastal dunes, scrub, and grasslands were recently estimated in a FAA study as ranging between 30 to <40 dBA-LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011). This level incorporates any existing sources of human-caused noise related to ranching and park operations and, therefore, overstates natural background conditions. However, it relates most directly to everyday experience and serves as a reasonable upper bound for the natural ambient sound level for most coastal dune areas within the Seashore. Higher sound levels could be found at atypical locations close to noise sources such as sections of dunes directly adjacent to the ocean.

-- The hours of construction for most dune restoration projects would be 7 a.m. to 6 p.m. during weekdays. Any work exceeding these hours or occurring on the weekends would be short-term and would require approval by the Seashore. The absence of project-related construction noise during the evening and night hours means that noise during night hours would not exceed low-level ambient or background conditions for town and rural areas (~45 dBA). Therefore, construction-related noise that does not exceed 75 dBA during the hours of 7:00 a.m. to 6:00 p.m., Monday through Friday, would not exceed 60 dB-Ldn during a 24-hour period.

-- Noise produced by construction equipment depends upon a number of variables. These variables include: 1) the type of equipment (e.g., excavator, jackhammer, bulldozer, sheet pile driver, dump truck, etc.), 2) period of operation of equipment, 3) number of pieces of equipment operated simultaneously, 4) distance to construction equipment, and 5) effects of topography and other factors (e.g., sound walls, wind direction, thick, dense vegetation) on noise propagation or attenuation. The number of pieces of construction equipment operating simultaneously can vary considerably during the construction period, but it can be assumed that several pieces of equipment might be operating simultaneously.

For the purposes of this analysis, it was assumed that mechanical removal would represent the greatest potential impact to soundscapes due to use of heavy equipment. Based on the Abbotts Lagoon Phase I project, two excavators were typically teamed with one bulldozer. When multiple teams of heavy equipment were used during that project, teams were typically separated by at least 100 feet, if not more. For that reason, this analysis does not combine multiple teams into one noise source. Noise generated by maximum number of simultaneously operating construction equipment in these construction focus areas will be evaluated relative to a standard distance of 50 feet.

-- Noise levels decrease with increasing distance from the source. For this analysis, the attenuation of noise with distance was factored into the analysis. Noise decreases approximately 6 dBA for every doubling of distance.

Impact Thresholds

The thresholds below focus on noise generated during implementation of proposed projects and changes in ambient sound levels following implementation. There would be no long-term operations associated with these projects. The following thresholds are adapted from those used for the Giacomini Wetland Restoration Project (NPS 2007).

Negligible: Proposed projects would generate construction-related noise that would be barely detectable (change of ≤ 3 dBA) from existing conditions and within the range of ambient or background noise conditions. Over the long-term, proposed projects would generate an undetectable or barely detectable change (generally ≤ 3 dBA) in ambient noise conditions.

Minor: The proposed project would generate construction-related noise that would have small, but detectable or measurable effects on soundscapes during construction. Maximum noise levels during construction would not exceed 75 dBA as perceived by the nearest sensitive receptor. Over the long-term, the proposed project could generate a small, but detectable change in ambient noise conditions.

Moderate: Proposed projects would generate construction-related noise that would have a apparent or appreciable effect on soundscapes during construction. Maximum noise levels during construction may exceed 75 dBA as perceived by the nearest sensitive receptor for short periods of time, without construction noise mitigation measures. Over the long term, proposed projects would generate an apparent or appreciable change in ambient noise conditions.

Major: Proposed projects would generate construction-related noise that would have a substantial effect on ambient noise levels (change of > 9 dBA) and highly apparent to sensitive receptors (e.g., beachwalkers) beyond existing conditions. Maximum noise generated during construction would potentially exceed 75 dBA for long periods of time as perceived by the nearest sensitive receptor. Over the long-term, proposed projects would generate a major or substantial change (> 10 dBA) in ambient noise conditions.

Impact of Alternative A

Analysis

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Long-Term Effects

Alternative A would result in no long-term changes to ambient noise levels within the Seashore's dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Ambient noise along the Great Beach ranges form 30 to <40 dBA-LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011). Noise sources are largely natural ones such as waves crashing on the beach and birdcalls or the sounds associated with beachwalkers or people hiking in the dunes, with the intensity of noise dependent on the level of visitation. Visitaton rates at AT&T, B Ranch, A Ranch, and Davis Property are relatively low, while they are much higher at Limantour and North Beach. There would be no potential for near-term dune restoration activities to change ambient noise levels, nor would the absence of restoration be expected to have any detectable effect on soundscapes.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects on ambient noise levels at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, as no near-term dune restoration would be conducted, except for previously permitted projects.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Because AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour are located some distance from non-park lands, there are no external projects that could have cumulative impacts on soundscapes within these dune systems. Actions in the park that may have cumulative effects with Alternative A on soundscapes include maintenance and upgrade of park facilities near coastal areas. However, Alternative A in combination with these park actions would be expected to have no cumulative effect on soundscapes.

Conclusions

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Alternative A would be expected to have no long-term effect on ambient noise levels or soundscapes within either the project areas or the Seashore's dunes. Ambient noise along the Great Beach ranges form 30 to <40 dBA-LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011). There would be no potential for near-term dune restoration activities to change ambient noise levels, nor would the absence of restoration be expected to have any detectable effect on soundscapes. There would also be no implementation-related or short-term effects on ambient noise levels.

Because AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour are located some distance from non-park lands, there are no external projects that could have cumulative impacts on soundscapes within these dune systems. Actions in the park that may have cumulative effects with Alternative A on soundscapes include maintenance and upgrade of park facilities near coastal areas. However, Alternative A in combination with these park actions would be expected to have no cumulative effect on soundscapes.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Long-Term Effects

Alternative B would result in no long-term changes to ambient noise levels within the Seashore's dunes. Once implementation has ended, background noise sources would revert largely to natural ones such as waves crashing on the beach and birdcalls. There may be occasional sounds from crews performing follow-up removal work, biologists monitoring changes in the dunes, or people hiking in the dunes. In addition, UTVs may be occasionally to support either follow-up treatment or monitoring. While UTVs are loud, generating noise potentially around 93- to 96 dB, these and other noise sources would not result in more than an undetectable or barely detectable change (generally ≤ 3 dBA) in ambient noise conditions due to the intermittent and short-term nature of these activities. Also, monitoring and visitation also occurs within unrestored dunes, as well, so some of these noises can be considered part of the ambient condition within dunes. For these reasons, Alternative B would be considered to have no long-term effect on soundscapes within the proposed project areas at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Implementation-Related and Short-Term Effects

Staging and Access: At AT&T and B Ranch/A Ranch, staging and primary access would occur primarily in adjacent grasslands or coastal scrub, while some of the staging and access at the Davis Property and North Beach could occur via paved roads and parking lots. At Limantour, staging and access would occur in the southernmost Limantour Beach parking lot. Manual removal is the least equipment-intensive alternative and would largely involve contractor crews, which might use UTVs or all-terrain vehicles to access sites. UTVs can generate noise as high as 93- 96 dBs.

For these reasons, adverse impacts to soundscapes from staging and access would be negligible to potentially minor, because staging and access activities tend to concentrate noise sources.

Manual Removal: Manual removal of invasive plant species could have very negligible to negligible impacts on soundscapes during implementation due to the presence of crews and use of all-terrain vehicles such as UTVs. UTV sounds are expected to be loud, but very intermittent, as crews drive to specific locations and park while conducting work. Potential impacts from use of UTVs would be minimized by limiting UTV access as much as possible to the minimum number of vehicles needed. Higher intensity impacts would be expected where UTVs are used for transporting removed biomass to stockpile areas. In general, hilly topographic features such as dunes would tend to dampen the magnitude and intensity of noise from crews and vehicles. In addition, during implementation, crews and vehicles are more dispersed than during staging, which reduces noise levels, as well.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative on soundscapes are the same as those described in Alternative A. Based on distance or projected timing of other projects, there is no potential for a cumulative effect of dune restoration with other park projects on soundscapes within the project areas.

Conclusions

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Under Alternative B, dune restoration projects would be expected to have no long-term effect on ambient noise levels or soundscapes within the project areas. Ambient noise along the Great Beach ranges form 30 to <40 dBA-LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011).

During implementation, the presence of crews and UTVs could have very negligible to negligible adverse impacts on soundscapes. Staging and access could also have negligible to potentially minor impacts.

Based on distance or projected timing of projects, there is no potential for external or park projects to have cumulative impacts with Alternative B on soundscapes within the project areas.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Long-Term Effects

A complete discussion of the potential long-term effects of dune restoration on soundscapes can be found in Alternative B. For the reasons discussed, Alternative C would also be considered to have no long-term effect on soundscapes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Implementation-Related and Short-Term Effects

Staging and Access: Impacts of staging and primary access would be very similar to those discussed under Alternative B, although the intensity may increase slightly, because heavy equipment would potentially be used for invasives removal in wetland and organic pasture buffer areas. Under Alternative C, potential adverse impacts to soundscapes from staging and access would be negligible to minor, with minor impacts potentially resulting from staging of heavy equipment, particularly in public areas such as parking lots (e.g., Limantour, North Beach).

Manual Removal: Impacts of manual removal on soundscapes are very similar to those discussed under Alternative B, although the intensity of impacts may be reduced slightly as manual removal would be used primarily for iceplant and removal of European beachgrass in buffers and wetlands. Manual removal of invasive plant species could have very negligible adverse impacts on soundscapes during implementation due to the presence of crews and use of UTVs.

Mechanical Removal: Mechanical removal of European beachgrass could have implementation-related adverse impacts on soundscapes due to the presence of heavy equipment, crews, and UTVs. As described earlier, based on equipment used for the Abbotts Lagoon Phase I project, mechanical removal could involve one or more teams of two (2) excavators and one (1) bulldozer. These teams are likely to be distributed throughout different portions of a project area rather than working together. Average maximum noise levels (Lmax) at 50 feet from heavy equipment range from about 73 to 101 dBA for equipment (WSDOT 2013). These numbers were identified from several studies and represent average maximum noise levels of reported values (WSDOT 2013). Based on likely groupings of equipment during dune restoration, the maximum noise generated at 50 feet would be 86 dBA. During construction using heavy equipment, noise is generated more or less at a constant level (WSDOT 2013). UTVs may also be used for worker transport, but, as they are not operated continuously, noise levels would not be constant.

Noise levels are not only affected by distance from the source, but by topography. The undulating topography of the dunes provides a natual sound barrier that dampens noise levels based on hilliness of the terrain. Levels of noise reduction at 50 feet from heavy equipment could vary from 9 to almost 20 dB based on representative dune topographic cross-sections from LIDAR information collected at Abbotts Lagoon. Based on this, the adjusted maximum noise generated at 50 feet within hilly dune areas could vary from 67 to 77 dBA, with relatively flat sections of dunes having higher, unattenuated noise levels (~86 dBA). Higher intensity construction noise would be expected in relatively flat dune areas or in low-relief dune areas such as foredunes at Limantour and B Ranch, while lower noise levels would be expected at AT&T, which is much hillier than either of the other two project areas.

Because earthmoving and other construction activities would generate noise at levels that may exceed 75 dBA in certain areas or for short periods of time, impacts under this alternative would be characterized as moderate at Limantour and in certain areas of B Ranch, A Ranch, Davis Property, and North Beach. These impacts would be very short-term and localized within portions of the project areas (e.g., dune basins, foredunes) and would be mitigated to less than moderate using Best Management Practices identified below. In general, construction in other portions of the project areas at B Ranch, A Ranch, Davis Property, and North Beach and at AT&T would be expected to have no more than minor impacts to soundscapes due to the presence of sound-attenuating features such as dunes.

Chemical Control: Chemical control could have negligible to minor adverse impacts on soundscapes on a localized scale during implementation due to the presence of crews and use of all-terrain vehicles such as UTVs. UTV sounds are expected to be loud, but very intermittent, as crews drive to specific locations and park while conducting work. Potential impacts from use of UTVs would be minimized by limiting UTV access as much as possible to the minimum number of vehicles needed.

Possible Additional Mitigation Measures: To reduce noise levels to the maximum extent practicable in foredune areas, the construction contractor shall employ the following noise-reducing Best Management Practices (BMP). Construction would be limited to the hours of 8 a.m. and 6 p.m. Monday through Saturday, with weekends permissible only under special authorization from the Park Service. All equipment would have sound control devices that are no less effective than those provided by the original equipment and would have muffled exhaust. In addition, contractor would be required to maintain properly tuned equipment and limit idling time to 5 minutes, and limit the number of concurrently operating pieces of construction equipment in foredune areas.

Effectiveness of Proposed Mitigation Measures: Implementation of the proposed mitigation measures would reduce the intensity of impacts from moderate to minor and possibly even negligible.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative on soundscapes are described under Alternative A. Based on distance and projected project timing, there is no potential for a cumulative effect of dune restoration with other projects on soundscapes within the project areas.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, although it would also incorporate manual and mechanical removal potentially. Under Alternative C, dune restoration projects would be expected to have no long-term effect on ambient noise levels or soundscapes within within the project areas. Ambient noise along the Great Beach ranges from 30 to <40 dBA-LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011).

During implementation, staging and access could have negligible to minor adverse impacts on soundscapes, with minor impacts potentially resulting from staging of heavy equipment, particularly in public areas such as parking lots (e.g., Limantour, North Beach). At most of the other project areas, staging areas would be quite distant (>2,000 feet) from the nearest sensitive receptors (e.g., beachwalkers).

Use of UTVs by manual removal and chemical control crews could have very negligible impacts. Moderate impacts would potentially result from heavy equipment removing invasives in wetland or organic pasture buffers at Limantour, North Beach, B Ranch/A Ranch/Davis Property, as terrain is less hilly and, therefore, less able to dampen equipment noise. However, impacts from equipment working elsewhere at B Ranch/A Ranch/Davis Property, North Beach, and at AT&T would be minor. Potential moderate impacts would be mitigated to minor and possibly even negligible levels by requiring contractors to implement a number of Best Management Practices.

Based on distance and projected project timing, there is no potential for external or park projects to have cumulative impacts with the dune restoration program on soundscapes within the project areas.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Long-Term Effects

A complete discussion of the potential long-term effects of dune restoration on soundscapes can be found under Alternatives B and C. For the reasons discussed under these alternatives, Alternative D would also be considered to have no long-term effect on soundscapes.

Implementation-Related and Short-Term Effects

Staging and Access: Impacts of staging and primary access would be very similar to those discussed under Alternative C, although the intensity may be increased, because mechanical removal would be the primary restoration method. Under Alternative D, potential adverse impacts to soundscapes from staging and access would be minor to possibly moderate. Moderate impacts would be mitigated to less than moderate using Best Management Practices identified below.

Manual Removal: Impacts of manual removal on soundscapes are very similar to those discussed under Alternative B, although the intensity of impacts may be reduced, as manual removal would be used primarily for iceplant and removal of European beachgrass in buffers and wetlands, as well as removal of re-sprouts. Manual removal of invasive plant species could have very negligible adverse impacts on soundscapes during implementation due to the presence of crews and use of UTVs.

Mechanical Removal: Impacts of mechanical removal on soundscapes are very similar to those discussed under Alternative C. Maximum noise generated by heavy equipment at 50 feet within hilly dune areas could vary from 67 to 77 dBA, with relatively flat sections of dunes having higher, unattenuated noise levels (~86 dBA). Higher intensity construction noise would be expected in relatively flat dune areas or in low-relief dune areas such as foredunes at Limantour and portions of North Beach, B Ranch, A Ranch, and Davis Property, while lower noise levels would be expected at AT&T, which is much hillier than the other project areas.

Because earthmoving and other construction activities would generate noise at levels that may exceed 75 dBA in certain areas or for short periods of time, impacts under this alternative would be characterized as moderate at Limantour and portions of North Beach, B Ranch, A Ranch, and Davis Property. These impacts would be short- to at most medium-term and localized within portions of the project areas (e.g., dune basins, foredunes): Relative to Alternative C, the duration of time in which the threshold of 75 dBA would be exceeded would increase, but, as the scale of restoration would also decrease due to costs of mechanical removal, the impact intensity would not increase substantially. Moderate impacts would be mitigated to less than moderate using Best Management Practices identified below. In general, construction in other portions of the project areas at B Ranch/A Ranch/ Davis Property and North Beach and at AT&T would be expected to have no more than minor impacts to soundscapes due to the presence of sound-attenuating features such as dunes.

Chemical Control: Impacts of chemical control on soundscapes are very similar to those discussed under Alternative C, although the intensity of impact would be reduced considerably, as chemical control only be used for treatment of re-sprouts in mechanical removal areas. Chemical control of invasive plant species could have very negligible adverse impacts on soundscapes during implementation due to the presence of crews and use of UTVs.

Possible Additional Mitigation Measures: To reduce noise levels to the maximum extent practicable in foredune areas, the construction contractor shall employ the following noise-reducing Best Management Practices (BMP). Construction would be limited to the hours of 8 a.m. and 6 p.m. Monday through Saturday, with weekends permissible only under special authorization from the Park Service. All equipment would have sound control devices that are no less effective than those provided by the original equipment and would have muffled exhaust. In addition, contractor would be required to maintain properly tuned equipment and limit idling time to 5 minutes, and limit the number of concurrently operating pieces of construction equipment in foredune areas.

Effectiveness of Proposed Mitigation Measures: Implementation of the proposed mitigation measures would reduce the intensity of impacts from moderate to minor or even negligible.

Cumulative Impacts

Projects with the potential to have cumulative effects with those proposed under this alternative on soundscapes are described under Alternative A. Based on distance and projected project timing, there is no potential for a cumulative effect of dune restoration with other projects on soundscapes within the project areas.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Under Alternative D, dune restoration would be expected to have no long-term effect on ambient noise levels or soundscapes within the project areas. Ambient noise along the Great Beach ranges form 30 to <40 dBA-LD50 during both summer and winter months, with slightly higher ambient noise levels during winter months (FAA 2011).

During implementation, staging and access could have minor to potentially moderate adverse impacts, with potentially moderate impacts occurring due to staging of multiple pieces of heavy equipment. Use of UTVs by manual removal and chemical control crews could have very negligible adverse impacts. Moderate impacts would potentially result from heavy equipment removing invasives at Limantour and portions of North Beach, B Ranch, A Ranch, and Davis Property as terrain is less hilly and, therefore, less able to dampen equipment noise. Relative to Alternative C, the duration of time in which the threshold of 75 dBA would be exceeded would increase, but, as the scale of restoration would also decrease due to costs of mechanical removal, the impact intensity would not increase substantially. Impacts from equipment working elsewhere at North Beach, B Ranch, A Ranch, and Davis Property and at AT&T would be minor. Moderate impacts would be mitigated to minor and possibly even negligible levels by requiring contractors to implement a number of Best Management Practices.

Based on distance and projected project timing, there is no potential for external or park projects to have cumulative impacts with the dune restoration program on soundscapes within the project areas.

Cultural Resources

Policies and Regulations

Since the early 1900s, a number of laws and policies have been enacted to protect cultural resources, including the Antiquities Act of 1906 (16 USC §432), the Archeological Resources Protection Act of 1979 (16 USC §470aa et seq.), and the National Historic Preservation Act of 1966, as amended (NHPA; 16 USC §470 et seq.). In addition to federal and state laws governing protection of cultural resources, Executive Order 11593 instructs all federal agencies to support the preservation of cultural properties. The Park Service incorporated direction from law and federal policy into development of the Cultural Resources Management Guidelines (NPS 1998), which recognizes five types of cultural resources: archeological resources, historic structures, ethnographic resources, cultural landscapes, and museum objects.

The California Office of Historic Preservation is responsible for oversight of the NHPA in California. Federal and federally-sponsored programs and projects are reviewed pursuant to Sections 106 and 110 of the NHPA. Section 106 of the NHPA requires federal agencies to consider the effects of proposed federal undertakings on historic properties. NHPA requires federal agencies to initiate consultation with the State Historic Preservation Officer (SHPO) as part of the Section 106 review process.

Under these regulations, a determination of either adverse effect or no adverse effect must be made for affected NRHP-listed or eligible cultural resources. An adverse effect occurs whenever an action in an alternative alters, directly or indirectly, any characteristic of a cultural resource that qualifies it for inclusion in the NRHP. Adverse effects also include reasonably foreseeable effects caused by the proposal that would occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5, Assessment of Adverse Effects). The resolution of adverse effects can occur in a variety of ways, in accordance with 36 CFR 800.6 (Resolution of Adverse Effects). A determination of no adverse effect means there is an effect, but the effect would not diminish, in any way, the characteristics of the cultural resource that qualify it for inclusion in the NRHP. All effect determinations are made in consultation with the SHPO and/or the appropriate Tribal Historic Preservation Officers (THPO).

The DOI has included the presence of historic or cultural resources and/or on properties listed or eligible for listing on the National Register of Historic Places and potential for impacts to them in its criteria for determining potential significance under NEPA for the purposes of determining the appropriate NEPA pathway.

Assessment Methodology

As with consultations and permitting for other resources such as wetlands, water quality, and threatened and endangered species, individual Section 106 identification studies and consultations would need to be completed for any projects proposed at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. No project could be implemented until SHPO consultation – and consultation and permitting with other agencies – is complete.

One previously conducted archaeological survey and several resource specific studies have been conducted within the B Ranch/A Ranch/Davis Property portion of the project areas. Most recently, an archaeological survey was conducted for B Ranch Area of Potential Effect as part of another project: *Iceplant Removal at B Ranch, Section 106 Study Report, Point Reyes National Seashore, California* (Engel 2013). This study drew on results of earlier survey and report for a ranching project on B and C Ranches. The northern portion of the AT&T project area was surveyed previously as part of the Abbotts Lagoon Coastal Dune Restoration Project – *Archaeological Survey and Geoarchaeological Trenching Results for Abbotts Lagoon Dune Restoration, Point Reyes National Seashore* (Meyer and Dalldorf 2006). Another archaeological surface survey was conducted in 2013 to cover the northern portions of this portion of the project area not covered by the study for the Abbotts Lagoon restoration.

Surveys have also been conducted previously at Limantour. Within the vicinity of the Limantour Spit, several Native American archaeological sites are also recorded. These sites are listed as contributors to the Point Reyes Indigenous Archaeological District as part of the Drakes Estero Site Cluster. Four of these sites are also listed as contributing sites of the Drakes Bay Historic and Archaeological District National Historic Landmark. In general, these sites are characterized as sandy, shell middens with a diverse assemblage of materials suggesting a variety of subsistence and specialized activities over a long period. Two of the sites were extensively excavated in the 1960s, and the resultant collections are housed in the Red Barn Collections Facility at the Seashore.

The information in these studies is used to specifically assess the probability of impacting archaeological or historic resources at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour given mitigation measures the park would enforce during invasives removal efforts.

Impact Thresholds

The following thresholds were used to determine the magnitude of potential impacts to cultural resources resulting from implementation of any of the alternatives at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. In general, cultural resources are non-renewable resources, and adverse effects to these resources generally consume, diminish, or destroy the original historic materials or form, resulting in a permanent loss in the integrity of the resource that can never be recovered.

The impact thresholds were informed by the processes outlined in 36 CFR 800, the process for compliance with Section 106 of the National Historic Preservation Act. The "Negligible" and "Minor" levels of adverse impact were meant to correspond with the Section 106 determinations of No Historic Properties Affected (36 CFR 800.4(d)(1)) or No adverse effect (36 CFR 800.5(d)(1)). Likewise, the "Moderate" and "Major" levels of adverse impact were meant to correspond with the Section 106 determination of Adverse Effect (36 CFR 800(d)(2)). However, these determinations can only be made through the Section 106 process and in consultation with participants in the Section 106 process as defined in 36 CFR 800.2.

Some of the potential adverse impacts may be eliminated or reduced by mitigation actions that include preservation or site stabilization. The alternatives' evaluation takes into consideration standard BMPs for cultural resource preservation.

The proposed projects have the potential to affect cultural landscapes and archaeological resources that occur within the project area and other possible culture resources that have not yet been discovered through removal of invasive plant species. This is evaluated based on the type of restoration method employed and likelihood that certain areas might have archaeological or historic resources based on locations of recorded finds.

Intensity definitions for impacts to archaeological and historic resources are described as follows:

Negligible. Impacts would be at the lowest level of detection, barely measurable with neither adverse nor beneficial consequences. Cultural resources would incur no change or barely perceptible changes having no effect on the property's significant characteristics or their integrity of location, design, setting, materials, workmanship, feeling, or association.

Minor. Impacts would be measureable or detectable but would be slight and would not diminish the overall integrity of the resource or its ability to convey significance.

Moderate. Impacts would result from changes that would alter the significant characteristics of a cultural resource in a manner that would diminish its integrity of location, design, setting, materials, workmanship, feeling, or association but not to the extent that the property loses its significance.

Major**:** Impacts would result from substantial or highly noticeable changes that would alter the significant characteristics of a cultural resource in a manner that would diminish its integrity of location, design, setting, materials, workmanship, feeling, or association to the extent that the property is no longer able to convey its significance.

Impact of Alternative A

Analysis

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Long-Term Effects

In general, there would be no potential for long-term effects associated with project implementation, as near-term dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would not be conducted, except for previously permitted projects. Under existing conditions, however, some impacts could occur to Historic District resources, recorded or unrecorded archeological or historic resources, and contributing archeological resources at Limantour. Limantour is located in the Drakes Bay Historic and Archaeological District, which is a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District.

AT&T/North Beach and B Ranch/A Ranch/Davis Property are located in the Shafter/Howard Tenant Ranches Historic District, however, F Ranch – which adjoins or historically adjoined

AT&T/North Beach -- is not one of the component ranches because it lacks sufficient integrity to be individually eligible for listing in the National Register of Historic Places. In general, for the other ranches, grazing pastures are considered "contributing features" to this historic district. Sand remobilization from dunes can impact adjacent pastures. While there would be no potential for direct impacts to these features under Alternative A, as restoration would not be conducted, indirect impacts may still occur even without restoration. Based on analysis of historic aerial imagery using GIS, the dunes have continued to migrate inland over the past 60- 70 years despite rapid spread of invasive plant species such as European beachgrass and iceplant, which were originally planted to stabilize the dunes. The rates of inland dune growth between 1943 and 2007 have varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual growth rates of dunes during this period of 0.25% to 0.91% (Johnson 2013a). Alternative A would not be expected to increase existing rates of dune expansion, so there would be no effect.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

There are no external projects that could have cumulative impacts on cultural resources within the Seashore's dunes and adjacent grasslands. Actions in the park that may have cumulative effects on cultural resources include routine and non-routine ranch maintenance projects initiated either by the rancher or by the park, maintenance and upgrade of park facilities near coastal areas, and other habitat restoration projects. As no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour under Alternative A, there would be no potential for this alternative to have any cumulative impact with other park and lessee projects.

Conclusions

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects. For this reason, there would be no potential for long-term effects on cultural resources associated with project implementation under Alternative A. There would also be no potential for a cumulative impact with either projects conducted inside or outside the park.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Long-Term Effects

Staging and Access: Most of the primary access roads and staging areas are located in the grasslands or coastal scrub adjacent to dunes. To the maximum extent practicable, existing ranch or other roads would be used for primary access. Staging areas would also be located within previously disturbed areas when possible, such as parking lots. Because Alternative B would focus on manual removal, the only equipment that would need access and staging are likely to be trucks, all-terrain vehicles such as UTVs or ATVs, and possibly other small motorized equipment. No heavy equipment would be required.

AT&T/North Beach and B Ranch/A Ranch/Davis Property occur in the Point Reyes Ranches Historic district or Shafter/ Howard Tenant Ranches Historic District, however, F Ranch – which adjoins or historically adjoined AT&T/North Beach -- is not one of the component ranches because it lacks sufficient integrity to be individually eligible for listing in the National Register of Historic Places. Staging and access at B Ranch/A Ranch/Davis Property may have negligible adverse impacts on the contributing features, including grazing pastures, to this historic district. Impacts would be no more than negligible, because it is unlikely that grading or any other improvements would be needed to establish staging and access under this alternative. At the Davis Property, some of the access and staging could be located in paved areas such as park access road.

Limantour is located in the Drakes Bay Historic and Archaeological District, which is a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District. Staging and primary access would be unlikely to affect indigenous archeological sites, which are the only contributing sites that could potentially be affected by dune restoration and associated operations. At Limantour, staging and primary access would be located in paved parking lots, and primary access would be via paved or existing maintenance access roads. Archeological sites are largely located in the dunes themselves. Secondary access or staging could affect these sites: this is addressed under Manual Removal below.

The minimal equipment needed for manual removal of invasive plants would not be likely to require any site grading or other site preparation for staging and access. For this reason, staging and access would have the potential for only negligible direct effects on recorded and unrecorded archaeological and historic resources and contributing sites at Limantour. No long-term indirect effects on these resources would be anticipated.

Manual Removal: Manual removal activities would be focused on removal of iceplant, European beachgrass, and other invasive plant species from dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. In terms of the potential of this activity to impact historic districts such as the Shafter/Howard Tenant Ranches Historic District, most dune areas have been marginal areas for grazing throughout the historic-era because the soil and vegetation types are not conducive to production of high quality forage. Also, iceplant and European beachgrass are not preferentially foraged by cattle, with the latter typically only grazed if plants are newly established (Department of Agriculture-Australia 1896, Engel 2013). Therefore, removal of these species at B Ranch/A Ranch/Davis Property would have only a negligible direct affect on grazing pastures in terms of being contributing features for the Shafter/Howard Tenant Ranches Historic District.

Indirectly, as it has been discussed in many previous sections, including *Vegetation Resources* and *Natural Physical Processes and Soils*, manual removal and eradication of these species could increase remobilization of sands that could be transported inland into adjacent grazing pastures at AT&T/North Beach and B Ranch/A Ranch/Davis Property. However, as excavation of both European beachgrass (<1.5 feet) and iceplant (<0.5 feet) would be relatively shallow with manual removal, the potential for sand remobilization and indirect adverse impacts to contributing features from this activity is considered negligible to possibly minor. Active revegetation in backdune areas would help to minimize sand remobilization into contributing features of the historic districts.

During manual removal, there is a potential for impacts to previously recorded or unrecorded archaeological or historic resources. At Limantour, indigenous archeological sites could be disturbed: these sites are contributing sites to Limantour's inclusion in the Drakes Bay Historic and Archaeological District, which is a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District. The potential for impact would be either from manual removal or secondary access and staging associated with manual removal such as stockpiling of removed biomass or UTV access. Excavation during manual removal would be relatively shallow (< 1.5 feet), so there is low potential for impacts to deeper buried resources.

Areas with known sensitive resources would require avoidance of manual removal, biomass stockpiling, and UTV access, while areas with high potential for buried cultural resources may require presence of a cultural resource monitor during removal activities. Avoidance areas may be designated not only to avoid direct impacts from excavation, but also indirect impacts to resources from destabilization of sands. Under certain circumstances, the Seashore may try to implement impact mitigation measures to allow for more thorough removal efforts. For example, in avoidance areas, removal could be phased slowly, with removal followed by installation of erosion control materials and replanting to maintain stability of the identified site while still removing invasive species that could readily reinvade adjacent restored areas. Should unrecorded resources be found while manual removal is being performed, contractors would be required to follow the impact avoidance and minimization measures for Cultural Resources outlined in the *Alternatives* chapter.

The primary area at B Ranch where impacts from manual removal could occur is a drainage swale in the very southern portion of the ranch that cuts from the pasture through the dunes to beach. To ensure that pre-historic archaeological sites in this area are not destabilized by erosion, manual removal would either not be conducted within 150 feet from the centerpoint of this drainage (Engel 2013), or iceplant and European beachgrass would be removed in phases, with erosion control materials installed and direct seeding performed to help stabilize this area. Disturbance to historic-era surface scatter sites would be avoided by either having a cultural resource monitor present if manual removal occurs near these sites (Engel 2013). No biomass stockpiling or secondary access would be allowed in these sites.

Similar constraints exist along some of the other drainage swales at A Ranch and Davis Property. At Limantour, quite a few recorded archeological resources are currently buried in dunes below extensive stands of European beachgrass and iceplant. Manual removal would either not be conducted within mapped or estimated boundaries of these resources, or iceplant and European beachgrass would be removed in phases, with erosion control materials installed and direct seeding performed to help stabilize this area. No biomass stockpiling or secondary access would be allowed in these sites. A cultural resource monitor may be required during phased removal efforts within known resource sites.

A cultural resource monitor would be present at the Sensitive Resource Area identified at the northwestern perimeter of the AT&T site (Meyer and Dalldorf 2006).

Based on factors discussed above, including proposed impact avoidance and minimization measures, manual removal would likely have the potential for very negligible to possibly moderate direct adverse impacts on recorded and unrecorded archaeological and historic resources and contributing sites, with the potential for moderate impacts most likely at Limantour and small portions of the other project areas. Moderate impacts would potentially occur where recorded and unrecorded resources exist within established European beachgrass stands or iceplant stands and where removal of these plants could destabilize soils of the site. These impacts could be reduced to either negligible or minor either by avoidance or potentially by phasing removal efforts and taking steps to stabilize the area with erosion control procedures and revegetation.

Possible Additional Mitigation Measures: To reduce impacts to previously recorded resources from indirect impacts of invasives removal and possible site destabilization, a number of minimization measures may be employed instead of just strict avoidance, including use of less invasive removal techniques near sites (e.g., chemical control or manual removal), installation of erosion control materials, and active revegetation.

Effectiveness of Possible Additional Mitigation Measures: Implementation of the proposed mitigation measures would reduce the intensity of impacts from moderate to negligible or minor.

Cumulative Impacts

There are no external projects that could have cumulative impacts on cultural resources within the Seashore's dunes and adjacent grasslands. Actions in the park that may have cumulative effects on cultural resources include routine and non-routine ranch maintenance projects initiated either by the rancher or by the park, maintenance and upgrade of park facilities near coastal areas, and other habitat restoration projects. Ranching projects and habitat restoration projects are ones that are most likely to have cumulative effects on contributing features to historic districts. They may also have the potential for cumulative effects on pre-historic and historic-era resources, along with park maintenance projects. Examples of current park maintenance projects near the Seashore's dunes include proposed maintenance of Chimney Rock Road, potential removal of a portion of the South Beach parking lot, and upgrade of the park's Beaches water system. Due to thorough review of proposed park and lessee projects by the Seashore's Cultural Resources Division, the potential for dune restoration and other park and lessee projects to have cumulative effects that would cause more than a minor adverse impact on cultural resources within the Seashore would be unlikely.

Conclusions

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Based on the reduced scale of dune restoration conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour under this alternative, over the long term, this alternative would, in general, have only a negligible direct impact on historic districts. AT&T/North Beach and B Ranch/A Ranch/Davis Property occur in the Shafter/Howard Tenant Ranches Historic District, however, F Ranch – which adjoins or historically adjoined AT&T/North Beach -- is not one of the component ranches. Grazing pastures are considered contributing features to this historic district, however, most dune areas have been marginal areas for grazing throughout the historic-era. Therefore, removal of European beachgrass, iceplant, or other invasive species at B Ranch/A Ranch/Davis Property would not directly affect grazing pastures in terms of being contributing features to the historic district. Staging and access may have negligible adverse impacts on the contributing features. However, these impacts would be short-term at most and would have only negligible adverse effects on the grazing pastures or historic district as a whole.

Indirectly, as it has been discussed in many previous sections, including *Vegetation Resources* and *Natural Physical Processes and Soils*, invasives removal could increase remobilization of sands that could be transported inland into adjacent grazing pastures. As manual removal results in relatively shallow excavation depths (0.5-1.5 feet), indirect adverse impacts on contributing features to historic districts at B Ranch/A Ranch/Davis Property from sand remobilization would range from negligible to possibly minor. In addition, active revegetation would be conducted in backdune areas, which would minimize the potential from indirect impacts from sand remobilization.

During invasives removal, there is a potential for impacts to previously recorded or unrecorded archaeological or historic resources. The potential for impact would be reduced for manual removal relative to mechanical removal due to the decreased excavation depth. Avoidance areas may be designated not only to avoid direct impacts, but also indirect impacts to resources from destabilization of sands. Under certain circumstances, the Seashore may try to implement impact mitigation measures to allow for more thorough removal efforts such as phasing removal, installation of erosion control materials, or active revegetation. Should unrecorded resources be found while mechanical removal is being performed, contractors would be required to follow the impact avoidance and minimization measures for Cultural Resources outlined in the *Alternatives* chapter.

At B Ranch/A Ranch/Davis Property AT&T/North Beach, and Limantour, avoidance and/or mitigation may be required to protect archeological, prehistoric, and/or historic era sites. In additional, a cultural resource monitor may need to be present in certain removal areas or removal phases at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Indigenous archeological sites contribute to Limantour's inclusion in the Drakes Bay Historic and Archaeological District, a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District.

Based on these factors, including proposed impact avoidance and minimization measures, Alternative B would likely have the potential for negligible to possibly moderate direct impacts on recorded and unrecorded archaeological and historic resources and contributing sites, with the potential for possibly moderate impacts most likely at Limantour and in small portions of the other project areas. Moderate impacts could be reduced to negligible or minor using either avoidance or one of the minimization measures discussed above.

There are no external projects that could have cumulative impacts on cultural resources. Due to thorough review of proposed park and lessee projects by the Seashore's Cultural Resources Division, the potential for dune restoration and other park and lessee projects to have cumulative effects that would cause more than a minor adverse impact on cultural resources within the Seashore would be unlikely.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A

Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Long-Term Effects

Staging and Access: Impacts of staging and access would be very similar to those described under Alternative B, although the intensity of impacts may increase slightly due to the fact that heavy equipment could be used for invasives removal in wetland and organic pasture buffer areas.

As discussed in more detail under Alternative B, staging and access at B Ranch/A Ranch/ Davis Property may have negligible to possibly minor adverse impacts on contributing features such as grazing pastures to the Shafter/Howard Tenant Ranches Historic District, because use of heavy equipment may require grading or other site improvements to create new primary access routes or staging areas. However, as mechanical removal would not be used within some of the wetland buffers at B Ranch/A Ranch/Davis Property, potential impacts from staging and access of heavy equipment would be reduced within these project areas. Access and staging impacts may also be reduced at the Davis Property, because the paved park access road could be used. (AT&T/North Beach occur in the the district, as well, however, F Ranch – which adjoins or historically adjoined AT&T/North Beach -- is not one of the component ranches.)

If grading is required to construct new primary access roads or staging areas, there is a potential for impacts to previously recorded or unrecorded archaeological or historic resources. Grading for staging areas and roads would likely be shallow (< 1 foot), so there is low potential for impacts to deeper buried resources. Prior to implementation of any project, the literature would be reviewed, and a survey would be conducted to identify potential resources that need to be avoided. These areas would be demarcated as avoidance areas for grading, parking, or other staging activities. Should unrecorded resources be found while grading or other activities are being performed, contractors would be required to follow the impact avoidance and minimization measures for Cultural Resources outlined in the *Alternatives* chapter, which include stopping work within the vicinity of the find and contacting the Seashore's Cultural Resources representative immediately, who may also contact a representative for the Federated Indians of Graton Rancheria (FIGR).

Limantour is located in the Drakes Bay Historic and Archaeological District, which is a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District. Staging and primary access would be unlikely to affect indigenous archeological sites, which are the only contributing sites that could potentially be affected by dune restoration and associated operations. At Limantour, staging and primary access would be located in paved parking lots, and primary access would be via paved or existing maintenance access roads. Archeological sites are largely located in the dunes themselves. Secondary access or staging could affect these sites: this is addressed as part of Manual and Mechanical Removal and Chemical Control.

In addition to ranching historic districts, the park also has historic radio facilities, including at AT&T. At AT&T, contractor crews may stage some equipment near the historic radio facility in the paved areas, including heavy equipment, but impacts would be minimized to the maximum extent practicable, and no permanent changes or impacts to buildings, transmission lines, paved areas, or other facilities would be allowed. Any impacts from staging of equipment, vehicles, or materials would be temporary. If fuels or chemicals were stored in this area, they would be required to be stored in a mobile container, and any mixing or fueling would need to be conducted in a self-contained, tarped area, as outlined in spill prevention and response procedures. This would also minimize impacts to contributing features to the historic district.

Staging and access would likely also have at negligible to possibly minor direct effects on recorded and unrecorded archaeological and historic resources and contributing sites. No long-term indirect effects on these resources would be anticipated.

Manual Removal: Impacts of manual removal would be very similar to those discussed under Alternative B, although the intensity may be slightly reduced as manual removal would be used primarily for removal of iceplant and removal of European beachgrass in wetlands, buffer areas, and re-treatment. Manual removal B Ranch/A Ranch/Davis Property would still have no direct effect on pastures in terms of contributing features to the Shafter/Howard Tenant Ranches Historic District, and the potential for indirect adverse impacts to these features from sand remobilization would be characterized as very negligible due to the reduced scale of manual removal under this alternative.

During manual removal, there is a potential for impacts to previously recorded or unrecorded archaeological or historic resources or to indigenous archeological sites that contribute to Limantour's inclusion in the Drakes Bay Historic and Archaeological District, which is a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District. The potential for impact would be either from manual removal or secondary access and staging associated with manual removal such as stockpiling of removed biomass or UTV access. Excavation during manual removal would be relatively shallow (< 1.5 feet), so there is low potential for impacts to deeper buried resources.

The park would employ the avoidance and mitigation measures discussed under Alternative B. To ensure that pre-historic archaeological sites at the identified resource site at B Ranch are not destabilized by erosion, manual removal would either not be conducted within 150 feet from the centerpoint of this drainage (Engel 2013), or iceplant and European beachgrass would be removed in phases, with erosion control materials installed and direct seeding performed to help stabilize this area. Disturbance to historic-era surface scatter sites would be avoided by either having a cultural resource monitor present if manual removal occurs near these sites (Engel 2013). No biomass stockpiling or secondary access would be allowed in these sites.

Similar constraints exist along some of the other drainage swales at A Ranch and Davis Property. At Limantour, quite a few recorded archeological resources are currently buried in dunes below extensive stands of European beachgrass and iceplant. Manual removal would either not be conducted within mapped or estimated boundaries of these resources, or iceplant and European beachgrass would be removed in phases, with erosion control materials installed and direct seeding performed to help stabilize this area. No biomass stockpiling or secondary access would be allowed in these sites. A cultural resource monitor may be required during phased removal efforts within known resource sites.

A cultural resource monitor would be present at the Sensitive Resource Area identified at the northwestern perimeter of the AT&T site (Meyer and Dalldorf 2006).

Based on the reduced scale of manual removal under Alternative C and factors discussed under Alternative B, including proposed impact avoidance and minimization measures, manual removal would likely have the potential for very negligible to possibly moderate direct adverse impacts on recorded and unrecorded archaeological and historic resources and contributing sites, with the potential for possibly moderate impacts most likely at Limantour and small portions of the other project areas. Moderate impacts would potentially occur where recorded and unrecorded resources exist within established European beachgrass stands or iceplant stands and where removal of these plants could destabilize soils of the site. These impacts could be reduced to either negligible or minor either by avoidance or potentially by phasing removal efforts and taking steps to stabilize the area with erosion control procedures and revegetation.

Mechanical Removal: Under Alternative C, mechanical removal activities would be focused on removal of European beachgrass from wetland and organic pasture buffer areas, and heavy equipment requirements would be considerably reduced relative to Alternative D. Mechanical excavation would not be used within the wetland buffer for the drainage at B Ranch identified as having pre-historic resources or any other drainage identified as having resources: the 150-foot buffer on either side of the drainage would either be avoided entirely or restored using other less invasive removal methods, with installation of erosion control materials and active revegetation.

Mechanical removal would not directly affect grazing pastures at B Ranch/A Ranch/Davis Property in terms of being contributing features for the Shafter/Howard Tenant Ranches Historic District, although it could affect these features indirectly through sand remobilization. Use of mechanical removal in narrow wetland or organic pasture buffer areas within these project areas, however, would be unlikely to cause any large-scale destabilization. In addition, active revegetation would be conducted in backdune areas. Therefore, the potential for indirect adverse impacts to contributing features would probably range from negligible to possibly minor.

During mechanical removal, there is a potential for impacts to previously recorded or unrecorded archaeological or historic resources and contributing sites within the project areas, particularly at Limantour. Indigenous archeological sites at Limantour are considered contributing sites to Limantour’s inclusion in the Drakes Bay Historic and Archaeological District, a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District. Excavation during mechanical removal would be fairly deep (at least 6 feet), so there is a higher potential to encounter resources, however, as noted above, the scale of mechanical removal under Alternative C would be greatly reduced relative to Alternative D. Heavy equipment would also require secondary access routes to reach buffer areas.

As was discussed under Manual Removal, the park would employ a number of impact avoidance and mitigation measures. Areas with known sensitive resources may require avoidance of mechanical removal, while areas with high potential for buried cultural resources may require presence of a cultural resource monitor during removal activities, such as occurred during the Abbotts Lagoon project. Avoidance areas may be designated not only to avoid direct impacts from excavation, but also indirect impacts to resources from destabilization of sands. These indirect effects may ultimately result in more long-term impacts than direct effects of excavation, with sand remobilization potentially removing light archaeological materials, deflating identified or unidentified sites, or stripping obsidian artifacts of their outer rind that provides chonometric or dating information.

In addition to mechanical removal not being performed within certain wetland buffer areas at B Ranch/A Ranch/Davis Property, mechanical removal would also not be conducted within wetland buffer areas located in known resource sites at Limantour, nor would heavy equipment be allowed access through these sites. No mechanical excavation would be allowed in the Sensitive Resource Area at the northwestern perimeter of AT&T without the presence of a cultural resource monitor.

Under certain circumstances, the Seashore may try to implement impact mitigation measures to allow for more thorough removal efforts. For example, in avoidance areas, other less invasive methods such as manual removal might be used, with removal followed by installation of erosion control materials and replanting to maintain stability of the identified site while still removing invasive species that could readily reinvade adjacent restored areas. Should unrecorded resources be found while mechanical removal is being performed, contractors would be required to follow the impact avoidance and minimization measures for Cultural Resources outlined in the *Alternatives* chapter.

Based on the reduced scale of mechanical removal under Alternative C and factors discussed above, including proposed impact avoidance and minimization measures, mechanical removal would result in the potential for negligible to possibly moderate direct adverse impacts on recorded and unrecorded archaeological and historic resources and contributing sites, with the potential for moderate impacts most likely at Limantour and in small portions of the other project areas. Moderate impacts would potentially occur where recorded and unrecorded resources exist within established European beachgrass stands or iceplant stands and where removal of these plants could destabilize soils of the site. These impacts could be reduced to either negligible or minor either by avoidance or potentially by phasing removal efforts and taking steps to stabilize the area with erosion control procedures and revegetation.

Chemical Control: Chemical control activities would be focused on removal of European beachgrass and possibly dense iceplant patches from dunes at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. As was discussed under Manual Removal under Alternative B, removal of European beachgrass from dunes at B Ranch/A Ranch/Davis Property would not directly impact the Shafter/Howard Tenant Ranches Historic District, because most dune areas have been marginal areas for grazing throughout the historic-era. Grazing pastures are contributing features to this historic district. Therefore, removal of European beachgrass and iceplant at B Ranch/A Ranch/Davis Property would not directly affect grazing pastures in terms of being contributing features for this historic district.

Indirectly, as it has been discussed in many previous sections, including *Vegetation Resources* and *Natural Physical Processes and Soils*, chemical control could increase remobilization of sands that could be transported inland into adjacent grazing pastures, however, the potential for remobilization is greatly reduced relative to mechanical removal. No excavation of surface sands would occur with chemical control. However, as sprayed plants decompose, there would be a potential for remobilization of sands. European beachgrass aboveground biomass and rhizomes appear to decompose very slowly, though, so other plants can establish in the interim that stabilize soils. In addition, use of spot-spraying techniques would help to maintain larger shrubs already present in treated areas that would also help to stabilize soils. Active revegetation would also be conducted in backdune areas to reduce remobilization of sands. Therefore, the potential for indirect adverse impacts from chemical control to historic district contributing features such as grazing pastures at B Ranch/A Ranch/Davis Property would be negligible.

During chemical control, there may be some potential for impacts to previously recorded or unrecorded archaeological or historic resources or contributing sites within the project areas, particularly at Limantour. Indigenous archeological sites at Limantour are considered contributing sites to Limantour's inclusion in the Drakes Bay Historic and Archaeological District, a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological

District. Most of the potential for impact associated with chemical control activities would be to surface resources. Also, chemical control could potentially have adverse effects on efforts to conduct radiocarbon dating depending on herbicides used: Use of herbicides in known cultural resource sites would be carefully evaluated before implementation, as was discussed under *Alternatives*.

Mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing would not impact buried resources due to height of the mower, but it could impact surface resources: no mowing would be conducted where surface resources have been identified, and, should previously unidentified resources be encountered, mowing in this area would cease, and the Seashore's Cultural Resource representative would be contacted.

Another pre-treatment measure that may be used is prescribed burning. Prescribed burning is unlikely to impact deeply buried resources, but resources that are either scattered on the surface or surficially buried may be adversely impacted. Prescribed burning would not be conducted where these types of resources might be affected, and, should previously unidentified resources be encountered during prescribed burning, burn activities would cease, and the Seashore's Cultural Resource representative would be contacted.

As was discussed under Manual Removal, areas with known sensitive resources may require avoidance, while areas with higher potential for cultural resources may require presence of a cultural resource monitor during removal activities. Avoidance areas may be designated not only to avoid direct impacts from excavation, but also indirect impacts to resources from destabilization of sands. Under certain circumstances, the Seashore may try to implement impact mitigation measures to allow for more thorough removal efforts. For example, in avoidance areas, treatment could be followed by installation of erosion control materials and replanting to maintain stability of the identified site. Should unrecorded resources be found while chemical control is being performed, contractors would be required to follow the impact avoidance and minimization measures for Cultural Resources outlined in the *Alternatives* chapter.

Chemical control would not be conducted within drainage swale at B Ranch that has prehistoric archaeological sites, as this area is a wetland. However, the outer perimeter of the 150-foot buffer may be treated chemically, however, if this occurred, direct seeding would be performed to help stabilize this area. Disturbance to historic-era surface scatter sites from treatment crews would be avoided by either having a cultural resource monitor present if chemical treatment occurs near these sites (Engel 2013). No secondary access would be allowed in these sites.

Similar constraints exist along some of the other drainage swales at A Ranch and Davis Property. At Limantour, quite a few recorded archeological resources are currently buried in dunes below extensive stands of European beachgrass and iceplant. Chemical treatment in recorded resource sites would be accompanied by direct seeding to help stabilize this area. No secondary access would be allowed in these sites.

Based on these factors, including proposed impact avoidance and minimization measures, chemical control would likely have the potential for negligible to possibly moderate direct adverse impacts on recorded and unrecorded archaeological and historic resources and contributing sites, with the potential for moderate impacts most likely at Limantour and in small portions of the other project areas. Moderate impacts would potentially occur where recorded and unrecorded resources exist within established European beachgrass stands or iceplant stands and where removal of these plants could destabilize soils of the site. These impacts could be reduced to either negligible or minor either by avoidance or potentially by phasing removal efforts and taking steps to stabilize the area with erosion control procedures and revegetation. Minor impacts could result if mowing or prescribed burning is conducted.

Possible Additional Mitigation Measures: To reduce impacts to previously recorded resources from indirect impacts of invasives removal and possible site destabilization, a number of minimization measures may be employed instead of just strict avoidance, including use of less invasive removal techniques near sites (e.g., chemical control or manual removal), installation of erosion control materials, and active revegetation.

Effectiveness of Possible Additional Mitigation Measures: Implementation of the proposed mitigation measures would reduce the intensity of impacts, with impacts being no more than minor.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative on cultural resources would be the same as described under Alternative B. Due to thorough review of proposed park and lessee projects by the Seashore's Cultural Resources Division, the potential for dune restoration and other park and lessee projects to cumulatively have effects that would cause more than a minor adverse impact on cultural resources within the Seashore would be unlikely.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal potentially. Over the long term, this alternative would, in general, not directly impact historic districts such as the Shafter/Howard Tenant Ranches Historic District. Grazing pastures at B Ranch/A Ranch/Davis Property are considered contributing features to this historic district, but most dune areas have been marginal areas for grazing throughout the historic-era. Staging and access at B Ranch/A Ranch/Davis Property may have negligible to possibly minor adverse impacts on grazing pastures as contributing features, with the intensity dependent on the amount of site grading and improvement needed for heavy or other equipment. However, these impacts would be short-term at most and would have only negligible adverse effects on the grazing pastures or historic district as a whole. Staging and access impacts at the Davis Property may also be reduced by use of a paved park access road.

Indirectly, as it has been discussed in many previous sections, including *Vegetation Resources* and *Natural Physical Processes and Soils*, invasives removal could increase remobilization of sands that could be transported inland into adjacent grazing pastures, with the intensity of impact dependent on restoration method employed. At AT&T/North Beach and B Ranch/A Ranch/Davis Property, indirect adverse impacts on contributing features such as pastures from sand remobilization could range from negligible to possibly minor, with higher intensity impacts resulting from mechanical removal efforts in buffers. Due to cultural resource constraints, there would be no mechanical removal within certain wetland buffer areas at B Ranch/A Ranch/Davis Property. In addition, active revegetation of backdune areas could help to minimize impacts to adjacent pastures from dune restoration.

During invasives removal, there is a potential for impacts to previously recorded or unrecorded archaeological or historic resources within the project areas, particularly at Limantour. Indigenous archeological sites at Limantour are considered contributing sites to Limantour's inclusion in the Drakes Bay Historic and Archaeological District, a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District. The potential for impact would be reduced under this alternative relative to Alternative D, because mechanical removal -- which involves deeper excavation -- would not be the primary removal method, but would be used only in wetland and organic pasture buffer areas. Avoidance areas may be designated not only to avoid direct impacts, but also indirect impacts to resources from destabilization of sands. Under certain circumstances, the Seashore may try to implement impact mitigation measures to allow for more thorough removal efforts such as use of less invasive removal method, installation of erosion control materials, or active revegetation. Should unrecorded resources be found while mechanical removal is being performed, contractors would be required to follow the impact avoidance and minimization measures for Cultural Resources outlined in the *Alternatives* chapter.

As noted earlier, mechanical removal would not be conducted within certain wetland buffer areas at B Ranch/A Ranch/Davis Property. Manual removal would also not be allowed within the drainage swale B Ranch where resources were recently identified in the 150-foot wetland buffer on either side of the drainage unless mitigation measures are employed such as phasing removal efforts, installing erosion control materials, and conducting active revegetation. Mechanical removal would also not be performed in wetland buffer areas at Limantour or other project areas with recorded resources. A cultural resource monitor may be required to be present within certain areas or during certain activities at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. No biomass stockpiling or secondary access would be allowed through recorded resource sites. At AT&T, contractor crews may stage some equipment near the historic radio facility in the paved areas, including heavy equipment, but impacts would be minimized to the maximum extent practicable, and no permanent changes or impacts would be allowed.

Based on these factors, including proposed impact avoidance and minimization measures, Alternative C would likely have the potential for negligible to possibly moderate direct impacts on recorded and unrecorded archaeological and historic resources and contributing features, with the potential for moderate impacts most likely at Limantour and in small portions of the other project areas. Moderate impacts would potentially occur where recorded and unrecorded resources exist within established European beachgrass stands or iceplant stands and where removal of these plants could destabilize soils of the site. These impacts could be reduced to either negligible or minor either by avoidance or potentially by phasing removal efforts and taking steps to stabilize the area with erosion control procedures and revegetation.

There are no external projects that could have cumulative impacts on cultural resources. Due to thorough review of proposed park and lessee projects by the Seashore's Cultural Resources Division, the potential for dune restoration and other park and lessee projects to cumulatively have effects that would cause more than a minor adverse impact on cultural resources within the Seashore would be unlikely.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Long-Term Effects

Staging and Access: Impacts of staging and access would be very similar to those described under Alternative C, although the intensity of impacts may increase due to the fact that mechanical removal would be the primary removal method.

Staging and access at B Ranch/A Ranch/Davis Property may have minor adverse impacts on the contributing features, including grazing pastures, to the Shafter/Howard Tenant Ranches Historic District, because new primary access roads may be needed, or grading may be required to create new roads or staging areas for heavy equipment. AT&T/North Beach occur in the district, however, F Ranch – which adjoins or historically adjoined AT&T/North Beach -- is not one of the component ranches.

Projects at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would also have the potential for negligible to minor direct effects on recorded and unrecorded archaeological and historic resources, particularly at Limantour. Limantour is located in the Drakes Bay Historic and Archaeological District, a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District, and some of the known archeological sites are considered contributing sites to Limantour's inclusion within the district.

Impact intensity would increase relative to Alternative C due to the higher intensity of staging and primary access required for more pieces of heavy equipment. Impacts would potentially be lowest (negligible) at Limantour and possibly at North Beach and Davis Property where staging and primary access could occur within or via existing paved roads and parking lots and established maintenance roads. Archeological sites are largely located in the dunes themselves. Secondary access or staging could affect these sites: this is addressed below.

Similar to what was described under Alternative C, at AT&T, contractor crews may stage some equipment near the historic radio facility. The amount of equipment that may be staged could increase under Alternative D relative to Alternative C. However, any staging of equipment, vehicles, or materials would be temporary, which would minimize adverse impacts to contributing features to the historic district that may occur near the radio facility building.

Staging and access would likely also have at negligible to possibly minor direct effects on recorded and unrecorded archaeological and historic resources. No long-term indirect effects on these resources would be anticipated.

Manual Removal: Impacts of manual removal would be very similar to those discussed under Alternative B, although the intensity would be greatly reduced, as manual removal would be used primarily for removal of iceplant and removal of European beachgrass in wetlands, buffer areas, and re-treatment. It would still have no direct effect on B Ranch/A Ranch/Davis Property pastures in terms of being contributing features to the Shafter/Howard Tenant Ranches Historic District, and the potential for indirect adverse impacts to these features from sand remobilization following manual removal would be characterized as negligible.

Based on factors discussed under Alternatives B and C, including proposed impact avoidance and minimization measures, manual removal would likely have negligible to possibly moderate direct adverse impacts on recorded and unrecorded archaeological and historic resources and contributing archeological sites, with the potential for moderate impacts most likely at Limantour and small portions of the other project areas. Limantour is located in the Drakes Bay Historic and Archaeological District, a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District, and some of the known archeological sites are considered contributing sites to Limantour's inclusion within the district. Moderate impacts would potentially occur where recorded and unrecorded resources exist within established European beachgrass stands or iceplant stands and where removal of these plants could destabilize soils of the site. These impacts could be reduced to either negligible or minor either by avoidance or potentially by phasing removal efforts and taking steps to stabilize the area with erosion control procedures and revegetation.

Mechanical Removal: Impacts of mechanical removal activities would be similar to those discussed under Alternative C, although the intensity of impact would increase considerably, as mechanical would be the primary removal method.

B Ranch/A Ranch/Davis Property are located in the Shafter/Howard Tenant Ranches Historic District. Grazing pastures are considered contributing features to this historic district. Mechanical removal would not directly affect grazing pastures B Ranch/A Ranch/Davis Property in terms of being contributing features for this historic district, although it could affect these features indirectly through sand remobilization. Use of mechanical removal as the primary removal method could be accompanied by higher rates of inland sand migration than under other alternatives. However, even with mechanical being the primary removal method, the potential for sand movement into adjacent pastures to result in major adverse impacts to contributing features does not seem likely. In addition, active revegetation would be conducted in backdune areas to minimize sand remobilization. Therefore, the potential for indirect adverse impacts to contributing features would probably range from minor to possibly moderate relative to existing rates of sand remobilization discussed under Alternative A.

During mechanical removal, there is a potential for impacts to previously recorded or unrecorded archaeological or historic resources, particularly at Limantour. Limantour is located in the Drakes Bay Historic and Archaeological District, a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District, and some of the known archeological sites are considered contributing sites to Limantour's inclusion within the district.

Excavation would be fairly deep (at least 6 feet), so there is a higher potential to encounter resources. As was discussed in detail under Alternatives B and C, areas with known sensitive resources may require avoidance to preclude either direct or indirect effects: No mechanical removal would be allowed in known resource sites. Areas with higher potential for cultural resources may require presence of a cultural resource monitor during removal activities. Under certain circumstances, the Seashore may try to implement other less invasive restoration methods in these areas, with removal followed by installation of erosion control materials and replanting to maintain stability of the identified site while still removing invasive species that could readily reinvade adjacent restored areas.

Mechanical excavation would not be used within the wetland buffer for the drainage at B Ranch identified as having pre-historic resources: the 150-foot buffer on either side of the drainage would either be avoided entirely or restored using other less invasive removal methods, with installation of erosion control materials and active revegetation. Similar constraints exist along some of the other drainage swales at A Ranch and Davis Property. Mechanical excavation would also not be conducted within the approximately 5 acres of the 124-acre treatment area at Limantour known to have recorded archeological resources. No mechanical excavation would be allowed in the Sensitive Resource Area at the northwestern perimeter of AT&T without the presence of a cultural resource monitor.

Based on these factors and others discussed under Alternative C, as well as proposed impact avoidance and minimization measures, mechanical removal would likely have negligible to possibly moderate direct impacts on recorded and unrecorded archaeological and historic resources and contributing archeological sites, with the potential for moderate impacts most likely at Limantour and in small portions of the other project areas. Moderate impacts would potentially occur where unrecorded resources exist or where recorded resources exist downwind of established European beachgrass stands, and removal of this stand destabilizes soils of the downwind site. As discussed earlier, these impacts could be reduced to either negligible or minor either using different removal approaches within established beachgrass stands either located on or upwind of a site and taking steps to stabilize the area with erosion control procedures and revegetation.

Chemical Control: Impacts from chemical control activities would be very similar to that discussed in detail under Alternative C, though the intensity would be reduced considerably due to the fact that herbicide would only be used to spot-spray resprouts in mechanical removal areas.

B Ranch/A Ranch/Davis Property are located in the Shafter/Howard Tenant Ranches Historic District. Grazing pastures are considered contributing features to this historic district. Chemical control at AT&T/North Beach and B Ranch/A Ranch/Davis Property would not directly affect these contributing features, and the potential for indirect adverse impacts to these features from sand remobilization would be characterized as negligible.

Based on factors discussed under Alternative C, including proposed impact avoidance and minimization measures, chemical control would likely have negligible effects on recorded and unrecorded archaeological and historic resources and contributing archeological sites within the project areas, including at Limantour. Limantour is located in the Drakes Bay Historic and Archaeological District, a National Historic Landmark, and the Point Reyes Peninsula Indigenous Archaeological District, and some of the known archeological sites are considered contributing sites to Limantour's inclusion within the district.

Possible Additional Mitigation Measures: To reduce impacts to previously recorded resources from indirect impacts of invasives removal and possible site destabilization, a number of minimization measures may be employed instead of just strict avoidance, including use of less invasive removal techniques near sites (e.g., chemical control or manual removal), installation of erosion control materials, and active revegetation.

Effectiveness of Possible Additional Mitigation Measures: Implementation of the proposed mitigation measures would reduce the intensity of impacts from moderate to negligible or minor.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative on cultural resources would be the same as described under Alternative B. Due to thorough review of proposed park and lessee projects by the Seashore's Cultural Resources Division, the potential for dune restoration and other park and lessee projects to have cumulative effects that would cause more than a minor adverse impact on cultural resources within the Seashore would be unlikely.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Over the long term, this alternative would, in general, not directly impact historic districts such as the Shafter/Howard Tenant Ranches Historic District. While grazing pastures are considered contributing features to this historic district, most dune areas have been marginal areas for grazing throughout the historic-era. Therefore, removal of European beachgrass, iceplant, or other invasive species at B Ranch/A Ranch/Davis Property would not directly affect grazing pastures in terms of being contributing features. (AT&T/North Beach occur in the district, however, F Ranch – which adjoins or historically adjoined AT&T/North Beach -- is not one of the component ranches.) Staging and access at B Ranch/A Ranch/Davis Property may have minor direct impacts on these features, with the intensity dependent on whether heavy equipment mobilization requires new roads or staging areas, the degree of site disturbance from grading, and whether staging and access occurs in paved areas. However, these impacts would be short-term at most and would only have negligible to minor adverse effects on the grazing pastures or historic district as a whole.

Indirectly, as it has been discussed in many previous sections, including *Vegetation Resources* and *Natural Physical Processes and Soils*, invasives removal using mechanical removal could increase remobilization of sands that could be transported inland into adjacent pastures. Indirect adverse impacts from sand remobilization on B Ranch/A Ranch/Davis Property pastures being contributing features to the Shafter/Howard Tenant Ranches Historic District could range from minor to possibly moderate. However, even with mechanical being the primary removal method, the potential for sand movement into adjacent pastures to result in major adverse impacts to contributing features does not seem likely. Active revegetation of backdune areas would help to minimize impacts to adjacent pastures from dune restoration.

During invasives removal, there is a potential for impacts to previously recorded or unrecorded archaeological or historic resources or contributing archeological sites within the project areas, particularly at Limantour. The potential for impact would be increased under this alternative relative to Alternative C, because mechanical removal -- which involves deeper excavation -- would be the primary removal method. Avoidance areas may be designated not only to avoid direct impacts, but also indirect impacts to resources from destabilization of sands. Under certain circumstances, the Seashore may try to implement impact mitigation measures to allow for more thorough removal efforts such as use of less invasive removal method, installation of erosion control materials, or active revegetation. Should unrecorded resources be found while mechanical removal is being performed, contractors would be required to follow the impact avoidance and minimization measures for Cultural Resources outlined in the *Alternatives* chapter.

Mechanical excavation would not be used within the wetland buffer for the drainage at B Ranch identified as having prehistoric resources. Similar constraints exist along some of the other drainage swales at A Ranch and Davis Property. Manual removal would not be allowed either in the 150-foot buffer on either side of these drainages unless mitigation measures are employed such as phasing removal efforts, installing erosion control materials, and conducting active revegetation. Mechanical excavation would also not be conducted within the approximately 5 acres of the 124-acre treatment area at Limantour known to have recorded archeological resources. A cultural resource monitor would be required to be present for activities near historic-era sites at B Ranch, in the Sensitive Resource Area at the northwestern perimeter of AT&T, and possibly near known archeological sites at Limantour. At AT&T, contractor crews may stage equipment near the historic radio facility in the paved areas, including more heavy equipment relative to Alternative C, but impacts would be minimized to the maximum extent practicable, and no permanent changes or impacts would be allowed. Impacts to the historic radio district would be temporary and have no long-term adverse effect.

Based on these factors, including proposed impact avoidance and minimization measures, Alternative D would likely have negligible to possibly moderate direct impacts on recorded and unrecorded archaeological and historic resources and contributing archeological sites, with the potential for moderate impacts most likely at Limantour and in small portions of other project areas. Moderate impacts could be reduced to negligible or minor using either avoidance or one of the minimization measures discussed above.

There are no external projects that could have cumulative impacts on cultural resources. Due to thorough review of proposed park and lessee projects by the Seashore's Cultural Resources Division, the potential for dune restoration and other park and lessee projects to have cumulative effects that would cause more than a minor adverse impact on cultural resources within the Seashore would be unlikely.

Visitor Experience

Policies and Regulations

For the Park Service, "providing opportunities for appropriate public enjoyment is an important part of the Service's mission" (NPS 2006, Section 8.1). The Park Service *Management Policies 2006* regulate several features of the visitor experience, including soundscapes, lightscapes, facilities, recreational use, and interpretation. An "open, inviting and accessible" atmosphere is considered central to the purpose of all parks (Section 8.2). Analysis of the effects of noise on visitor experience in national parks include, among other things, a visitor's expectation (e.g., presumptions of noise levels in developed vs. undeveloped areas), a visitor's personal characteristics (the likelihood of being annoyed by noise), and the degree to which a quiet experience is desired (Gramann 1999 *in* NPS 2009). For instance, visitors may perceive noise as more annoying when it occurs in areas they expect to be very quiet such as beaches and dunes. Visitor use or visitor access is only to be restricted if it impedes attainment of the park's desired condition for natural resources (Section 8.2) and for several other resource or safety reasons.

Assessment Methodology

The proposed dune restoration program has the potential to affect visitor and resident experience during and following implementation of proposed projects. Implementation has the potential to adversely affect, at least temporarily, the visitor experience by limiting or increasing the difficulty of public access in project areas and possibly other areas of the park and by disrupting the subjective quality of the visitor experience in project areas and vicinity. Implementation of projects has the potential to cause both beneficial and adverse long-term impacts to visitor and resident experience resources, as well.

This section specifically addresses impacts to visitation and viewsheds from project implementation. Impacts from dune restoration on soundscapes is assessed in a separate section, and that analysis is intended to address implementation-related and long-term impacts of the various alternatives on ambient noise levels and natural soundscapes.

Impact Thresholds

Negligible**:** Visitors would not likely be aware of treatment or staging and access operations. There would be no measurable change in landscapes or viewsheds and attractiveness of these areas to visitors. There would be no measurable change in the level of accessibility relative to current conditions.

Minor**:** Visitors would be aware of treatment or staging and access operations, but activities would only result in a minor disruption in visitor experience and enjoyment of the site. There would be small, but detectable or measurable changes in landscapes or viewsheds and attractiveness of these areas to visitors. There would be small, but detectable or measurable changes in the level of accessibility relative to current conditions.

Moderate**:** Visitors would be moderately aware of treatment or staging and access operations, and activities could result in appreciable disruption in visitor experience and enjoyment of the site for visitors. There would be apparent or appreciable change in landscapes and viewsheds and attractiveness of these areas to visitors. There would be apparent or appreciable change in the level of accessibility relative to current conditions.

Major**:** Visitors would be highly aware of treatment or staging and access operations, and activities could result in major disruption in visitor experience and enjoyment of the site for visitors. There would be striking or highly noticeable change in landscapes and viewsheds and attractiveness of these areas to visitors. There would be striking or highly noticeable change in the level of accessibility relative to current conditions.

Impact of Alternative A

Analysis

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Long-Term Effects

The presence of invasive non-native plant species is the single largest disturbance to Point Reyes' plant diversity and native plant communities (which provide wildlife habitat). More than 1,400 acres of the Seashore's dunes are invaded by either European beachgrass or ice-plant. These species create dense monocultures that directly displace native coastal dune vegetation communities and associated rare plants such as Tidestrom's lupine (FE) and beach layia (FE). Many of these native dune species act as nectar sources for the federally endangered Myrtle's silverspot butterfly.

A number of park visitors come to the Seashore to view native coastal dune vegetation communities and some of the wildlife that occurs in these dunes. The degree of visitation varies between project areas: Limantour and, to a lesser extent, are heavily visited, while AT&T, Davis Property, B Ranch, and A Ranch are much less frequently visited by members of the public. Under Alternative A, these areas may remain less attractive for visitation due to the lack of natural landscapes and more inaccessible for hikers due to the density of European beachgrass and iceplant stands. In addition, without restoration, European beachgrass and iceplant would continue to expand in these dune systems, thereby further decreasing attractiveness and visitor enjoyment in these areas.

Over the long-term, Alternative A could result in negligible adverse impacts on visitor experience at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Implementation-Related and Short-Term Effects

There would be no implementation-related or short-term effects under Alternative A, because near-term restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on visitor experience would primarily be other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration. There may be some potential for cumulative effects with other non-park projects within the region that affect dunes and beaches. These would include the potential Chicken Ranch Beach Restoration Project, continued restoration of coastal dunes at Tom's Point, potential restoration of dunes and wetlands at Lawson's Landing, wetland and small-scale dune restoration efforts being conducted as part of the Muir Beach Restoration Project at GGNRA, and restoration of coastal dunes at Bodega Marine Laboratory in Sonoma County. The Wildlife Protection and Habitat Improvement Plan proposed by MMWD would principally affect higher-elevation vegetation communities such as oak woodland and grassland habitat that have been invaded by non-native brooms or invasive species, so it would likely have no cumulative effect on visitor experience with this project. Specific actions in the park that may have cumulative effects on visitor experience include maintenance and upgrade of park facilities near coastal areas, such as the Beaches Water System project, Federal Highways' Sir Francis Drake Boulevard and Limantour road maintenance project, and other smaller scale road and trail maintenance projects.

Based largely on the type and scale of projects proposed inside and outside the park, Alternative A would cumulatively have the potential for very negligible beneficial long-term effects on visitor experience within the region, particularly within beach and dune systems, even without restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Conclusions

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

The presence of invasive non-native plant species is the single largest disturbance to Point Reyes' plant diversity and native plant communities (which provide wildlife habitat). More than 1,400 acres of the Seashore's dunes are invaded by either European beachgrass or ice-plant. A number of park visitors come to the Seashore to view native coastal dune vegetation communities and some of the wildlife that occurs in these dunes. The degree of visitation varies between project areas: Limantour and, to a lesser degree, North Beach are heavily visited, while AT&T, Davis Property, B Ranch, and A Ranch are much less frequently visited by members of the public. Under Alternative A, these areas may remain less attractive for visitation due to the lack of natural landscapes and more inaccessible for hikers due to the density of European beachgrass and iceplant stands. In addition, without restoration, European beachgrass and iceplant would continue to expand in these dune systems, thereby further decreasing attractiveness and visitor enjoyment in these areas. Over the long-term, Alternative A could result in negligible adverse impacts on visitor experience at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

There would be no implementation-related or short-term effects.

Based largely on the type and scale of projects proposed inside and outside the park, Alternative A would cumulatively have the potential for very negligible beneficial long-term effects on visitor experience within the region, particularly within beach and dune systems, even without restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Long-Term Effects

The presence of invasive non-native plant species is the single largest disturbance to Point Reyes' plant diversity and native plant communities (which provide wildlife habitat). More than 1,400 acres of the Seashore's dunes are invaded by either European beachgrass or ice-plant. A number of park visitors come to the Seashore to view native coastal dune vegetation communities and some of the wildlife that occurs in these dunes. The degree of visitation varies between project areas: Limantour and, to a lesser extent, North Beach are heavily visited, while AT&T, Davis Property, B Ranch, and A Ranch are much less frequently visited by members of the public.

Removal of invasive plants can improve visitor enjoyment of the dunes, as restored areas would potentially be considered more scenic with establishment of native dune vegetation communities. Also, visitor enjoyment would increase, because restored areas would not be as densely vegetated and would be more open to hiking. Active revegetation in backdune should also increase the aesthetic appeal of the newly restored dunes. In general, the extent of restoration would be reduced under Alternative B relative to Alternative C and possibly Alternative D, so benefits to natural landscapes and attractiveness of these areas to visitors from both a scenic and accessibility standpoint would be reduced. In adjacent unrestored areas, European beachgrass and iceplant would continue to expand in these dune habitats, thereby decreasing attractiveness and visitor enjoyment in these areas. Therefore, over the long-term, Alternative B would generate negligible benefits to visitor experience at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Implementation-Related and Short-Term Effects

Staging and Access: Staging and access would primarily occur in adjacent grasslands and coastal scrub, although, at Limantour, staging and access would occur via paved roads and within paved parking lots used by visitors. Staging and access could also occur on the paved road and parking lot at North Beach. The intensity of access and staging requirements -- and impacts -- may be reduced relative to the other action alternatives due to the fact that there would be no heavy equipment needed. At AT&T, Davis Property, B Ranch, and A Ranch, staging and primary access would have very negligible effects on visitor experience, because it would mostly occur on ranchlands or park areas that are rarely visited by the public. At Limantour, staging and primary access would cause no more than negligible adverse impacts on visitor enjoyment, because staging would primarily occur at the southern and less-visited end of the developed area. Effects would also be negligible at North Beach.

Manual Removal: Manual removal has the potential to impact visitor experience through visitors encountering manual removal crews or hearing UTVs used to transport crews or removed biomass. (Impacts from noise are addressed in more detail under Soundscapes.) Visitors coming to the dunes or the beach want solitude, and a multiple-member crew can disrupt that experience. Proposed impact avoidance and minimization measures include scheduling crews to the maximum extent practicable on weekdays rather than weekends and minimizing idling of equipment including UTVs. The intensity of impacts to visitor experience would be higher for manual removal activities under Alternative B relative to other action alternatives, because manual removal would be the primary removal method. Based on these factors, including proposed impact avoidance and minimization measures, manual removal would have no more than a very negligible to possibly minor adverse impact during implementation, with the intensity of impacts at AT&T, B Ranch, A Ranch, and the Davis Property -- which are much less frequently visited by the public -- being very negligible.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those conducted under this alternative would be very similar to those discussed under Alternative A. Based on the scale of projects that could be conducted in the park and proposed outside the park, these projects could cumulatively have negligible beneficial long-term effects on visitor experience in the region, particularly within beach and dune systems.

Conclusions

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine.

The presence of invasive non-native plant species is the single largest disturbance to Point Reyes' plant diversity and native plant communities (which provide wildlife habitat). More than 1,400 acres of the Seashore's dunes are invaded by either European beachgrass or iceplant. Removal of invasive plants can improve visitor enjoyment of the dunes, as restored areas would potentially be considered more scenic and accessible for hiking. In general, the extent of restoration would be reduced under Alternative B relative to Alternative C and possibly Alternative D, so benefits to natural landscapes and attractiveness of these areas to visitors from both a scenic and accessibility standpoint would be reduced. In adjacent unrestored areas, European beachgrass and iceplant would continue to expand in these dune habitats, thereby decreasing attractiveness and visitor enjoyment in these areas. Therefore, over the long-term, Alternative B would generate negligible benefits to visitor experience at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

During implementation, visitor experience could be disrupted by contractor crews, UTVs, and staging and access. Some impact avoidance and minimization measures would be implemented, including minimizing idling time of UTV equipment. Based on these factors, potential impacts to visitor experience during implementation would range from very negligible to possibly minor. Higher intensity impacts could occur at Limantour and North Beach, where staging and primary access would occur via paved roads and parking lots used by visitors, and dune restoration and adjacent beach areas have high visitation rates.

Based on the scale of projects that could be conducted in the park and proposed outside the park, these projects could cumulatively have negligible beneficial long-term effects on visitor experience in the region, particularly within beach and dune systems.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on visitor experience can be found under Alternative B. The presence of invasive non-native plant species is the single largest disturbance to Point Reyes' plant diversity and native plant communities (which provide wildlife habitat). More than 1,400 acres of the Seashore's dunes are invaded by either European beachgrass or iceplant. Removal of invasive plants can improve visitor enjoyment of the dunes.

In general, the extent of restoration would be increased under this alternative relative to Alternative B and possibly Alternative D, so benefits to natural landscapes and attractiveness of these areas to visitors from both a scenic and accessibility would be enhanced. The benefits would be less immediate than under Alternative D due to the extended time that it takes for European beachgrass and iceplant to decompose when treated with herbicide. However, active revegetation in backdune should also increase the aesthetic appeal of the newly restored dunes by promoting native dune vegetation communities.

Relative to current conditions, accessibility to visitors within restored areas would be improved, and the level of improvement would be increased relative to Alternative B. Alternative C, however, would maintain a more rugged, hilly terrain – and perhaps less natural dune landscape – than Alternative D, in which dune soils are completely flipped, eliminating all surface vegetation and creating a more uniform topography due to sand remobilization. Over the long-term, Alternative C would generate negligible to possibly moderate benefits to visitor experience, with potential benefits to visitor experience being highest at heavily-visited Limantour and, to a lesser extent, North Beach.

Implementation-Related and Short-Term Effects

Staging and Access: In general, access and staging impacts on visitor experience would be very similar to those under Alternative B, although the intensity of access and staging requirements – and impacts – may increase slightly due to the fact that mechanical removal would potentially be used in wetland and organic pasture buffer areas. Potential impacts on visitor experience from staging and access during implementation would range from very negligible to possibly moderate on a localized scale, depending upon the location of staging and access and its proximity to the public. Staging and access would have a very negligible to minor adverse impact on visitor experience at the project areas, with minor impacts more likely to occur at heavily visited areas such as Limantour and North Beach. AT&T is visited by a number of park visitors interested in the historic radio facility, so there could also possibly be negligible to minor impacts in this project area.

Manual Removal: Impacts of manual removal on visitor experience are very similar to those discussed under Alternative B, although the intensity of impacts may decrease as manual removal would be used primarily for removal of iceplant and for removal of European beachgrass from wetlands, buffers, and treatment of re-sprouts. Based on factors discussed under Alternative B, including proposed impact avoidance and minimization measures, manual removal would have a very negligible to possibly minor adverse impact during implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Mechanical removal has the potential to impact visitor experience through the presence of large, noisy heavy equipment, which may also produce odors and "dust" or localized remobilization of sand. As noted under Manual Removal in Alternative B, visitors coming to the dunes or beach want solitude and quiet or to listen to the sounds of the waves, and mechanical equipment would disrupt that experience.

Proposed impact avoidance and minimization measures include scheduling construction during the weekdays from 7 a.m. to 6 p.m., with weekends only permissible with express approval of the park. Based on anecdotal park staff observations, beach visitation is highest on the weekends. Other impact minimization measures implemented to reduce impacts on soundscapes would also benefit visitor experience, including limiting idling time of heavy equipment and requiring that vehicles be equipped with properly operating mufflers. Notices about the presence of construction equipment would also be posted at trailheads and on the park's website. For safety reasons, the public would not be allowed within the work area during construction, and signs would be posted near the work area to that effect.

Based on these factors, including proposed impact avoidance and minimization measures, mechanical removal would have a very negligible to minor adverse impact during implementation. Impacts to the visitor experience at AT&T, Davis Property, B Ranch, and A Ranch from mechanical removal would be very negligible to negligible. Higher intensity impacts (minor) would occur at Limantour and, to a lesser extent, North Beach, which are more highly visited by the public.

Chemical Control: Chemical control would have very similar potential impacts as manual removal. Chemical control has the potential to impact visitor experience through visitors encountering crews with backpacks spraying or hearing UTVs used to transport crews. (Potential impacts to public safety are addressed elsewhere under Public Health and Safety.) One notable difference between manual removal and chemical control is that treatment areas would be posted as no public entry during and 24 hours after spraying regardless of the fact that herbicides proposed for use do not have a mandatory restricted-entry interval (REI). As with mechanical removal, notices about these closures would be posted at trailheads and all potential access points.

Mowing may be as either a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. Mowing could also disrupt the visitor experience due to the constant drone from mowing equipment, although, due to short-lived nature of this activity, adverse impacts would be characterized as no more than minor.

Another pre-treatment measure that may be used is prescribed burning. While visitors would be restricted from these areas during burn activities, they could encounter smoke, odor, and possible UTV noise in adjacent areas, including along the beach. Such visual intrusions, odors, and possible UTV noise associated with burn activities could result in negligible to minor, short-term, localized adverse effects to the visitor experience. Implementation of mitigation measures – such as publishing the date and time the park anticipates prescribed burn and other restoration activities – could help to mitigate these effects.

Based on these factors, including proposed impact avoidance and minimization measures, chemical control would have very negligible to minor adverse impact during implementation. At AT&T, Davis Property, B Ranch, and A Ranch, impacts would range from very negligible to negligible, while impacts at Limantour and, to a lesser extent, North Beach would be slightly higher (minor).

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those conducted under this alternative would be very similar to those discussed under Alternative A. Based on the scale of projects that could be conducted in the park and proposed outside the park, these projects could cumulatively have up to minor beneficial long-term effects on visitor experience in the region, particularly within beach and dune systems.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal potentially.

A number of park visitors come to the Seashore to view native coastal dune vegetation communities and some of the wildlife that occurs in these dunes. Removal of invasive plants can improve attractiveness of the dunes to visitors from both a scenic and accessibility standpoint, as the areas would not be as densely vegetated and would be more open to hiking. Natural-looking dunes may also be considered more scenic from the perspective of passers-by walking along the beach. The benefits would be less immediate than under Alternative D due to the extended time that it takes for European beachgrass and iceplant to decompose when treated with herbicide. However, active revegetation in backdune should also increase the aesthetic appeal of the newly restored dunes. Alternative C would maintain a more rugged, hilly terrain – and perhaps less natural dune landscape – than Alternative D, in which dune soils are completely flipped, eliminating all surface vegetation and creating a more uniform topography due to sand remobilization. Over the long-term, Alternative C would generate negligible to possibly moderate benefits to visitor experience at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

During implementation, visitor experience could be disrupted by contractor crews, heavy equipment, UTVs, staging, and access, as well as by access limitations near heavy equipment and during herbicide application. A number of impact avoidance and minimization measures would be implemented, including limiting work to weekdays, minimizing idling time of equipment, and posting notices about construction and closures at trailheads, access points, and on the park's web site. Based on these factors, potential impacts to visitor experience during implementation would range from very negligible to minor adverse impacts, with minor impacts potentially occurring at more heavily-visited areas such as Limantour and, to a lesser extent, North Beach. AT&T is visited by a number of park visitors interested in the historic radio facility, so there could also possibly be negligible to minor impacts in this project area, with minor impacts being primarily restricted to just staging activities at the radio facility area.

Based on the scale of projects that could be conducted in the park and proposed outside the park, these projects could cumulatively have up to minor beneficial long-term effects on visitor experience in the region, particularly within beach and dune systems.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on visitor experience can be found under Alternatives B and C. In general, the scale of restoration would be decreased under this alternative relative to Alternative C, so benefits to natural landscapes and attractiveness of these areas to visitors from both a scenic and accessibility standpoint would be reduced. The benefits, however, would be more immediate than under Alternative C due to the fact that mechanical removal completely flips the soil horizons, instantly eradicating European beachgrass. Vegetation establishment may not occur immediately with mechanical removal depending upon climatic conditions –- see *Vegetation Resources* and *Natural Physical Processes and Soils* -- however, active revegetation in back-dune should help to increase the aesthetic appeal of the newly restored dunes.

Relative to current conditions, accessibility to visitors within restored areas would be improved, and the level of improvement would be increased relative to Alternative B and C. Not only would Alternative D eliminate all surface vegetation, but it could create a more uniform and less hilly, rugged terrain due to sand remobilization. Over the long-term, Alternative D would generate negligible to minor benefits to the visitor experience at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with higher intensity benefits occurring at more heavily-visited Limantour and, to a lesser extent, North Beach.

Implementation-Related and Short-Term Effects

Staging and Access: In general, access and staging impacts on visitor experience would be identical to those under Alternative C, although the intensity of access and staging requirements -- and impacts -- would increase due to the fact that mechanical would be the primary removal method. Potential impacts on visitor experience from staging and access during implementation would range from very negligible to moderate, with very negligible impacts expected at areas rarely visited by the public such as Davis Property, B Ranch, and A Ranch. Impacts would be minor to possibly moderate at AT&T, because AT&T is visited by a number of people interested in the historic radio facility. At North Beach and Limantour, impacts would be no more than moderate, with the intensity at Limantour moderated by the fact that staging would be principally conducted in the less heavily-visited southern portion of the visitor facilities at Limantour.

Manual Removal: Impacts of manual removal on visitor experience are very similar to those discussed under Alternatives B and C, although the intensity of impacts may decrease relative to Alternative B, as manual removal would be used primarily for removal of iceplant and for removal of European beachgrass from wetlands, buffers, and as re-treatment in mechanical removal areas. Based on factors discussed under Alternative B, including proposed impact avoidance and minimization measures, manual removal would have no more than a very negligible to possibly minor adverse impact during implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Impacts of mechanical removal on visitor experience are very similar to those discussed under Alternative C, although the intensity of impacts would increase due to the fact that mechanical would be the primary removal method. Based on factors discussed under Alternative C, including proposed impact avoidance and minimization measures, mechanical removal would have from negligible to moderate adverse impacts during implementation, with higher intensity impacts anticipated at more heavily-visited Limantour and, to a lesser extent, North Beach. Staging and access, use of heavy equipment, and presence of contractor crews at heavily-visited Limantour and, to a lesser extent, North Beach would have potentially higher impacts to visitor experience (minor to moderate).

Chemical Control: Impacts of chemical control on visitor experience are similar to those discussed under Alternative C, although the intensity of impacts would be reduced considerably due to the fact that chemical control would only be used for treatment of re-sprouts in mechanical removal areas. Based on the factors discussed under Alternative C, including proposed impact avoidance and minimization measures, chemical control would have a very negligible to negligible adverse impact on visitor experience during implementation at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those conducted under this alternative would be very similar to those discussed under Alternative A. Based on the scale of projects that could be conducted in the park and proposed outside the park, these projects could cumulatively have negligible to possibly minor long-term beneficial effects on visitor experience in the region, particularly within beach and dune systems.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

A number of park visitors come to the Seashore to view native coastal dune vegetation communities and some of the wildlife that occurs in these dunes. Removal of invasive plants can improve attractiveness of the dunes to visitors from both a scenic and accessibility standpoint, as the areas would not be as densely vegetated and would be more open to hiking. Natural-looking dunes may also be considered more scenic from the perspective of passers-by walking along the beach. The benefits would be more immediate under Alternative D than under Alternative C due to the fact that mechanical removal completely flips the soil horizons, instantly eradicating European beachgrass. Vegetation establishment may not occur immediately with mechanical removal depending upon climatic conditions, however, active revegetation in backdune should help to increase the aesthetic appeal of the newly restored dunes. Accessibility would also improve, including in relative to Alternative C and B, as Alternative D not only eliminates all surface vegetation, but creates a more uniform and less hilly, rugged terrain due to sand remobilization. Over the long-term, Alternative D would generate negligible to moderate benefits to visitor experience at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

During implementation, visitor experience could be disrupted by contractor crews, heavy equipment, UTVs, staging, and access, as well as by access limitations near heavy equipment and during herbicide application. A number of impact avoidance and minimization measures would be implemented, including limiting work to weekdays, minimizing idling time of equipment, and posting notices about construction and closures at trailheads, access points, and on the park's web site. Based on these factors, potential adverse impacts to visitor experience during implementation would range from very negligible to moderate at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with very negligible effects potentially expected at areas rarely visited by the public such as Davis Property, B Ranch, and A Ranch. Staging and access, use of heavy equipment, and presence of contractor crews at heavily-visited Limantour and, to a lesser extent, North Beach would have potentially higher impacts to visitor experience (minor to moderate). AT&T is visited by a number of park visitors interested in the historic radio facility, so there could possibly be negligible to minor impacts in this project area, with minor impacts being primarily restricted to just staging activities at the radio facility area.

Based on the scale of projects that could be conducted in the park and proposed outside the park, these projects could cumulatively have negligible to possibly minor long-term beneficial effects on visitor experience in the region, particularly within beach and dune systems.

Adjacent Land Use

Policies and Regulations

As was discussed in Affected Environment, most of the lands adjacent to the Seashore's coastal dunes are in federal ownership. Consistent with the park's enabling legislation, beef cattle and dairy ranching is authorized under agricultural lease/permits on approximately 18,900 acres of the park lands, with some of those lands adjacent to the Seashore's coastal dunes. In some instances, dunes fall within or are directly adjacent to wilderness areas: these impacts are addressed in a separate section.

Specific authority to issue agricultural leases/special use permits ("lease/permits") is provided by 16 U.S.C §§ 459 c-5 for the Seashore and 16 U.S.C. 460bb-2(j) for GGNRA. Beef cattle and dairy activities within the Seashore lands are guided by past authorizations, Park Service Management Policies, and RM 53. Section 8.6.8.2 of the Park Service Management Policies state that, "agricultural livestock grazing within parks are directed to use best management practices to protect park resources, with particular attention being given to protecting wetland and riparian areas, sensitive species and their habitats, water quality, and cultural resources" (NPS 2006). Managers are further directed by these policies to regulate livestock so "(1) ecosystem dynamics and the composition, condition and distribution of native plants and animal communities are not significantly altered or otherwise threatened, and (2) cultural values are protected."

Assessment Methodology

Under this section, impacts to one primary type of adjacent land use are analyzed -- livestock grazing by lessees on federal lands. In terms of other federal agencies that lease lands for livestock grazing, perhaps one of the most well known ones is another U.S. Department of Interior agency, Bureau of Land Management (BLM). Many impact analysis sections of NEPA documents prepared by this agency or its contractors focus on impacts of grazing to federal lands for issuance or renewal of leases, but a number of documents have also evaluated impacts of proposed actions such as gas, solar, or other resource extraction development on existing grazing leases.

Impact analysis sections for these types of documents have used various sets of criteria for evaluating impacts to livestock grazing operations. Some of the criteria used in these documents focused on major or "significant" impacts being those that would preclude grazing over the long-term of entire project areas and surrounding lands (BLM 2007); "reduction in animal unit months that would require modification in grazing allotments or other actions that would prevent the realization of grazing management goals" (BLM 2007); or changes that could result in "significant reduction" in foraging opportunities (Dover 2009). Another project defined major or significant impacts as those that cause long-term disruption of grazing management or ranching operations, including livestock trailing, watering, fencing, and feeding (BLM 1999). For a recent document for solar development in six southwestern states, significant impacts were considered in which allotments lost more than 50% of their land area (BLM/DOE 2012). Other factors considered in evaluating significant impacts were livestock safety (Dover 2009) and violation of BLM Resource Management Protection or other land use plans (BLM 2007).

Impact Thresholds

Negligible: There would be no measurable changes in forage available to beef and dairy cattle on individual leases of federal lands as a result of the proposed action, or changes would be barely detectable and within the range of natural variability. Actions would also cause no measurable or detectable long-term change in grazing management, such as the need to supplement feed, or ranching operations, including organic operations.

Minor**:** There would be small, but detectable or measurable changes in forage available to beef and dairy cattle on individual leases of federal lands as a result of the proposed action. Actions would also cause small, but measurable or detectable long-term change in grazing management, such as the need to supplement feed, or ranching operations, including organic operations.

Moderate**:** There would be apparent or appreciable change in forage available to beef and dairy cattle on individual leases of federal lands as a result of the proposed action. Actions would also cause apparent or appreciable long-term change in grazing management, such as the need to supplement feed, or ranching operations, including organic operations. For the latter, this could include issuance of a certificate of non-compliance that would require corrective measures to maintain organic certification.

Major**:** There would be striking or highly noticeable change in forage available to beef and dairy cattle on individual leases of federal land as a result of the proposed action. Actions would also cause striking or highly noticeable long-term change in grazing management, such as the need to supplement feed, or ranching operations, including organic operations. For the latter, this could include loss of organic certification for a period of three (3) years.

Alternative A

Analysis

Under Alternative A, no near-term dune restoration projects would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Long-Term Effects

Sand Movement

As has been discussed in a number of other sections, one of the natural processes for dune systems is inland migration. This inland migration can negatively impact adjacent land uses such as ranching operations. The intensity and immediacy of dune movement in both unrestored and restored systems is strongly dependent on many factors, including existing vegetation cover, weather conditions, and extent and type of dune restoration.

As was discussed under *Natural Physical Processes and Soils*, one of the primary differences between natural or native dunes and dunes heavily colonized by European beachgrass is the rate of sand movement, as species such as beachgrass and iceplant were planted to stabilize dunes and prevent encroachment into adjacent lands. In Humboldt, research found that natural parabolic dunes migrated on average 4.7 feet/year between 1939 and 1988, while some other parabolic dunes and transverse dunes moved as much as 15 to 21 feet/year (Wiedemann 1984; Pacific Watershed Associates 1991). Presumably sand movement rates would be lower in invaded dune, as these species were planted to stabilize these systems, however, there is not much quantitative information on dune movement rates in European beachgrass-dominated dunes. In England, where European beachgrass is native, rates of inland movement of the dunes varied between 5-10 feet/year on the more stable dune sections and up to 22 feet/year on the most mobile dune sections (Ranwell 1958). At Bodega Dunes, it is estimated that European beachgrass planting in the 1920s has caused an average annual accumulation rate of sand of up to 5,232 cubic yards/year, with sand transport three orders of magnitude lower in vegetated areas than in unvegetated areas (Cesmat et al. 2012).

While European beachgrass and iceplant were planted to stop movement of the dunes, the dunes within the Seashore have continued to migrate inland over the past 60- 70 years despite rapid expansion of these species, albeit perhaps at a slower rate. The total rate of increase in the extent of dunes between 1943 and 2007 has varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual growth rates in dune extent during this period of 0.25% to 0.91% (Johnson 2013a). Coastal dunes represent varying percentages of the total leased lands for different ranches, ranging from as low as 2% at G Ranch – most of the dune system is outside the lease boundary at this ranch – to 24% at AT&T, with B Ranch estimated at 22% (Johnson 2013a).

Sand movement rates can also be affected by differing physiology of European beachgrass in foredune and backdune areas. As active burial stimulates European beachgrass rhizome growth, rhizomes are deeper in the foredunes, where sand is more actively deposited, than in the reardunes (Baye 2008). Over decades, the internal fabric of interbedded European beachgrass roots and rhizomes in stabilized backdune areas begins to decay, particularly at lower depths, so backdune sands may be more susceptible to wind movement, although, because they are distant from the shore and are protected somewhat by the foredune, they are typically not subject to as high wind speeds or sand accretion as the foredune (Baye 2008).

Dune migration can affect forage potential for cattle, as well, by impacting fencing and water supplies. Some level of impact occurs under existing conditions, because planting of European beachgrass and iceplant in the dunes has not necessarily stopped inland migration of dunes despite their rapid spread throughout these systems. Remobilization of sand can have both subtle and non-subtle effects on grazing opportunity and forage for cattle. Sand may bury portions of pasture, often in elongated "fingers" of sand that extend into grasslands. It may also have more subtle effects by incrementally increasing sand content of soils and gradually altering the vegetation community. Sand can bury fencing and cause need for continued repair to ensure that animals do not get out of leased lands. Ranchers are required to maintain fencing in good, working condition, so burial of fences can incur additional costs for the ranchers. In addition, should either natural or manmade watering areas occur directly adjacent to dunes, dune migration can also impact these features, which could require the rancher to create additional water sources for cattle.

Taking all of these factors into account, Alternative A would have no long-term effects on adjacent land use from sand movement: the lack of restoration would not increase sand mobilization over existing dune migration rates under unrestored conditions discussed above. Alternative A would not trigger any change in lease conditions under any of the alternatives.

Organic Operations

As was described in Affected Environment, all dairy operations within the park are now certified organic. In addition, a handful of beef operations are either certified organic or are managed as if they are organic. B Ranch and A Ranch are certified organic Grade A dairies, whereas AT&T is a beef cattle operation that has been managed as organic, but not been certified, although the rancher is planning to seek certification. For this reason, AT&T is treated as an organic operation in this analysis. F Ranch beef cattle operations are not managed as organic. Limantour and the Davis Property do not directly border any federal lands leased for agricultural operations, organic or otherwise.

Organic operations must comply with a number of regulations, including restrictions on spraying or use of herbicides and pesticides and use of treated fence posts. Herbicides are not allowed to be used in areas designated as organic. No prohibited substances may be applied to the land for 36 months prior to the harvest of any product that will be labeled or otherwise represented as organic (NCAT 2004).

No near-term dune restoration would be conducted within the project areas, so there would be no impact to organic operations at AT&T, B Ranch, or A Ranch.

Implementation-Related and Short-Term Impacts

There would be no implementation-related or short-term impacts, because near-term dune restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on adjacent land use would primarily be other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration. One recent project adjacent to grazed lands includes hand removal of up to 12 acres of iceplant on the oceanward sections of dune at B Ranch: another project scheduled for fall 2014 involves spraying of up to 15 net acres of foredune European beachgrass and iceplant stands at B Ranch. Other dune restoration projects or potential projects in the region -- e.g., Lawson's Landing, Muir Beach, Bodega Marine Laboratory -- do not necessarily border ranchlands, although many fall adjacent to private lands. Specific actions in the park that may have cumulative effects on adjacent land use include ranch projects undertaken either by the lessee or by the park, maintenance and upgrade of park facilities near coastal areas, such as the Beaches Water System project, Federal Highways' Sir Francis Drake Boulevard and Limantour road maintenance project, and other smaller scale road and trail maintenance projects. Ranch projects are likely to have beneficial impacts on ranching operations, so, based on the scale of projects that could be conducted in the park, these projects could cumulatively have no effect or negligible beneficial long-term effects on adjacent land use.

Conclusions

Under Alternative A, no near-term dune restoration projects would be conducted at AT&T/ North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Over the long term, this alternative would have either no effect or the potential for no effect on adjacent land use. There would be no long-term effects on sand movement or organic operations, which would affect adjacent land use where federal lands are leased. There are no federal lands leased for grazing adjacent to Limantour and the Davis Property. The lack of restoration at AT&T, North Beach (F Ranch), Davis Property, B Ranch, and A Ranch would not increase sand mobilization over dune migration rates that currently exist under unrestored conditions. While European beachgrass and iceplant were planted to stop movement of the dunes, the dunes within the Seashore have continued to migrate inland over the past 60- 70 years despite rapid expansion of these species, albeit perhaps at a slower rate. The total rate of increase in the extent of dunes between 1943 and 2007 has varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual growth rates in dune extent during this period of 0.25% to 0.91% (Johnson 2013a). Based on impacts of other ranch and park projects, including the recently completed project to remove by hand iceplant on the oceanward portions of B Ranch dunes, Alternative A could cumulatively have no effect or negligible beneficial long-term effects on adjacent land use. Ranch projects are likely to have beneficial impacts on ranching operations

There would be no implementation-related or short-term impacts, because near-term restoration would not be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Long-Term Effects

Sand Movement

As has been discussed in a number of other sections, including under Alternative A of this section, one of the natural processes for dune systems is inland migration. This inland migration can negatively impact adjacent land uses such as ranching operations through adversely affecting grazing potential or forage, fencing, and water systems. This is discussed in more detail under Alternative A – Sand Movement.

The intensity and immediacy of dune movement in both unrestored and restored systems is strongly dependent on many factors, including existing vegetation cover, weather conditions, and extent and type of dune restoration. As was discussed under *Natural Physical Processes and Soils*, one of the primary differences between natural or native dunes and dunes heavily colonized by European beachgrass is the rate of sand movement, as species such as beachgrass and iceplant were planted to stabilize dunes and prevent encroachment into adjacent lands. Presumably sand movement rates would be lower in invaded dune, as these species were planted to stabilize these systems, however, there is not much quantitative information on dune movement rates in European beachgrass-dominated dunes. In England, where European beachgrass is native, rates of inland movement of the dunes varied between 5-10 feet/year on the more stable dune sections and up to 22 feet/year on the most mobile dune sections (Ranwell 1958). At Bodega Dunes, it is estimated that European beachgrass planting in the 1920s has caused an average annual accumulation rate of sand of up to 5,232 cubic yards/year, with sand transport three orders of magnitude lower in vegetated areas than in unvegetated areas (Cesmat et al. 2012).

While European beachgrass and iceplant were planted to stop movement of the dunes, the dunes within the Seashore have continued to migrate inland over the past 60- 70 years despite rapid expansion of these species, albeit perhaps at a slower rate. The total rate of increase in the extent of dunes between 1943 and 2007 has varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual growth rates in dune extent during this period of 0.25% to 0.91% (Johnson 2013a). Coastal dunes represent varying percentages of the total leased lands for different ranches, ranging from as low as 2% at G Ranch – most of the dune system is outside the lease boundary at this ranch – to 24% at AT&T, with B Ranch estimated at 22% (Johnson 2013a).

Sand movement rates can also be affected by differing physiology of European beachgrass in foredune and backdune areas. As active burial stimulates European beachgrass rhizome growth, rhizomes are deeper in the foredunes, where sand is more actively deposited, than in the reardunes (Baye 2008). With less active burial occurring in the backdunes, deeper rhizomes in these landward areas begin to decay, resulting in shallower rooting depths overall in backdunes. Therefore, sands in backdunes, which are typically adjacent to or closer to grazing pastures than foredunes, may be more susceptible to wind movement, although, because they are distant from the shore and are protected somewhat by the foredune, they are typically not subject to as high wind speeds or sand accretion as the foredune (Baye 2008).

The intensity of sand movement appears strongly related to removal method. Based on available information, mechanical removal, with its greater excavation depths (up to 6 feet), appears to result in more inland dune migration than seemingly either chemical control or manual removal. While manual removal involves excavation and, to some degree, "flipping" or turnover of the soil horizons, excavation depths are relatively shallow (0.5 to 1.5 feet), which reduces the potential for destabilization of sands and later transport during high wind events. Unfortunately, there are no studies on sand movement rates following dedicated manual removal projects that could be used to differentiate these impacts between removal methods. Manual removal would probably have inland sand migration rates intermediate between that of mechanical removal and herbicide treatment, but generally closer to that of herbicide treatment, particularly as active revegetation would be conducted in backdune areas immediately adjacent to leased ranchlands.

Estimates of potential impact must take into account that fact that dunes have continued to migrate even under existing, non-restored conditions. It must also take into account that migration rates would not be expected to remain linear through time, as, at some point, redistribution of excess sands that had previously accumulated due to establishment of invasive, non-native plant species would be expected to reach some type of dynamic equilibrium due to decreased storage volume. Lastly, as discussed above, dune restoration under this alternative would include active revegetation as an impact minimization measure.

Based on these factors and those discussed under Alternative A, potential long-term adverse impacts to adjacent land use from dune migration would be expected to range from very negligible to possibly minor at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. No effects on adjacent land use from dune migration would be expected where dunes do not border federal lands leased for grazing (e.g., Limantour and Davis Property). Impact intensity would be lower under Alternative B than under Alternative D, because excavation depths would be shallower than under Alternative D, and the scale of restoration conducted within the project areas would also be reduced slightly relative to that alternative.

Under this alternative, there would be either no detectable or potentially a small, detectable loss of forage. For most ranches, which graze their pastures year-round, loss of available forage could require additional forage supplementation or provision of additional water sources to allow cattle to forage on currently underutilized forage. Most ranchers already supplement forage: based on discussions with ranchers, costs of forage supplementation for cattle have increased in recent years, particularly for ranchers that run an organic operation. As noted under Alternative A, in addition to potential reductions in forage, dune migration can also impact fencing and water supplies for cattle. Restoration would not trigger any change in lease conditions under any of the alternatives.

Organic Operations

As was described in Affected Environment, all dairy operations within the park are now certified organic. In addition, a handful of beef operations are either certified organic or are managed as if they are organic. B Ranch and A Ranch are certified organic Grade A dairies, whereas AT&T is a beef cattle operation that has been managed as organic, but not been certified, although the rancher is planning to seek certification. For this reason, AT&T is treated as an organic operation in this analysis. F Ranch is not managed as an organic operation. Limantour and the Davis Property do not directly border any federal lands leased for agricultural operations, organic or otherwise.

Organic operations must comply with a number of regulations, including restrictions on spraying or use of herbicides and pesticides and use of treated fence posts. Herbicides are not allowed to be used in areas designated as organic. No prohibited substances may be applied to the land for 36 months prior to the harvest of any product that will be labeled or otherwise represented as organic (NCAT 2004).

In some instances, the park constructs new permanent or temporary fencing as part of the project: long-term impacts to organic certification if proper fencing materials (i.e., untreated posts) are not used. Also, areas along primary access routes may be contaminated with fuel or oil in the case of an uncontained spill or leaking equipment. However, equipment would be regularly inspected, and the staging area would be managed using Best Management Practices, which includes requiring that fueling be conducted in areas with an impermeable lining or some other barrier to minimize contamination of fuels into the soils.

Based on these factors, including the proposed impact avoidance and mitigation measures, dune restoration could potentially have at most very negligible adverse impacts to organic operations on adjacent leased ranch lands at AT&T, B Ranch, and A Ranch. There would be no effects at North Beach (F Ranch), which does not border organic agricultural operations, or at Limantour or the Davis Property, where the dune restoration projects would not border federal lands leased for agricultural operations.

Implementation-Related and Short-Term Impacts

Staging and Access: Most of the primary staging and access at AT&T, North Beach (F Ranch), B Ranch, and A Ranch would occur in adjacent grasslands or scrub communities, most of which are used as pastures for cattle, although some staging and access at North Beach (F Ranch) could occur in the paved roads and visitor parking lot. In general, when staging and access must occur in leased ranch areas, impact avoidance and minimization measures call for the preferential use of existing ranch roads before establishment of any new primary access roads. Contractors are required to leave roads in the same or better condition as when the project started.

If new primary access routes are required, the Seashore would work with ranchers on siting of these routes so that they have the least temporary impacts on ranching operations. The same is true of staging areas. Staging areas would be fenced off temporarily, if not already fenced off, to ensure the least impact to livestock.

The Seashore also requires contractors to clean equipment and tires before entering (and exiting) an area to ensure that new weeds are not introduced, as well as other BMPs focused on reducing noise, dust, and other environmental quality issues that could affect adjacent land use. Contractors are required to not interfere with livestock operations and to maintain gates and fencing, including keeping gates closed.

Given these factors, including the proposed impact avoidance and minimization measures, potential adverse impacts to adjacent land use from staging and access under this alternative would generally be very negligible at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. There would be no potential for effect at Limantour or the Davis Property, as the dune restoration projects would not border federal lands leased for agricultural operations or other uses.

Manual Removal: The primary impacts associated with manual removal would be from people and all-terrain vehicle use, although most of the ranching operations use ATVs or UTVs, so use of these vehicles should not frighten livestock. Contractors are required to not interfere with livestock operations and to maintain gates and fencing, including keeping gates closed.

Based on these factors, including proposed impact avoidance and minimization measures, manual removal would be expected to have very negligible potential implementation-related effects associated with the presence of crews or ATV or UTV use at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. There would be no potential for effect at Limantour or the Davis Property, as the dune restoration projects would not border federal lands leased for agricultural operations or other uses.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative on adjacent land use would the same as described under Alternative A. Based on the scale of projects that could be conducted in the park and proposed outside the park, these projects could cumulatively have very negligible adverse long-term effects on adjacent land use on federal lands leased for grazing.

Conclusions

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Based on the scale of restoration that may be implemented within these project areas, over the long term, this alternative would have the potential for very negligible to possibly minor adverse effects on adjacent land use at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. The proposed project would have the potential for at most only very negligible effects on organic operations, with very negligible to possibly minor impacts from manual removal on sand movement into adjacent pastures. There would be no potential for effect at Limantour or the Davis Property where the dune restoration projects would not border federal lands leased for agricultural operations or other uses. The magnitude of these long-term impacts would not be expected to increase based on cumulative impacts with other routine and non-routine ranch and park maintenance and other projects.

Long-term impacts from sand movement on adjacent leased ranch lands would be minimized by active revegetation of backdune areas adjacent to pastures. If losses of forage were minor or small, but detectable, they could require additional forage supplementation or provision of additional water sources to allow cattle to forage on currently underutilized forage. Most ranchers already supplement forage: based on discussions with ranchers, costs of forage supplementation for cattle have increased in recent years, particularly for ranchers that run an organic operation. As noted under Alternative A, in addition to potential reductions in forage, dune migration can also impact fencing and water supplies for cattle. Restoration would not trigger any change in lease conditions under any of the alternatives.

During implementation and over the short-term, dune restoration could potentially have very negligible adverse impacts on adjacent land use at AT&T/North Beach and B Ranch/A Ranch/Davis Property.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Long-Term Effects

A description of some of the baseline conditions and long-term impacts associated with restoration on adjacent land use can be found under Alternatives A and B.

Sand Movement

As has been discussed in a number of other sections, one of the natural processes for dune systems is inland migration. This inland migration can negatively impact adjacent land uses such as ranching operations, including affecting grazing potential or forage, fencing, and watering sources. The intensity and immediacy of dune movement in both unrestored and restored systems is strongly dependent on many factors, including existing vegetation cover, weather conditions, and extent and type of dune restoration.

As was discussed under *Natural Physical Processes and Soils* and Alternatives A and B, one of the primary differences between natural or native dunes and dunes heavily colonized by European beachgrass is the rate of sand movement, as species such as beachgrass and iceplant were planted to stabilize dunes and prevent encroachment into adjacent lands. Presumably sand movement rates would be lower in invaded dune, as these species were planted to stabilize these systems, however, there is not much quantitative information on dune movement rates in European beachgrass-dominated dunes. At the Seashore, where European beachgrass and iceplant were planted prior to the 1940s to stop inland dune migration, the dunes have continued to migrate inland over the past 60- 70 years despite rapid expansion of these invasive plant species, albeit perhaps at a slower rate. The total rate of increase in the extent of dunes between 1943 and 2007 has varied from 16% at G Ranch to 59% at AT&T, with B Ranch estimated at 27%, resulting in average annual growth rates in dune extent during this period of 0.25% to 0.91% (Johnson 2013a).

Certain types of dune restoration can result in more sand movement. At Little River State Beach in Humboldt County where excavation with heavy equipment had been conducted to remove European beachgrass, dunes moved, on average, 2.5 feet per month shortly after restoration in an inland-trending direction, although the rate of inland dune movement may have been retarded by sand moving over existing European beachgrass stands (Vaughan and Fiori 2007).

Following extensive excavation as part of mechanical removal of European beachgrass at Abbotts Lagoon in 2011, sands that had accumulated from decades of artificial stabilization by European beachgrass were remobilized, with remobilization exacerbated by lack of vegetation establishment during the successive dry winters that were also accompanied by high spring winds. By spring 2013, approximately 10.1 acres of grassland, scrub, and wetland had been buried by newly remobilized sand (Johnson 2013a), which is equivalent to about 3% of the entire 300-acre restoration project area. Of the 10.1 acres, 7.3 acres involved inland "creep" of dunes, with the remainder being internal to the dune system (Johnson 2013a). Of those 7.3 acres, approximately 2 acres occurred in portions of the G Ranch lease mapped as being on Sirdrak Variant soils and therefore considered "grazeable." Of these 2 acres, only 0.8 acre is currently being grazed due to a change in the fence alignment (Johnson 2013a): 2 acres represents approximately 0.2% of the 952-acre leased pasture. Another 3.5 acres of pasture characterized as "ungrazeable" due to its Dune land soil mapping designation unit were buried (Johnson 2013a).

Of these 5.5 acres, 4.1 acres or 75% occurred within areas previously buried by sand through dune migration (Johnson 2013a). In fact, review of historic aerial imagery indicates that the proportion of ungrazeable pasture within G Ranch lease/permit boundaries due to the presence of barren, sandy areas actually appears lower in 2013 – even with sand remobilization – than in 1963, around the time that the Seashore was established (Johnson 2013a). In general, sand movement since 2011 has tended to follow established historical sand deposition paths as evidenced by the fact that most of the ungrazeable areas buried were pre-existing dune "fingers" that extended into the pasture, which were already very sandy and dominated by dune and scrub type species. In the 1960s, two decades after European beachgrass was planted at Abbotts, these fingers are very distinguishable on aerial imagery as barren, sandy areas (Johnson 2013a). Over the next 30- to 40 years, these fingers remained within the pasture, but became sparsely vegetated by dune and dune scrub plant species, as can be seen in 2010 aerial imagery (Johnson 2013a). While there has been an inland creep from the perimeter of the mechanical removal area, this creep has largely been re-burying areas that have been repeatedly buried by sand in the past, with some very minor (<1 acre) exceptions.

The intensity of sand movement appears strongly related to removal method. In the same year that mechanical removal was performed at Abbotts Lagoon, some of the backdune and foredune areas immediately adjacent to these areas were treated with herbicide. Although European beachgrass was almost completely killed during the initial treatment effort (>99%), the dead aboveground biomass and presumably the rhizomes did not decompose rapidly. This delayed decomposition may have reduced the potential for sands in these areas to remobilize, as they are being held in place by the dead rhizomes. As of 2013, no migration of dune has occurred inland of these herbicide-treated areas (Johnson 2013a). The propensity for dunes to migrate inland could increase as beachgrass decomposes, however, this potential could be countered to some degree by establishment of new vegetation or expansion of remnant native vegetation within treated areas: new plants are already colonizing these areas, including some more deeply rooted species such as coyotebrush, mock heather, and wild cucumber, that could contribute to stabilization of dune soils. Many of the intermixed dune shrubs that occurred there prior to treatment are still alive, so these may help hold soils until other shrubs can establish.

Estimates of potential impact must take into account that fact that dunes have continued to migrate even under existing, non-restored conditions. It must also take into account that migration rates would not be expected to remain linear through time, as, at some point, redistribution of excess sands that had previously accumulated due to establishment of invasive, non-native plant species would be expected to reach some type of dynamic equilibrium due to decreased storage volume.

Under Alternative C, very negligible to minor effects on sand movement and forage potential at AT&T, North Beach (F Ranch), B Ranch, and A Ranch would be expected where dunes are restored through use of herbicide and possibly some areas where manual removal is employed. No excavation would be conducted under this alternative, except in wetland and organic pasture buffer and manual removal areas. In areas treated chemically, gradual decomposition of the European beachgrass and its rhizomes would enable native vegetation to establish that would help stabilize dunes. In addition, active revegetation would be conducted in backdune areas immediately adjacent to leased ranchlands, and backdune restoration efforts may also be phased.

If losses of forage were minor or small, but detectable, it could require additional forage supplementation or provision of additional water sources to allow cattle to forage on currently underutilized forage. Most ranchers already supplement forage: based on discussions with ranchers, costs of forage supplementation for cattle have increased in recent years, particularly for ranchers that run an organic operation.

In addition to potential reductions in forage, dune migration can also impact fencing and water supplies for cattle. Sand can bury fencing and cause need for continued repair to ensure that animals do not get out of leased lands. Ranchers are required to maintain fencing in good, working condition, so burial of fences can incur additional costs for the ranchers. In addition, should either natural or manmade watering areas occur directly adjacent to dunes, dune migration can also impact these features, which could require the rancher to create additional water sources for cattle.

Based on all these factors, potential adverse impacts on adjacent land use from dune migration would be expected to range from very negligible to minor at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. Alternative C would probably have the lowest inland sand migration rates of any of the alternatives, with the possible exception of Alternative B. There is a potential for minor effects in areas where mechanical removal is conducted in wetland and organic pasture buffer areas. There would be no potential for effect at Limantour or the Davis Property where the dune restoration projects would not border federal lands leased for agricultural operations or other uses. Restoration would not trigger any change in lease conditions under any of the alternatives.

Organic Operations

As was described in *Affected Environment*, all dairy operations within the park are now certified organic. In addition, a handful of beef operations are either certified organic or are managed as if they are organic. B Ranch and A Ranch are certified organic Grade A dairies, whereas AT&T is a beef cattle operation that has been managed as organic, but not been certified, although the rancher is planning to seek certification. For this reason, AT&T is treated as an organic operation in this analysis. F Ranch beef cattle operations are not managed as organic. Limantour and the Davis Property do not directly border any federal lands leased for agricultural operations, organic or otherwise.

Organic operations must comply with a number of regulations, including restrictions on spraying or use of herbicides and pesticides and use of treated fence posts. Herbicides are not allowed to be used in areas designated as organic. No prohibited substances may be applied to the land for 36 months prior to the harvest of any product that will be labeled or otherwise represented as organic (NCAT 2004).

If herbicides are used in areas adjacent to organic certified or managed pastures, buffers must be established. The Organic Crop Workbook published by NCAT stated that no standardized buffer widths for spraying of herbicide and adjacent areas certified as Organic Crop or Organic Livestock have been developed, but 25-feet is the most common buffer width applied (NCAT 2004). This buffer has been previously agreed to as being sufficient by both the ranching operators and the Marin County Department of Agriculture – Weights and Measures (John DiGregoria, former NPS, *pers. comm*.). For this reason, the park has standardly employed this 25-foot buffer in addition to a large number of other measures to prevent drift, including weather restrictions and use of a spot spraying technique with handheld spray wand and backpack units.

The National Organic Program defines residues as "too high" when they are greater than 5 percent of the EPA's tolerance for the pesticide. The USEPA sets maximum amounts of pesticide residue that may lawfully remain on a food commodity that has been treated, either intentionally or not, with pesticide. These are known as "tolerances." Tolerances are used on all food and grain crops and also on cattle forage.

All tolerance values for a wide array of pesticides (including glyphosate and imazapyr, as well as their derivatives or parent chemicals) are published as part of the Code of Federal Regulations (CFR) Title 40, Part 180. The two herbicides proposed for use for dune restoration are glyphosate and imazapyr. For glyphosate, the USEPA tolerance limit is 300 ppm for "grass, forage, fodder and hay, group 17" is 300 ppm, so the 5% tolerance residue would be 15 ppm. For imazapyr, the USEPA tolerance is 100 ppm for "grass forage," which is equivalent to a 5% tolerance residue of 5 ppm.

The primary ways in which organic operations could be affected by dune restoration would be through spray drift if herbicide treatment is conducted or through installation of treated fence posts. Because both of these impacts could require exclusion of certain areas for at least three (3) years before they could be included again in organic operations, potential impacts from these factors would be considered long-term, although not necessarily permanent.

Of the herbicides proposed for use, glyphosate has received the most attention, perhaps due to the fact that multiple glyphosate products exist, as well as its ready availability in household herbicides. Most studies on glyphosate address so-called technical grade glyphosate (SERA 2011a), which is glyphosate without surfactants. Many formulations of glyphosate either incorporate a surfactant or require that a surfactant be separately added during mixing. Round-Up® is one of the most familiar glyphosate formulations, and it incorporates a surfactant called polyoxyethyleneamine (POEA). Toxicity studies clearly indicate that the POEA surfactants may be nine times more toxic than glyphosate itself (SERA 2011a). The park would not use this glyphosate formulation, but would use Aqua-Master® or another aquatic-label glyphosate brand that does not incorporate a surfactant. Instead, a non-ionic surfactant such as Competitor® would be added during mixing.

As noted above, the largest concern for organic operations with herbicide treatment would be spray drift. Herbicide drift results when herbicide application extends beyond the intended area of application and can be influenced by many factors, including the method of application (e.g., aerial or broadcast versus ground), topography, wind speed, humidity, type of herbicide, and droplet size. The park employs a number of impact avoidance and minimization measures during herbicide treatment, including use of backpack sprayers with calibrated nozzles; and discontinuation of spraying when wind speeds reach an average or consistent gusts of 10 mph at plant level or when conditions are very foggy. Labels for both AquaMaster® (currently marketed as Round-Up Custom®) and Habitat® recommend spraying between 2 or 3 to 10 mph to minimize drift. In addition, wicking of herbicide onto vegetation or drift shields may also be used to minimize the potential for herbicide drift. No broadcast (e.g., boom) or aerial spraying would be conducted.

A more detailed description of issues associated with drift can be found under *Vegetation Resources* – Alternative A. Most studies on herbicide drift are focused on either aerial application or boom sprayer-type application methods used in agricultural operations (Salyani and Cromwell 1992, Holterman et al. 1997 *in* SERA 2011a). An earlier U.S. Forest Service (USFS) risk assessment showed that, for a boom sprayer rather than a backpack unit, a wind velocity of no more than 5 mph with a wind direction perpendicular to the line of application could cause drift of herbicide as far as 23 feet (USFS 2003 *in* NPS 2009). Herbicide emitted from a boom sprayer could drift twice as far with winds at 10 miles per hour (USFS 2003 *in* NPS 2009). However, these studies greatly overestimate the potential for drift for more focused backpack-specific application methods (SERA 2011a). For the 2011 update of the USFS risk assessment, which uses the EPA's AgDRIFT Tier 1 model (Teske et al. 2002 *in* SERA 2011a), estimates of drift from backpack applications were based on increasing the droplet size and on reducing the percentile estimates of drift (SERA 2011a). However, as cautioned in SERA (2011b), "The drift estimates for backpack applications, which are based on a modified set of assumptions for low-boom ground applications, are likely to overestimate drift associated with carefully conducted backpack applications under conditions that do not favor drift."

Based on USFS risk assessment worksheets developed by SERA, use of the proposed 4.0 pounds a.e./acre of glyphosate could result in drift of 0.8% (0.033 lbs a.e./acre) of the applied solution within 25 feet of the application area, 0.4% (0.017 lbs a.e./acre) within 50 feet, and 0.03% (0.001 lbs a.e./acre) within 900 feet. There is no direct way to correlate these numbers with the potential residue tolerances due to the fact that former is expressed as volume, and the latter is expressed as concentration. However, there have been some studies that evaluated plant residues at specific glyphosate application rates. In a study by Newton et al. (1984) *in* CDPR (1998), glyphosate herbicide residues and metabolites were evaluated in forest brush field ecosystems in the Oregon Coast Range which had been aerially treated with 2.9 lbs/acre glyphosate. In the first 12 hours after spraying before any rain, foliar glyphosate residues were approximately 84.0 ppm (Newton et al. 1984 *in* CDPR 1998). These represent residues at essentially "ground zero:" based on drift estimates for backpack spraying discussed above, residues 25 feet from the spray area could drop to 0.7 ppm, which is well below the organic residue tolerance threshold of 15 ppm for glyphosate and forage for organic cattle. While glyphosate application rates for dune restoration would be greater than 2.9 lbs/acre (4 lbs a.e./acre), even doubling the number above (1.4 ppm) would still yield an estimate far below the tolerance threshold.

Based on USFS risk assessment worksheets developed by SERA for imazapyr, the proportion of herbicide subject to drift shows the same relationship with distance from application area as glyphosate, however, the volume of herbicide delivered downstream with drift would differ. Use of the park's maximum application rate of 1.0 pounds a.e./acre of imazapyr could result in drift of 0.008 lbs a.e./acre of the applied solution within 25 feet of the application area, 0.004 lbs a.e./acre within 50 feet, and 0.0003 lbs a.e./acre within 900 feet. Again, as with glyphosate, it is difficult to correlate application rates specifically with foliar residue concentrations. However, the research that supported the current USEPA tolerances for imazapyr of 100 ppm for grass forage came from a project in which application rates were 0.75 lbs a.i./acre (USEPA 2006): at distances of 25 feet, drift could result in delivery of 0.8% of the applied volume, which would equate to 0.8 ppm, well below the organic residue tolerance of 5 ppm, even taking into consideration the park's slightly higher application rate (1 lb a.e./acre).

Another form of drift that may affect adjacent land is wind erosion (SERA 2011a). Wind erosion leading to off-site movement of pesticides is likely to be highly site-specific and depends on several factors, including application rate, depth of incorporation into the soil, persistence in the soil, wind speed, and topographical and surface conditions of the soil (SERA 2011a). The earlier USFS risk assessment (2003) calculated that for a reasonable worst case scenario – a sandy surface with high wind speeds and arid conditions – approximately 0.54% of the glyphosate applied to an application area would be lost due to wind erosion. While dune systems meet most of these conditions – sandy, high winds, arid conditions – areas where spraying would be conducted would be less likely to have wind erosion due to the very low rates of sand remobilization in these areas due to the slow decomposition rates for European beachgrass (See *Natural Physical Processes and Soils* for more detailed discussion).

A third potential avenue for herbicides to exert effects on adjacent lands comes from run-off. One recent study conducted for MMWD found that glyphosate and its breakdown product, AMPA, were not found either in dissolved or particulate phases of stormwater run-off collected from an application area, probably due to strong soil and litter adsorption (Hwang and Young 2011). The proportion of run-off as a fraction of application rate varies with soils, as well as climate, specifically temperature and rainfall. During some modeling conducted as part of the 2011 USFS risk assessment, run-off of glyphosate was estimated at a maximum of 0.089 lbs a.e./acre for areas with predominantly clay soils, cool temperatures, and high rainfall, while run-off for arid areas with predominantly loam or sandy soils was estimated closer to 0.0000001 lbs a.e./acre (SERA 2011a). Coastal dunes within the Seashore should tend towards the lower value due to the very sandy soils and moderate rainfall. The same is true for imazapyr: "In areas with predominantly sandy soils, the runoff of imazapyr following foliar applications should be negligible, and risks to non-target plants should also be negligible" (SERA 2011b). The potential for impact would be further reduced by impact avoidance and mitigation measures such as spraying during dry periods, not spraying 24 hours before a rainfall event with a 20% probability of occurrence, or 24 hours after a rainfall event. In addition, herbicide application methods emphasize avoidance of any drip of herbicide from foliage onto the ground.

In some instances, the park constructs new permanent or temporary fencing as part of the project: long-term impacts to organic certification can occur if proper fencing materials (i.e., untreated posts) are not used. Also, areas along primary access routes may be contaminated with fuel or oil in the case of an uncontained spill or leaking equipment. However, equipment would be regularly inspected, and the staging area would be managed using Best Management Practices, which includes requiring that fueling and herbicide application be conducted in areas with an impermeable lining or some other barrier to minimize contamination of fuels or chemicals into the soils. Even with these precautions, if staging is conducted within actively used pastures, areas used for staging may need to be taken out of organic operations for at least three years. Every effort would be made to locate staging areas outside of pastures certified or managed as organic.

Based on these factors, including the proposed impact avoidance and mitigation measures, chemical control could potentially have very negligible to at most negligible adverse impacts to organic operations on adjacent leased ranch lands at AT&T, B Ranch, and A Ranch. There would be no potential for effect at North Beach (F Ranch), which does not border organic agricultural operations, or at Limantour or the Davis Property where the dune restoration projects would not border federal lands leased for agricultural operations or other uses. Some small areas adjacent to the dunes that are used for staging areas may need to be closed off to cattle for at least three years if herbicide mixing was conducted in that area: as noted above, all herbicide mixing is required by the Seashore to be conducted in a contained environment, but temporary closures of staging areas may be conducted as a precautionary measure. Every effort would be made to stage outside of organic pastures, when possible.

Implementation-Related and Short-Term Impacts

Staging and Access: In general, access and staging impacts on adjacent land use would be identical to those under Alternative B, although the intensity of access and staging requirements -- and impacts -- may increase slightly given that mechanical removal would be potentially conducted in wetland and organic pasture buffer areas, which increases heavy equipment needs. Given the factors discussed under Alternative B, including the proposed impact avoidance and minimization measures, potential adverse impacts to adjacent land use from staging and access under this alternative would generally range from negligible to possibly minor at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. There would be no potential for effect at Limantour or the Davis Property, as the dune restoration projects would not border federal lands leased for agricultural operations or other uses.

Manual Removal: Impacts of manual removal on adjacent land use are very similar to those discussed under Alternative B, although the intensity of impacts may decrease slightly as manual removal would be used primarily for removal of iceplant and European beachgrass in wetland and buffers. Manual removal would be expected to have very negligible potential adverse effects from the presence of crews or UTV use at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. There would be no potential for effect at Limantour or the Davis Property, as the dune restoration project would not border federal lands leased for agricultural operations or other uses.

Mechanical Removal: Mechanical removal would be expected to have negligible potential implementation-related or short-term effects on adjacent land uses at AT&T and B Ranch. The intensity of the impact would be reduced relative to Alternative D, as mechanical removal would be used only in wetland and organic pasture buffer areas. Mechanical removal areas would be fenced off from active cattle operations, or the Seashore would work with the lessees to move cattle from that particular pasture. In some instances, mechanical removal could occur when cattle are present: operators would be required to be careful around livestock to ensure their safety. Heavy equipment is sometimes used on ranches for ranch maintenance, so cattle should be used to equipment noise. There would be no potential for effect at Limantour, as the dune restoration project would not border federal lands leased for agricultural operations or other uses.

Chemical Control: Chemical control would be expected to have no more than a negligible potential implementation-related or short-term effect on adjacent land uses at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. Potential long-term effects of chemical control are discussed under Organic Operations above. No implementation-related or short-term effects would be expected on organic operations during implementation, because chemical control would not be used in organic pastures or pastures with organic cattle, regardless of certification status, and a 25-foot buffer would be maintained between chemical control and organic pastures/cattle. The park would follow very strict weather restrictions to minimize potential of drift, including no spraying when winds exceed 10 mph.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative on adjacent land use would the same as described under Alternative A. Based on the scale of projects that could be conducted in the park and proposed outside the park, these projects could cumulatively have very negligible adverse long-term effects on adjacent land use on federal lands leased for grazing.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal potentially.

Based on the scale of restoration that may be implemented under this alternative, over the long term, this alternative would have the potential for very negligible to minor adverse effects from sand movement and chemical control on organic ranching operations. While sand has continued to migrate inland even with historic planting of European beachgrass and ice-plant, projects that incorporate more areas with mechanical removal in buffers or even manual removal may have slightly higher rates of sand remobilization. If losses of forage were minor or small, but detectable, it could require additional forage supplementation or provision of additional water sources to allow cattle to forage on currently underutilized forage. Most ranchers already supplement forage: based on discussions with ranchers, costs of forage supplementation for cattle have increased in recent years, particularly for ranchers that run an organic operation. As noted under Alternative A, in addition to potential reductions in forage, dune migration can also impact fencing and water supplies for cattle. Restoration would not trigger any change in lease conditions under any of the alternatives. There would be no potential for effect at Limantour or the Davis Property, as the dune restoration project would not border federal lands leased for agricultural operations or other uses.

Chemical control in dune restoration has the potential for indirect impacts on adjacent land use, particularly organic operations, through possibly drift during spray operations or from run-off or wind erosion. Based on estimates derived from worksheets developed for the USFS by SERA, drift, run-off, or wind erosion of the proposed application rates for glyphosate and imazapyr at a distance of at least 25 feet from organic operations -- the most standardly used buffer width -- would not appear to pose a risk of foliar herbicide residues exceeding the established USEPA tolerances for organic grass forage. If staging is conducted within actively used pastures, areas used for staging may need to be taken out of organic operations for at least three years. Every effort would be made to locate staging areas outside of pastures certified or managed as organic.

During and shortly following implementation, dune restoration could have potentially have very negligible to possibly minor adverse impacts on adjacent land use at AT&T, North Beach (F Ranch), B Ranch, and A Ranch, with possible minor impacts resulting primarily from staging and access of heavy equipment in actively used pastures. As already noted, there would be no potential for effect at Limantour or the Davis Property, as they do not border leased federal lands.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on adjacent land use can be found under Alternative A.

Sand Movement

Based on the factors discussed under Long-Term Effects of Alternatives A-C, Alternative D would probably have the highest inland sand migration rates of any of the alternatives. Excavation conducted as part of "horizon flipping" would potentially remobilize sands, particularly if restoration is followed by dry winters and high spring winds. On a localized scale, potential long-term adverse impacts to adjacent land use from dune migration would be expected to range from minor to possibly moderate at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. There is a potential for moderate or apparent, appreciable effects in some areas where large-scale mechanical removal might be performed, although remobilization could be countered to some degree by active revegetation of backdune areas that would help stabilize newly excavated sands and reduce possible impacts. There is no potential for effect at Limantour or the Davis Property, as the dune restoration projects would not border federal lands leased for agricultural operations or other uses.

If losses of forage were minor or moderate, it could require additional forage supplementation or provision of additional water sources to allow cattle to forage on currently underutilized forage. Most ranchers already supplement forage: based on discussions with ranchers, costs of forage supplementation for cattle have increased in recent years, particularly for ranchers that run an organic operation. As noted under Alternative A, in addition to potential reductions in forage, dune migration can also impact fencing and water supplies for cattle. Restoration would not trigger any change in lease conditions under any of the alternatives.

Organic Operations

A full discussion of the potential impact of herbicide treatment on adjacent organic land use can be found under Alternative C. The scale of herbicide treatment under Alternative D would be greatly reduced, with spot-spraying only occurring for resprouts within areas treated mechanically. Therefore, the intensity of potential impacts would be reduced accordingly. As it has done in the past, the Seashore would work cooperatively with ranchers when installing new fencing to ensure that only materials that meet organic certification needs are used. Staging areas used for fueling or chemical mixing may need to be closed off to organic cattle for at least three years, even if BMPs regarding contained environments are implemented, however, every effort would be made to stage outside of organic pastures.

Based on these factors, including the proposed impact avoidance and mitigation measures, chemical control could potentially have very negligible adverse impacts to organic operations at AT&T, B Ranch, and A Ranch. There is no potential for effect at North Beach (F Ranch), which does not border organic agricultural operations, or at Limantour or the Davis Property, as the dune restoration projects would not border federal lands leased for agricultural operations or other uses.

Implementation-Related and Short-Term Impacts

Staging and Access: In general, access and staging impacts on adjacent land use would be very similar to those under Alternative C, although the intensity of access and staging requirements -- and impacts -- would increase given that mechanical removal would be the primary removal method, which increases the need for access and staging of heavy equipment. Given the factors discussed under Alternatives B and C, including the proposed impact avoidance and minimization measures, potential adverse impacts to adjacent land use from staging and access under this alternative would generally range from negligible to minor at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. There is no potential for effect at Limantour or the Davis Property, as the dune restoration projects would not border federal lands leased for agricultural operations or other uses.

Manual Removal: Impacts of manual removal on adjacent land use are very similar to those discussed under Alternative B, although the intensity of impacts may decrease slightly as manual removal would be used primarily for removal of iceplant and European beachgrass in wetland and buffers. Manual removal would be expected to have very negligible potential implementation-related effects from the presence of crews and ATV or UTV use on adjacent land uses at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. There is no potential for effect at Limantour or the Davis Property, as the dune restoration projects would not border federal lands leased for agricultural operations or other uses.

Mechanical Removal: Potential impacts of mechanical removal on adjacent land use are similar to those discussed under Alternative C, although the intensity of impact would increase considerably, as mechanical removal would be the primary removal method. In most instances, mechanical removal areas would be fenced off from active cattle operations, or the Seashore would work with the lessees to move cattle from that particular pasture. Mechanical removal would be expected to have no effect to negligible potential implementation-related or short-term effects on adjacent land uses at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. There is no potential for effect at Limantour or the Davis Property, as the dune restoration projects would not border federal lands leased for agricultural operations or other uses.

Chemical Control: Potential impacts of chemical control are similar to those discussed under Alternative C, although the intensity would be reduced relative to that alternative due to the fact that herbicides would only be used for spot-spraying of re-sprouts in mechanical removal areas. Based on the factors discussed under Alternative C, including proposed impact avoidance and minimization measures, chemical control would be expected to have either no effect or no more than very negligible implementation-related or short-term effects on adjacent land uses at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. No effect would be expected on organic operations during implementation, because chemical control would not be used in organic pastures or pastures with organic cattle, regardless of certification statusm and a 25-foot buffer would be maintained between chemical control and organic pastures/cattle. The park would follow very strict weather restrictions to minimize potential of drift, including no spraying when winds exceed 10 mph. There is no potential for effect at Limantour or the Davis Property, as the dune restoration project would not border federal lands leased for agricultural operations or other uses.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative on adjacent land uses would be the same as described under Alternative A. Based on the scale of projects that could be conducted in the park and proposed outside the park, these projects could cumulatively have negligible adverse long-term effects on adjacent land use on federal lands leased for grazing.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Based on the scale of restoration that may be implemented, over the long term, this alternative would have the potential for very negligible to possibly moderate adverse impacts at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. While sand has continued to migrate inland even with historic planting of European beachgrass and iceplant, large-scale mechanical removal projects may have higher rates of sand remobilization, although remobilization would be reduced due to active revegetation of backdune areas adjacent to pastures. There is no potential for effect at Limantour or the Davis Property, as the dune restoration projects would not border federal lands leased for agricultural operations or other uses.

If losses of forage were minor or moderate, it could require additional forage supplementation or provision of additional water sources to allow cattle to forage on currently underutilized forage. Most ranchers already supplement forage: based on discussions with ranchers, costs of forage supplementation for cattle have increased in recent years, particularly for ranchers that run an organic operation. As noted under Alternatives B and C, in addition to potential reductions in forage, dune migration can also impact fencing and water supplies for cattle. Restoration would not trigger any change in lease conditions under any of the alternatives.

Chemical control in dune restoration has the potential for indirect impacts on adjacent land use, particularly organic operations, through possibly drift during spray operations or from run-off or wind erosion. Under Alternative D, chemical treatment would be primarily used for treatment of resprouts in mechanical removal areas. Based on estimates derived from worksheets developed for the USFS by SERA, drift, run-off, or wind erosion of the proposed application rates for glyphosate and imazapyr at a distance of at least 25 feet from organic operations -- the most standardly used buffer width -- would not appear to pose a risk of foliar herbicide residues exceeding the established USEPA tolerances for organic grass forage. If staging is conducted within actively used pastures, areas used for staging may need to be taken out of organic operations for at least three years, even with implementation of BMPs. Every effort would be made to locate staging areas outside of pastures certified or managed as organic.

During and shortly following implementation dune restoration could have potentially very negligible to minor adverse impacts on adjacent land use at AT&T, North Beach (F Ranch), B Ranch, and A Ranch. As noted earlier, there would be no potential for effect at Limantour or the Davis Property, as they do not border federal lands leased for agricultural or other operations.

Public Health and Safety

Policies and Regulations

Enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks (NPS 2006, Section 8.2). Some of this enjoyment may ultimately depend on health and safety of park visitors. While recognizing that there are limitations on its capability to totally eliminate all hazards, the Park Service – and its concessioners, contractors, and cooperators – are directed to provide a safe and healthful environment for visitors and employees (NPS 2006, Section 8.2).

Based on Park Service Management Policies (2006, Section 8.2), unacceptable impacts are impacts that, individually or cumulatively, would … create an unsafe or unhealthy environment for visitors or employees. The Park Service is further directed to strive to identify and prevent injuries from recognizable threats to the safety and health of persons … by applying nationally accepted codes, standards, engineering principles, and the guidance contained in Director's Orders #50B, #50C, #58, and #83 and their associated reference manuals (NPS 2006, Section 8.2). Some of the measures that may be used to reduce or remove or minimize the risk of known hazards include "closures, guarding, signing, or other forms of education" (NPS 2006, Section 8.2).

Any closures or restrictions—other than those imposed by law—must be consistent with applicable laws, regulations, and policies, and (except in emergency situations) require a written determination by the superintendent that such measures are needed to protect public health and safety.

Under NEPA, agencies are required to consider impacts of the proposed actions on health, as CEQ includes "health" among its list of effects that must be considered (40 C.F.R. § 1508.8). The regulations instruct agencies to evaluate "the degree to which the proposed action affects public health or safety" in determining significance (40 C.F.R. § 1508.27).

Assessment Methodology

Impact Thresholds

Negligible: There would be no measurable change in risks to public health and safety, or change would be barely detectable and often within the natural range of variability.

***Minor*:** There would be small, but detectable or measurable changes in risks to public health or safety.

***Moderate*:** There would be apparent or appreciable change in risks to public health or safety.

***Major*:** There would be striking or highly noticeable change in risks to public health or safety.

Impact of Alternative A

Analysis

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, except for previously permitted projects.

Long-Term Effects

In general, Alternative A would have the potential for few long-term effects on public health and safety. One of the primary direct effects – and impacts – of not restoring dunes in these areas and allowing continued expansion of European beachgrass and iceplant is that these dense monocultures pose some risk to public safety in terms of hiking conditions. Currently, many of the heavily invaded dune areas have rough, hilly terrain with treacherous footing due to dense vegetation and debris. The dense vegetation and debris pose tripping hazards, and hikers are less able to perceive terrain conditions due to decreased visibility. Dunes at AT&T, Davis Property, B Ranch, and A Ranch are less frequently hiked by dune visitors than the heavily-visited beach and dune systems at Limantour and, to a lesser extent, North Beach. Based on these factors, potential long-term adverse effects on risks to public safety from Alternative A would be very negligible adverse.

Implementation-Related and Short-Term Effects

There would be no potential for implementation-related or short-term effects, as no near term restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on public health and safety would primarily be other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration projects. Specific actions in the park that may have cumulative effects on public health and safety include previously permitted dune restoration projects such as hand removal of iceplant at B Ranch, maintenance and upgrade of park facilities near coastal areas, such as the Beaches Water System project, Federal Highways' Sir Francis Drake Boulevard and Limantour road maintenance project, and other smaller scale road and trail maintenance projects. There would be the potential for Alternative A and park projects to cumulatively have either no effect or very negligible adverse effects on public health and safety.

Conclusions

Under Alternative A, no near-term dune restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, or Limantour, except for previously permitted projects.

In general, Alternative A would have the potential for few long-term effects on public health and safety. One of the primary direct effects – and impacts – of not restoring dunes in these areas and allowing continued expansion of European beachgrass and iceplant is that these dense monocultures pose some risk to public safety in terms of hiking conditions. Currently, many of the heavily invaded dune areas have rough, hilly terrain with treacherous footing due to dense vegetation and debris. The dense vegetation and debris pose tripping hazards, and hikers are less able to perceive terrain conditions due to decreased visibility. Dunes at AT&T, Davis Property, B Ranch, and A Ranch are less frequently hiked by dune visitors than the heavily-visited beach and dune systems at Limantour and, to a lesser extent, North Beach. Based on these factors, potential long-term adverse effects on risks to public safety from Alternative A would be very negligible adverse.

There would be no potential for implementation-related or short-term effects, as no near term restoration would be conducted at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Projects with the potential to have cumulative effects with this alternative on public health and safety would primarily be other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration. There would be the potential for Alternative A and park projects to cumulatively have either no effect or very negligible adverse effects on public health and safety.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Long-Term Effects

In general, Alternative B would have the potential for few long-term effects on public health and safety. One of the direct effects – and benefits – of restoration is that removal of European beachgrass and, to a lesser extent, would improve the safety of hiking conditions within the dunes. Currently, unrestored areas generally have rough, hilly terrain with treacherous footing due to dense vegetation and debris. There would be less tripping hazards, and hikers would be better able to perceive terrain conditions due to improved visibility. Dunes at AT&T, Davis Property, B Ranch, and A Ranch are less frequently hiked by dune visitors than the heavily-visited beach and dune systems at Limantour and, to a lesser extent, North Beach, so benefits to public safety from restoration would be greater at Limantour and North Beach than at AT&T, Davis Property, B Ranch, or A Ranch.

One of the indirect effects of dune restoration on public safety involves transport of sand onto roadways. As has been discussed under many previous sections, following restoration, sands that have been artificially stabilized by decades of European beachgrass and iceplant colonization accumulate to higher-than-normal volumes and then can be remobilized and blown inland. The potential for sand remobilization is highly dependent on the extent and type of restoration method. Mechanical removal can result in more sand remobilization due to the fact that excavation is deeper (at least 6 feet), and sand horizons are "flipped," placing European beachgrass and its soil-stabilizing rhizomes at least 3 feet below the sand surface. In addition to removing non-native, invasive plants, excavation essentially destabilizes the soil horizons. Manual removal involves shallower excavation, so destabilization – and the potential for remobilization – is considerably reduced.

The potential for restoration activities to impact public safety through increasing sands on roadways depends substantially on distance of the project from these roadways. Many of the Seashore's dune systems are located a considerable distance from the roads and are buffered by adjacent grasslands, coastal scrub, or open water (e.g., Abbotts Lagoon, AT&T). In other areas, such as the Point Reyes Headlands or North Beach, dunes sometimes directly abut roadways and parking lots. During restoration of dunes conducted several years ago at A Ranch, which is located in the Point Reyes Headlands, a "buffer" of unremoved iceplant was retained adjacent to Sir Francis Drake Boulevard to trap sands mobilized from adjacent restoration areas where iceplant was removed and minimize "sand drift" onto adjacent roads. While no formal analyses have been performed, park records document that maintenance staff has removed sand from this section of road a number of times over the years, however, removal predates restoration at A Ranch, suggesting that sand drift occurs with and without restoration. To increase public safety, this section of road has been posted with signs, cautioning drivers about sand drifts.

The distance of AT&T, Davis Property, and B Ranch dunes from nearby public roadways is great enough that dune restoration in these project areas would have no effect on public safety on park and County of Marin roadways. Most of the dunes on Limantour Spit also fall quite some distance from public roadways, with the exception of those dunes oceanward of Limantour Pond near the public parking lots. Similarly, most of the dunes at North Beach are some distance from the parking lot or park road, but proposed restoration areas at North Beach do abut the parking lot on the north side. Despite this, however, there would likely be no impact or the potential for only a very negligible adverse impact on public safety from manual removal activities at Limantour or North Beach. Under Alternative B and other action alternatives, active revegetation would be conducted in backdune areas, which would help to minimize sand movement.

Based on these factors, potential long-term adverse effects to public safety from dune restoration would be no more than very negligible. Some of this impact could be offset by improvements to hiker safety from removal of portions of these dense monocultures, leading to very negligible beneficial effects. The intensity of benefits to hiker safety from invasive plant removal would be reduced under Alternative B relative to Alternative C and possibly Alternative D.

Implementation-Related and Short-Term Effects

Staging and Access: At AT&T/North Beach and B Ranch/A Ranch/Davis Property, staging and access would primarily occur in adjacent grasslands and coastal scrub, which are generally not visited by the public, although staging at Limantour and North Beach would or could occur in public areas, e.g., Limantour Beach and North Beach parking lots, respectively. At AT&T, some staging may be located within the paved area at the historic radio facility. While this facility is not heavily visited by the general public, it does receive some public visitation. Under Alternative B, the intensity of access and staging requirements -- and impacts -- may be reduced relative to the other alternatives due to the fact that no heavy equipment would be needed. In general, at AT&T, Davis Property, B Ranch, and A Ranch, staging and access would have the potential for only very negligible effects on public safety, because it would mostly occur on ranchlands that are rarely visited by the public. At Limantour and North Beach, staging and access could have the potential for a negligible increase in risk to public safety. Contractors would be required to secure equipment and materials at all times to reduce risks to the public and to store materials and equipment in such a way that it reduces tripping or fall hazards to the public.

Manual Removal: Manual removal has the potential to increase risks to public health and safety by increasing the unevenness of terrain within treatment areas due to shallow excavation of European beachgrass, iceplant, and other invasives. As discussed under Long-Term Effects, risks posed by these activities are offset by the fact that unrestored areas generally have rough, hilly terrain with treacherous footing due to dense vegetation: removal of plants would actually increase visibility of the ground surface and improve accessibility. Based on these factors, manual removal would have the potential for a very negligible increase in risk to public safety.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects would the potential to have cumulative impacts with those under this alternative are the same as those discussed under Alternative A. From a regional perspective, park projects under this alternative cumulatively have the potential for very negligible adverse effects on public health and safety.

Conclusions

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

In general, Alternative B would have the potential for few long-term effects on public health and safety. One of the direct effects – and benefits – of restoration is that removal of European beachgrass and, to a lesser extent, would improve the safety of hiking conditions within the dunes. Dunes at AT&T, Davis Property, B Ranch, and A Ranch are less frequently hiked by dune visitors than the heavily-visited beach and dune systems at Limantour and, to a lesser extent, North Beach, so benefits to public safety from restoration would be greater at Limantour and North Beach than at AT&T, Davis Property, B Ranch, and A Ranch.

Sands that have been accumulated over decades can be remobilized after restoration, resulting in sands being blown inland and possibly onto public roadways depending on how close dunes are to roads. This is primarily an issue in the Point Reyes Headlands, near A Ranch, where dunes are closest to roads. The distance of AT&T, Davis Property, and B Ranch dunes from nearby roadways is great enough that dune restoration in these project areas would have no effect on public safety on park and County of Marin roadways. Most of the dunes on Limantour Spit also fall quite some distance from public roadways, with the exception of those dunes oceanward of Limantour Pond near the public parking lots. Similarly, most of the dunes at North Beach are some distance from the parking lot or park road, but proposed restoration areas at North Beach do abut the parking lot on the north side. Despite this, however, there would likely be no impact or the potential for only a very negligible adverse impact on public safety from manual removal activities at Limantour, North Beach, and A Ranch. Under Alternative B and other action alternatives, active revegetation would be conducted in backdune areas, which would help to minimize sand movement. Based on these factors, potential long-term adverse effects to public safety from dune restoration would be no more than very negligible, but some of these impacts could be offset by improvements to hiker safety from removal of portions of these dense monocultures, leading to very negligible beneficial effects.

Implementation of dune restoration could pose some short-term risks to public safety. Manual removal can create uneven terrain, although it also would reduce the amount of dense vegetation that obscures the ground surface. Potential implementation-related adverse effects would be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Staging should have at most negligible effects on public safety risks, because heavy equipment would not be involved, and most staging would occur away from heavily trafficked areas, except at Limantour and North Beach.

Projects with the potential to have cumulative effects with this alternative on public safety would primarily be other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration. From a regional perspective, park projects cumulatively have the potential for very negligible adverse effects on public health and safety.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Long-Term Effects

A more complete description of the long-term benefits and risks associated with restoration on risks to public health and safety can be found under Alternative B.

Benefits to hiker safety from removal of dense European beachgrass and iceplant stands would be increased relative to Alternative B due to the expanded scale of restoration under Alternative C. Dunes at AT&T, Davis Property, B Ranch, and A Ranch are less frequently hiked by dune visitors than the heavily-visited beach and dune systems at Limantour and, to a lesser extent, North Beach, so benefits to public safety from restoration would be greater at Limantour and North Beach than at AT&T, Davis Property, B Ranch, and A Ranch.

Sands that have been accumulated over decades can be remobilized after restoration, resulting in sands being blown inland and possibly onto public roadways depending on how close dunes are to roads. This is primarily an issue in the Point Reyes Headlands, near A Ranch, where dunes are closest to roads. The distance of AT&T, Davis Property, and B Ranch dunes from nearby roadways is great enough that dune restoration would have no effect on public safety on park and County of Marin roadways. Most of the dunes on Limantour Spit also fall quite some distance from public roadways, with the exception of those dunes oceanward of Limantour Pond near the public parking lots. Similarly, most of the dunes at North Beach are some distance from the parking lot or park road, but proposed restoration areas at North Beach do abut the parking lot on the north side.

The intensity of adverse impacts under Alternative C from sand remobilization would probably remain very similar to or be possibly even lower than Alternative B. Manual removal -- the primary removal method under Alternative B -- involves shallow excavation (<1.5 feet) and turnover of soils. Chemical control, the primary removal method under Alternative C, involves no excavation, although, over time, European beachgrass and iceplant decompose, thereby increasing potential risk of sand remobilization. However, because these plants both decompose very slowly, other plants can establish in the interim that can help to stabilize soils. In addition, the application method – backpack sprayer with wand – focuses treatment on target plant and allows non-target plants such as coyote brush and mock heather to remain: both of these shrubs would provide strong, soil-stabilizing benefits. With the exception of wetlands where cultural resource constraints may exist, there could be some deeper excavation under Alternative C associated with mechanical removal in wetland and organic pasture buffers, however, the scale of mechanical removal proposed would not considerably increase the potential for sand remobilization. Under all action alternatives, active revegetation would be conducted in backdune areas, which would help to minimize sand movement.

Based on these factors and those discussed under Alternative B, potential long-term adverse effects to public safety from dune restoration would be negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with the potential for both beneficial and adverse impacts being highest at Limantour and North Beach due to the fact they are much more heavily visited by the public. Some of these impacts could be offset by improvements to hiker safety from removal of portions of these dense monocultures, leading to negligible beneficial effects.

Implementation-Related and Short-Term Effects

Staging and Access: In general, access and staging impacts on risks to public health and safety would be identical to those under Alternative B although the intensity of access and staging requirements -- and impacts – may increase slightly relative to Alternative B, because heavy equipment may be needed for mechanical removal of European beachgrass in wetland and organic pasture buffers. Potential impacts on public safety from staging and access would range from very negligible to possibly minor adverse effects. Potential minor adverse effects on public safety risks may occur if staging is located in public areas, such as parking lots at Limantour and North Beach.

Manual Removal: Impacts of manual removal on risks to public health and safety would be very similar to those discussed under Alternative B. Based on factors discussed under Alternative B, manual removal would have no more than a negligible effect on public safety risks at AT&T, B Ranch, and Limantour.

Mechanical Removal: Mechanical removal has the potential to impact public health and safety through the presence of heavy equipment. For safety reasons, the public would not be allowed within the work area during construction, and signs would be posted near the work area to that effect. Equipment operators would cease operation should a member of the public approach the equipment while in operation despite area being closed. Notices about the presence of construction equipment would also be posted at trailheads and on the park's website. Safety risks would be further minimized by limiting construction hours to weekdays from 7 a.m. to 6 p.m., with weekends only permissible with express approval of the park: Beach visitation is highest on the weekends.

Based on these factors, including proposed impact avoidance and minimization measures, mechanical removal would have the potential for no more than a very negligible effect on public safety at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Impact intensity would be reduced relative to Alternative D, because mechanical removal would be used only in wetland and organic pasture buffers.

Chemical Control: Chemical control has the potential to impact public health and safety through drift during spray operations and through direct contact with sprayed vegetation. Treatment areas would be posted as no public entry during and 24 hours after spraying regardless of the fact that herbicides proposed for use do not have a mandatory restricted-entry interval (REI). Notices about these closures would be posted at trailheads and all potential access points.

Two herbicides would be used under this alternative, as well as a surfactant and a dye. The two herbicides are glyphosate and imazapyr. By far, glyphosate has received the most attention, perhaps due to multiple glyphosate products that exist, as well as its availability in some household herbicides. Most studies on glyphosate address so-called technical grade glyphosate (SERA 2011a), which is glyphosate without surfactants. Many formulations of glyphosate either incorporate a surfactant or require that a surfactant be separately added during mixing. Round-Up® is one of the most familiar glyphosate formulations, and it incorporates a surfactant called polyoxyethyleneamine (POEA). In terms of potential human health effects, toxicity studies clearly indicate that the toxicity of POEA surfactants may be up to nine times more toxic than glyphosate (SERA 2011a). The park would not use this type of formulation, but would use Aqua-Master® or another aquatic-label glyphosate brand that does not incorporate a surfactant. Instead, a non-ionic surfactant such as Competitor® would be added during mixing.

For technical grade glyphosate, most available data clearly indicates that the mammalian toxicity of glyphosate is low, and very few specific hazards can be identified (SERA 2011a). Doses of technical grade glyphosate that exceed around 300 mg a.e./kg bw may cause signs of toxicity, including decreased body weight gain, changes in certain biochemical parameters in blood as well as tissues, and inhibition of some enzymes (i.e., P450) involved in certain metabolic cycles (SERA 2011a). At doses from about 1,000 to 5,000 mg a.e./kg bw, glyphosate can cause death (SERA 2011a). The most sensitive endpoint for glyphosate – i.e., the adverse effect occurring at the lowest dose – involves developmental effects: accordingly, the USEPA-derived reference doses (RfDs) for glyphosate are based on developmental effects (SERA 2011a). These adverse effects relate primarily to delayed development, which occurs only at doses causing signs of maternal toxicity (SERA 2011a). There is no indication that technical grade glyphosate causes birth defects (SERA 2011a).

The exposure assessments developed in the USFS risk assessments for both glyphosate (and imazapyr) are based on Extreme Values rather than a single value (SERA 2011a). Extreme value exposure assessments, as the name implies, bracket the most plausible estimate of exposure (referred to statistically as the central or maximum likelihood estimate) with lower and upper bounds of credible exposure levels (SERA 2011a). This Extreme Value approach is essentially an elaboration on the concept of the Most Exposed Individual (MEI), sometime referred to as the Maximum Exposed Individual (SERA 2011a). Exposure assessments that use the MEI approach attempt to characterize the extreme, but still plausible, upper limit on exposure (SERA 2011a). This common approach to exposure assessment is used by USEPA, other government agencies, and the International Commission on Radiological Protection (e.g., ATSDR 2002; ICRP 2005; Payne-Sturges et al. 2004 *in* SERA 2011a). In addition to concern for the most exposed individual, there is concern for individuals who may be more sensitive than most members of the general population to exposure to a specific herbicide (SERA 2011a). This concern is considered in the dose-response assessment by USFS, which bases exposures on the most sensitive endpoint in the most sensitive species and uses an uncertainty factor for sensitive individuals (SERA 2011a). Young women are typically used, because lower body weight of women results in higher chemical dosages per unit body weight (e.g., Boxenbaum and D'Souza. 1990 *in* SERA 2011a), as well as being one of the more sensitive individuals in terms of reproductive effects as discussed above for glyphosate specifically (SERA 2011a).

Consistent with the USEPA approach, the current USFS risk assessment does not adopt an explicit acute RfD for glyphosate and uses the chronic RfD to characterize risks associated with both acute and longer-term exposures (SERA 2011a). The Office of Drinking Water (USEPA/ODW 1998 *in* SERA 2011a) proposes a 20 mg/L 10-day health advisory for glyphosate (SERA 2011a). The 10-day health advisory is based on the no-observed-adverse-effect level (NOAEL) of 175 mg/kg/day from a rabbit reproduction study (Rodwell et al. 1980b *in* SERA 2011a). While rats are typically used in research studying potential effects on humans, the developmental studies submitted to the USEPA clearly indicate that rabbits are more sensitive than rats (SERA 2011a). An uncertainty factor of 100 was applied to this NOAEL, and the 10-day exposure limit was set at 1.75 mg/kg/day and rounded to 2 mg/kg bw/day, identical to the chronic RfD derived by USEPA (SERA 2011a). The uncertainty factor of

100 incorporates factors of 10 for species extrapolation and 10 for sensitive subgroups, which includes pregnant mammals and the developing fetus (SERA 2011a). The current USFS risk assessment adopts the RfD of 2 mg a.e./kg bw/day from USEPA to characterize risks associated with acute and longer-term exposure levels (SERA 2011a).

For visitors, the most likely scenario that could pose risks of contamination involves contact with sprayed vegetation after treatment. This would assumably happen at least 24 hours after spraying due to the fact that treatment areas closed for 24 hours regardless of whether the herbicide calls for a restricted-entry interval (REI) or not. This exposure scenario depends on estimates of dislodgeable residue (a measure of the amount of the chemical that could be released from the vegetation) and the availability of dermal transfer rates (i.e., the rate at which the chemical is transferred from the contaminated vegetation to the surface of the skin; SERA 2011a). Dermal transfer rates are reasonably consistent for a number of different pesticides (Durkin et al. 1995 *in* SERA 2011a). This exposure scenario assumes both a contact period of 1 hour and that the chemical is not effectively removed by washing for at least 24 hours after exposure (SERA 2011a). Based on using glyphosate application rates of 4 lbs a.e./acre in the USFS worksheets developed by SERA, an adult female wearing shorts and a t-shirt would be exposed to dosages ranging from 0.002 to 0.01 mg a.e./kg/event, which is well below the acute RfD of 2 mg a.e./kg bw/day.

Another potential risk for visitors would be herbicide drift during spray operations. Herbicide drift results when herbicide application extends beyond the intended area of application and can be influenced by many factors, including the method of application (e.g., aerial or broadcast versus ground), topography, wind speed, humidity, type of herbicide, and droplet size. The park employs a number of impact avoidance and minimization measures during herbicide treatment, including avoidance of broadcast application methods; use of backpack sprayers with calibrated nozzles; and discontinuation of spraying when wind speeds reach an average or consistent gusts of 10 mph at plant level or when conditions are very foggy. Labels for both AquaMaster® (currently marketed as Round-Up Custom®) and Habitat® recommend spraying between 2 or 3 to 10 mph to minimize drift. In addition, wicking of herbicide onto vegetation or drift shields may also be used to minimize the potential for herbicide drift.

Most studies on herbicide drift are focused on either aerial application or boom sprayer-type application methods used in agricultural operations (Salyani and Cromwell 1992, Holterman et al. 1997 *in* SERA 2011a). An earlier U.S. Forest Service (USFS) risk assessment showed that, for a boom sprayer, a wind velocity of no more than 5 mph with a wind direction perpendicular to the line of application could cause drift of herbicide as far as 23 feet (USFS 2003 *in* NPS 2009). Herbicide emitted from a boom sprayer could drift twice as far with winds at 10 miles per hour (USFS 2003 *in* NPS 2009). However, these studies greatly overestimate the potential for drift for more focused backpack-specific application methods (SERA 2011a). For the 2011 update of the USFS risk assessment, which uses the EPA's AgDRIFT1 model, estimates of drift for backpack applications were calculated based on increasing the droplet size and reducing the percentile estimates of drift relative to those for boom sprayer applications (SERA 2011a).

Based on USFS risk assessment worksheets developed by SERA, use of the proposed 4.0 pounds a.e./acre of glyphosate would result in drift of 0.2% (0.01 lbs a.e./acre) of the applied solution within 100 feet of the application area, 0.09% (0.004 lbs a.e./acre) within 300 feet, 0.06% (0.002 lbs a.e./acre) within 500 feet, and 0.03% (0.001 lbs a.e./acre) within 900 feet. As noted above, the public would be kept out of spray application areas, so these would appear to be the most applicable numbers for drift. At 100 feet from the spray area, then, the estimated exposure for either a child or adult female from direct spray would range from 0.00003 to 0.002 mg a.e./kg/event, which is well below the acute RfD of 2 mg a.e./kg bw/day.

Risks to the general public from accidental and non-accidental exposures are often expressed in hazard quotients (HQs), in which a HQ of 1 is considered the threshold level of concern. Based on USFS risk assessment worksheets developed by SERA, HQs for contact of an adult female wearing shorts and a t-shirt with vegetation sprayed with glyphosate would range from 0.0007 to 0.006, well below the level of concern (1.0). HQs for possible direct body or leg spray of either a child or an adult female associated with drift would range from 0.00001 to 0.001, again well below the level of concern (1.0).

Indeed, for the general public, the only non-accidental exposure scenario of concern for glyphosate is for consumption of contaminated vegetation shortly after application (SERA 2011a). For this exposure scenario, the HQ reaches a level of concern (HQ=1) at an application rate of about 1.4 lbs a.e./acre (SERA 2011a). At the maximum labeled application rate of about 8 lbs a.e./acre, the resulting HQ value would be about 5.6 with a corresponding dose of about 10.8 mg/kg bw (SERA 2011a). A HQ of 5.6 would raise concerns for adverse health effects in pregnant women (SERA 2011a). Based on the more recent study by Moxon (1996b *in* SERA 2011a) which notes a LOAEL for fetotoxicity of 300 m/kg bw, a HQ in the range of 5 might raise concern for fetotoxicity (SERA 2011a). Again, this assumes consumption of contaminated European beachgrass or iceplant, which is extremely unlikely.

Imazapyr is the other herbicide proposed for use. The USEPA classifies imazapyr as practically non-toxic to mammals, birds, honeybees, fish, and aquatic invertebrates (SERA 2011b), and SERA (2011b) states that, "this classification is clearly justified." None of the expected (non-accidental) exposures to these groups of animals raise substantial concern; indeed, most accidental exposures raise only minimal concern (SERA 2011b). The reported signs and symptoms of imazapyr poisoning include vomiting, impaired consciousness, and respiratory distress requiring intubation: There are no reports of human fatality due to imazapyr ingestion (SERA 2011b). An adequate number of multi-generation reproductive and developmental studies have been conducted with imazapyr, none of which indicated adverse effects on reproductive capacity or normal development (SERA 2011b). Also, the results of assays for carcinogenicity and mutagenicity are consistently negative (SERA 2011b). Accordingly, the USEPA categorizes the carcinogenic potential of imazapyr as Class E: evidence of non-carcinogenicity (SERA 2011b). Based on studies, imazapyr also does not appear to be neurotoxic (SERA 2011b). Imazapyr and imazapyr formulations can be mildly irritating to the eyes and skin (SERA 2011b).

According to the USFS risk assessment prepared by SERA (2011b), toxicity information for imazapyr is reasonably complete and unambiguous. The USEPA derived a chronic RfD of 2.5 mg a.e./kg/day based on a dog study that documented a NOAEL of 250 mg a.e./kg/day with an uncertainty factor of 100 (SERA 2011b). The NOAEL selected by the USEPA "appears to be the most appropriate and is supported by additional NOAELs in rats and mice, as well as a number of studies on potential reproduction and developmental effects" (SERA 2011b). Consistent with the USEPA's approach, no acute RfD is derived in the current USFS risk assessment, with the chronic RfD of 2.5 mg a.e./kg/day being used to characterize the risks of both acute and long-term exposure (SERA 2011b). The only adverse effects associated with exposure to imazapyr, albeit at very high doses, are those documented in developmental toxicity studies, so young women were selected as the most sensitive individuals for this assessment (SERA 2011b).

No data are available on dermal transfer rates for imazapyr specifically, but, as noted earlier, dermal transfer rates are reasonably consistent for numerous pesticides (Durkin et al.

1995 *in* SERA 2011b). Similarly, no data are available on dislodgeable residues for imazapyr, which is a greater source of uncertainty (SERA 2011b). For the USFS exposure scenario, a default dislodgeable residue rate of 0.1 of the nominal application rate was used (SERA 2011b). The exposure scenario assumes a contact period of 1 hour and that the chemical is not removed by washing for at least 24 hours (USFS 2011b). Based on use of an application rate of 1 lbs a.e./acre in the USFS worksheet developed by SERA, acute exposure dosage rates for contact of young females wearing shorts and a t-shirt with sprayed vegetation would range from 0.001 to 0.007 mg a.e./kg/event, which is well below the acute and chronic RfD of 2.5 mg a.e./kg bw/event.

Based on USFS risk assessment worksheets developed by SERA for imazapyr, the proportion of imazapyr subject to drift shows the same relationship with distance from application area as glyphosate, however, the volume would differ. Use of the park's maximum application rate of 1.0 pounds a.e./acre of imazapyr would result in drift of 0.002 lbs a.e./acre of the applied solution within 100 feet of the application area, 0.0009 lbs a.e./acre within 300 feet, and 0.0006 lbs a.e./acre within 500 feet. As discussed with glyphosate, treatment areas would be closed off to the public, so visitors would be unlikely to be exposed to drift at distances less than 100 feet. At a distance of 100 feet, acute exposure dosages from direct spray of either a child or adult female would range from 0.0005 to 0.03 mg a.e./kg/event, which is again well below the acute and chronic Rfd of 2.5 mg a.e./kg bw/event.

Imazapyr is somewhat unusual in that doses of imazapyr that may cause adverse effects have actually not been determined: no study has documented an adverse effect on mammals as yet. Therefore, interpretation of HQs that exceed a value of 1 – which is typically considered the level of concern – is somewhat unclear (SERA 2011b). Based on USFS risk assessment worksheets developed by SERA, HQs for contact of an adult female wearing shorts and a t-shirt with vegetation sprayed with imazapyr would range from 0.0004 to 0.003, well below the level of concern (1.0). HQs for possible direct body or leg spray of either a child or an adult female associated with drift would range from 0.0002 to 0.01, again well below the level of concern.

In general, none of the HQs modeled for imazapyr by SERA exceed at the level of concern (1.0) at an application rate of 1.0 lb a.e./acre (SERA 2011b). The highest HQs are those associated with an accidental spill of imazapyr into a small pond and the subsequent consumption of contaminated water by a small child: For this exposure scenario, the HQs range between 0.2 and 5.0 (SERA 2011b). The park would not apply imazapyr in or within at least 25 feet of aquatic areas, so both of these scenarios are unlikely. The highest HQ for members of the general public associated with expected (i.e., non-accidental) exposure scenarios is 0.5, which is maximum HQ for consumption of contaminated vegetation by a woman (SERA 2011b). Based on these analyses, imazapyr is unlikely to pose risks to visitors, nor would this chemical have more effect on other sensitive types of sensitive individuals (SERA 2011b): USEPA (2005a *in* SERA 2011b) concluded that infants and children were not likely to be more sensitive than adults to imazapyr.

Compared to herbicides, information on separately packaged surfactants is not as widely available (PRI 2010). Competitor® – the product that the park has been using – is not acutely toxic to humans and terrestrial wildlife (PRI 2010). The chronic toxicity of the mixture remains unknown (PRI 2010). The oral LD50 for rats and the dermal LD50 for rabbits exposed to Competitor are both greater than 5,000 mg/kg (PRI 2010). Competitor has a "Caution" signal word on the label, meaning that it has low acute toxicity: it is minimally irritating to the eyes and is not toxic or irritating to the skin. There is no information available on chronic toxicity, including cancer, endocrine disruption, or reproductive and developmental toxicity (PRI 2010).

Mowing may be used as a pre-treatment or post-treatment measure to either stimulate European beachgrass growth for improved uptake of herbicide or speed decomposition of dead biomass. As discussed under Alternative A, mowing could pose a potential risk to public safety, but the slow speed of this equipment, coupled by the noise generated, should ensure that there are no additional safety threats to visitors.

Another pre-treatment measure that may be used is prescribed burning. Prescribed burns can impact public health and safety both directly and indirectly. Direct impacts would result in the immediate vicinity of the burn, and threats to public safety would be minimized by closing off the treatment area to the public during the burn activity and posting closure notices at all access points, trailheads, and on the park website.

Indirect impacts would result from smoke generated by burns and effects on sensitive receptors. Prescribed burns would most likely occur in the fall between August 15 and December 15. The Seashore would notify Bay Air Quality Management District (BAAQMD) 24 hours prior to burning and on each burn day to obtain a meteorological forecast, determine whether it is an approved burn day, and request an acreage allocation before burning. Actual acreage burned would also be reported to BAAQMD. Burning would not occur on 1) holidays or weekends, 2) on "no burn days" as determined by BAAQMD unless a variance is requested and granted or 3) if the National or Regional Preparedness Levels preclude new prescribed fires.

One week prior to burning, burn notification flyers would be delivered to residents and businesses near the location of the burn. Flyers would be posted on bulletin boards and in post offices, and a press release would be sent to local media. On burn days, prescribed fire warning signs would be placed at trailheads, parking lots, and other public access locations.

Wind flow and direction would be monitored by the crew prior to and during ignition, and smoke emission and behavior would be continually monitored and documented. If hazardous or unhealthful smoke conditions are observed in Smoke Sensitive Areas, the Fire Management Officer would advise the Chief Ranger and the Fire Information Officer, who would coordinate notification about smoke conditions and potential health impacts. Hazardous conditions can be defined as chronic smoke that reduces visibility to less than 3 miles in Smoke Sensitive Areas: short-term reduced visibility in the immediate fire vicinity should not cause hazardous conditions. Unhealthful conditions can be defined as chronic smoke that exceeds federal ambient air standards in a Smoke Sensitive Area.

Based on these factors and proposed impact avoidance and minimization measures, chemical control and associated pre- and post-treatment measures would have the potential for negligible to minor adverse impacts on public safety at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, with impact intensity potentially higher at Limantour and North Beach, which are more heavily visited by the public. Minor impacts to risks to public health and safety may occur due to smoke if a prescribed burning pre-treatment measure is implemented.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects would the potential to have cumulative impacts with those under this alternative are the same as those discussed under Alternative A. From a regional perspective, park projects cumulatively have the potential for very negligible adverse effects on public health and safety.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal potentially.

In general, Alternative C would have the potential for few long-term effects on public health and safety. Benefits to hiker safety from removal of dense European beachgrass and iceplant stands would be increased relative to Alternative B due to the expanded scale of restoration under Alternative C. Dunes at AT&T, Davis Property, B Ranch, and A Ranch are less frequently hiked by dune visitors than the heavily-visited beach and dune systems at Limantour and North Beach, so benefits to public safety from restoration would be greater at Limantour and North Beach than at AT&T, Davis Property, B Ranch, and A Ranch.

Sands that have been accumulated over decades can be remobilized after restoration, resulting in sands being blown inland and possibly onto public roadways depending on how close dunes are to roads. This is primarily an issue in the Point Reyes Headlands, near A Ranch, where dunes are closest to roads. The distance of AT&T, Davis Property, and B Ranch dunes from nearby roadways is great enough that dune restoration would have no effect on public safety on park and County of Marin roadways. Most of the dunes on Limantour Spit also fall quite some distance from public roadways, with the exception of those dunes oceanward of Limantour Pond near the public parking lots. Similarly, most of the dunes at North Beach are some distance from the parking lot or park road, but proposed restoration areas at North Beach do abut the parking lot on the north side. The intensity of adverse impacts under Alternative C from sand remobilization would probably remain very similar to or be possibly even lower than Alternative B, because the primary removal method does not involve soil excavation. Under all action alternatives, active revegetation would be conducted in backdune areas, which would help to minimize sand movement. Based on these factors, potential long-term adverse effects on public safety risks from dune restoration would be no more than negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Some of these impacts could be offset by improvements to hiker safety from removal of portions of these dense monocultures, leading to negligible beneficial effects.

Implementation of dune restoration could pose some short-term risks to public safety. Manual removal can create uneven terrain, although it also would reduce the amount of dense vegetation that obscures the ground surface. Heavy equipment can pose a risk to visitor safety, although construction areas would be off-limits to the public and posted as such at all points of access, as well as at the trailhead. Potential implementation-related adverse effects from manual and mechanical removal would range from very negligible to minor. Staging of equipment should have very negligible effects on public safety due to the remoteness of most staging areas such as AT&T, Davis Property, B Ranch, and A Ranch, unless staging occurs in public parking lots, such as at Limantour and North Beach, in which case there may be a minor increase in risks.

There is potential for adverse impacts from chemical control due to contact with sprayed vegetation or drift during treatment, however, these risks would be avoided or greatly minimized by closing treatment areas to the public during and 24 hours after treatment and imposing strict weather restrictions on spraying. Based on risk assessment analyses, threats to public safety from focused spot spraying of glyphosate and imazapyr and associated pre- and post-treatment measure would range from negligible to potentially minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Minor impacts to risks to public health and safety may occur due to smoke if a prescribed burning pre-treatment measure is implemented.

Projects with the potential to have cumulative effects with this alternative on public health and safety would primarily be other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration. From a regional perspective, park projects cumulatively have the potential for very negligible adverse effects on public health and safety.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Long-Term Effects

A more complete description of the long-term benefits and risks associated with restoration on public health and safety can be found under Alternatives B and C. The intensity of impacts under Alternative D would probably remain very similar to Alternative C, although they may increase slightly due to the fact that mechanical removal involving deep excavation would be the primary removal method. Based on these factors, potential long-term adverse effects to public safety from dune restoration would range from very negligible to possibly minor, with higher intensity impacts potentially occurring at Limantour and North Beach, because portions of the restored dunes would be near the Limantour Beach and North Beach parking lots/access roads. Some of these impacts could be offset by improvements to hiker safety from removal of portions of these dense monocultures, leading to very negligible beneficial effects. Benefits to hiker safety from removal of dense European beachgrass and iceplant stands would be increased relative to Alternative B due to the expanded scale of restoration, while benefits may be slightly reduced relative to Alternative C due to reduction in total acreage that might be restored.

Implementation-Related and Short-Term Effects

Staging and Access: In general, access and staging impacts on risks to public health and safety would be identical to those under Alternative C, although the intensity of access and staging requirements -- and impacts -- may be increased relative to Alternative C, because mechanical removal would be the primary removal method, which requires staging and access of more heavy equipment. Potential impacts from staging and access on public safety would range from very negligible to minor adverse effects. Potential minor impacts to public safety risk may occur if staging is located in public areas, such as parking lots (e.g., Limantour Beach and North Beach parking lots).

Manual Removal: Impacts of manual removal on risks to public health and safety would be very similar to those discussed under Alternatives B and C. Based on factors discussed under Alternatives B and C, manual removal would have the potential for a very negligible impact on public safety at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Mechanical Removal: Impacts of mechanical removal on risks to public health and safety would be similar to those discussed under Alternative C, although the intensity of impacts would be increased due to the fact that mechanical removal would be the primary removal method. Based on these factors, including proposed impact avoidance and minimization measures, mechanical removal would have the potential for no more than a minor adverse effect on public safety risks at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Chemical Control: Impacts of chemical control on risks to public health and safety would be very similar to those discussed under Alternative C, although impact intensity would decrease substantially as focused spot-spraying would only occur for re-sprouts in mechanical removal areas. Based on these factors, including proposed impact avoidance and minimization measures, chemical control would have the potential for no more than a very negligible adverse impact on public safety risks at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Possible Additional Mitigation Measures: No additional mitigation measures would be performed.

Effectiveness of Possible Additional Mitigation Measures: Not applicable.

Cumulative Impacts

Projects would the potential to have cumulative impacts with those under this alternative are the same as those discussed under Alternative A. From a regional perspective, park projects cumulatively have the potential for very negligible adverse effects on public health and safety.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

In general, Alternative C would have the potential for few long-term effects on public health and safety. Benefits to hiker safety from removal of dense European beachgrass and iceplant stands would be increased relative to Alternative B due to the expanded scale of restoration under Alternative C. Dunes at AT&T, Davis Property, B Ranch, and A Ranch are less frequently hiked by dune visitors than the heavily-visited beach and dune systems at Limantour and North Beach, so benefits to public safety from restoration would be greater at Limantour and North Beach than at AT&T, Davis Property, B Ranch, and A Ranch.

Sands that have been accumulated over decades can be remobilized after restoration, resulting in sands being blown inland and possibly onto public roadways depending on how close dunes are to roads. This is primarily an issue in the Point Reyes Headlands, near A Ranch, where dunes are closest to roads. The distance of AT&T, Davis Property, and B

Ranch dunes from nearby roadways is great enough that dune restoration would have no effect on public safety on park and County of Marin roadways. Most of the dunes on Limantour Spit also fall quite some distance from public roadways, with the exception of those dunes oceanward of Limantour Pond near the public parking lots. Similarly, most of the dunes at North Beach are some distance from the parking lot or park road, but proposed restoration areas at North Beach do abut the parking lot on the north side. The intensity of adverse impacts under Alternative D from sand remobilization would be higher than the other action alternatives, because the primary removal method would rely on deep soil excavation. Under all action alternatives, active revegetation would be conducted in backdune areas, which would help to minimize sand movement. Based on these factors, potential long-term adverse effects on public safety risks from dune restoration would range from very negligible to possibly minor, with minor risks occurring where dune restoration efforts would occur closer to roads and parking lots such as at Limantour and North Beach.

Implementation of dune restoration could pose some short-term risks to public safety. Manual removal can create uneven terrain, although it also would reduce the amount of dense vegetation that obscures the ground surface. Heavy equipment can pose a risk to visitor safety, although construction areas would be off-limits to the public and posted as such at all points of access, as well as at the trailhead. Potential implementation-related adverse effects from manual and mechanical removal would range from very negligible to minor at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Staging of equipment should have very negligible effects on public safety due to the remoteness of most staging areas, unless staging occurs in public parking lots such as at Limantour and North Beach, in which case there may be a minor increase in risks.

There is potential for adverse impacts from chemical control due to contact with sprayed vegetation or drift during treatment, however, chemical control would only be used for re-treatment of resprouts in mechanical removal areas. Risks would be avoided or greatly minimized by closing treatment areas to the public during and 24 hours after treatment and imposing strict weather restrictions on spraying. Based on risk assessment analyses, potential impacts to public safety from focused spot spraying of glyphosate and imazapyr would be very negligible at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

Projects with the potential to have cumulative effects with this alternative on public health and safety would primarily be other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration. From a regional perspective, park projects cumulatively have the potential for very negligible adverse effects on public health and safety.

Park Operations and Management

Policies and Regulations

To fulfill its mission, the Park Service receives funding from both the federal appropriations process and other federal revenue sources. Like most federal agencies, the Park Service relies on Federal appropriations to fund its core activities through base funding, although there is increasing use of alternative revenue sources, such as private monies and grants, to fund specific projects. In addition to base funding, certain parks receive monies from fees generated through park admissions, and parks can also apply for one-time funding through certain appropriation programs that cover cyclic maintenance, construction, etc. The Park Service requests direct Congressional funding and reports on the other federal revenue sources through an annual budget document submitted to Congress entitled "Budget Justifications," or more popularly called, the "Green Book." Because of the limited amount of base funding available to support the 401 park units or areas, the Park Service directs its units to consider the effects of proposed projects on base funding, including any increases in operations and maintenance expenses.

Assessment Methodology

Some of the assumptions made during this analysis include:

- Dune restoration projects have the potential to affect park management and operations after implementation through administrative and long-term operations and maintenance or life-cycle costs.
- Potential effects of the proposed project on park operations were analyzed by assessing potential or anticipated administrative, operations, and maintenance costs that would not be covered by private funding under the various alternatives or those such as cyclic repair or rehabilitation, which is covered by a separate federal funding source other than base funding.
- Each alternative estimates staffing and funding levelss associated with actions in the alternatives. The estimates were intended to facilitate the impact analysis and to allow a general assessment of potential effects. The discussions of impacts focus on projects that would create a need for new operations or that would result in major changes in existing operations.

Impact Thresholds

Negligible: There would be no measurable change in park and operations spending or maintenance needs, or change would be barely detectable and often within the natural range of variability.

***Minor*:** There would be small, but detectable or measurable changes in park and operations spending or maintenance needs.

***Moderate*:** There would be apparent or appreciable change in park and operations spending or maintenance needs.

***Major*:** There would be striking or highly noticeable change in park and operations spending or maintenance needs.

Impact of Alternative A

Analysis

Under Alternative A, dune restoration would not be conducted in the near-term at AT&T/ North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Long-Term Effects

Alternative A would have the potential for no long-term effects on park operations and maintenance.

Implementation-Related and Short-Term Effects

There would be no potential for implementation-related or short-term effects, as dune restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects.

Possible Additional Mitigation Measures: No mitigation measures would be proposed under this alternative.

Effectiveness of Possible Additional Mitigation Measures: Not applicable

Cumulative Impacts

Projects with the potential to have cumulative effects with this alternative on park operations and maintenance would primarily be other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration. Specific actions in the park that may have cumulative effects on park operations and maintenance include hand removal of iceplant at B Ranch, maintenance and upgrade of park facilities near coastal areas, such as the Beaches Water System project, Federal Highways' Sir Francis Drake Boulevard and Limantour road maintenance projects initiated by the Park Service and by County of Marin, and other smaller scale road and trail maintenance projects. Road projects or projects staging along roads or in parking lots could have cumulative effects with dune restoration on road maintenance requirements.

Based on the scale and type of projects that could be conducted in the park, Alternative A in combination with these projects could cumulatively have either no effect or negligible beneficial effects on park operations and maintenance, at least over the long-term. There may be negligible to minor implementation-related adverse effects on Park Service operations due to staffing needs for facilities and other maintenance and habitat restoration projects.

Conclusions

Under Alternative A, dune restoration would not be conducted in the near-term at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, except for previously permitted projects. There would be no potential for long-term, short-term, or implementation-related effects.

Most of the potential for cumulative effects on park operations and maintenance would come from other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration projects. Based on the scale and type of projects that could be conducted in the park, Alternative A in combination with these projects could cumulatively have either no effect or negligible beneficial effects on park operations and maintenance, at least over the long-term. There may be negligible to minor implementation-related adverse effects on Park Service operations due to staffing needs for facilities and other maintenance and habitat restoration projects.

Impact of Alternative B

Analysis

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket, and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Long-Term Effects

In general, Alternative B would have the potential for few long-term effects on park operations and maintenance. Dune restoration would not involve construction of any new facilities that would need to be maintained. Once dune restoration is completed, most of the recurring costs associated with this alternative would come from incidental administrative and staff support and periodic maintenance requirements, with the latter largely associated with the potential need for increased maintenance of roads, parking lots, and other park facilities near restored dunes. Maintenance would either be performed in-house by park staff or by contractors through park-administered contracts.

There are some potential effects on road maintenance associated with sand remobilization. As has been discussed under many previous sections, following restoration, sands that have been artificially stabilized by decades of European beachgrass and iceplant colonization accumulate to higher-than-normal volumes and then can be remobilized and blown inland. The potential for sand remobilization is highly dependent on the extent and type of restoration method. Manual removal involves shallower excavation (<1.5 feet), so destabilization -- and the potential for remobilization -- is considerably reduced.

The potential for restoration activities to impact park operations depends substantially on distance of the project from these roadways. In some areas, such as the Point Reyes Headlands, dunes sometimes directly abut roadways. During restoration of dunes conducted several years ago at A Ranch, a "buffer" of unremoved iceplant was retained adjacent to Sir Francis Drake Boulevard to trap sands mobilized from adjacent restoration areas where iceplant was removed and minimize "sand drift" onto adjacent roads. While no formal analyses have been performed, park records document that maintenance staff has removed sand from this section of road a number of times over the years, however, removal predates restoration at A Ranch, suggesting that sand drift occurs with and without restoration. To increase public safety, this section of road has been posted with signs, cautioning drivers about sand drifts.

Many of the Seashore's dune systems are located a considerable distance from the roads or other park facilities and are buffered by adjacent grasslands, coastal scrub, or open water. Dunes at AT&T and B Ranch both occur some distance from any park facility. Dunes at A Ranch are closer than AT&T and B Ranch ones to Sir Francis Drake Boulevard. The Davis Property adjoins a park road only used by park personnel. Proposed restoration areas at Limantour Spit and North Beach do partially adjoin restroom facilities and parking lots, although, at Limantour, dunes are separated from these facilities by Limantour Pond and Limantour Marsh, which would reduce the amount of impact that any sand remobilization would have on park operations and maintenance.

Based on these factors, potential long-term adverse effects to park operations from dune restoration at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour would range from no effect to negligible on a localized scale, with negligible impacts occurring where dune restoration efforts would occur closer to roads such as at Limantour, North Beach, A Ranch, and, to a lesser extent, Davis Property. Under Alternative B and other action alternatives, active revegetation would be conducted in backdune areas, which would help minimize sand movement.

Implementation-Related and Short-Term Effects

Alternative B would have the potential for only very negligible adverse impacts on park operations and management during implementation, because dune restoration would be funded largely out of Park Service monies from outside the park or non-Park Service monies. Most of the projects are implemented either by contractors or park staff hired specifically to implement the project. These monies have also paid in the past for biological technicians who assist with field oversight and monitoring for the projects. Park monies are largely spent on administrative oversight and management of the projects, including preparation of compliance documents, contracting, budgeting, personnel, and public information. On an annual basis, it is estimated that, on average, permanent, base-funded staff would contribute less than 60 days each year to dune restoration projects.

Relative to Alternatives C and D, impact intensity may be reduced due to the fact that less restoration would probably occur, and implementation would not require preparation and oversight of construction-scale contracts. Overall, base-funded support during implementation would be expected to result in a very negligible adverse impact on park operations and management.

Possible Additional Mitigation Measures: No mitigation measures would be proposed under this alternative.

Effectiveness of Possible Additional Mitigation Measures: Not applicable

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative would be the same as those discussed under Alternative A. Based on the scale of projects that could be conducted in the park, these projects could cumulatively have very negligible adverse short-term effects and very negligible beneficial long-term effects on park operations and maintenance.

Conclusions

Restoration under this alternative would primarily use manual methods at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour to remove non-native or invasive species such as European beachgrass, iceplant, and potentially other species such European searocket and bush lupine. Both initial treatment and re-treatment would be conducted using manual methods.

Alternative B would result generally in very negligible to negligible adverse effects on park operations during implementation and over the long-term, largely related to incidental administrative support and periodic maintenance requirements. In terms of maintenance, sands that have been accumulated over decades can be remobilized after restoration, resulting in sands being blown inland and possibly onto public roadways depending on how close dunes are to roads and other park facilities. Restoration activities at AT&T and B Ranch would not occur near any park facilities such as roads and parking lots. Dunes at A Ranch are closer than AT&T and B Ranch ones to Sir Francis Drake Boulevard. The Davis Property adjoins a park road only used by park personnel. Proposed restoration areas at Limantour Spit and North Beach do partially adjoin restroom facilities and parking lots, although, at Limantour, dunes are separated from these facilities by Limantour Pond and Limantour Marsh, which would reduce the amount of impact that any sand remobilization would have on park operations and maintenance. In addition, under Alternative B and other action alternatives, active revegetation would be conducted in backdune areas, which would help minimize sand movement.

Most of the potential for cumulative effects on park operations and maintenance would come from other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration projects. Cumulative impacts to park operations would be expected to be very negligible both over the short- and long-term.

Impact of Alternative C

Analysis

Restoration in this alternative would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal methods, particularly in wetlands and buffers to wetland and organic pasture and for certain other invasive species such as iceplant. Herbicide treatment areas may be pre-treated or post-treated using either prescribed burning or mowing to improve efficacy of treatment efforts and reduce herbicide application volume.

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on park operations and maintenance can be found under Alternative B. In general, Alternative C would also have the potential for few long-term effects on park operations and maintenance. Dune restoration would not involve construction of any new facilities that would need to be maintained. Once dune restoration is completed, most of the recurring costs associated with this alternative would come from incidental administrative and staff support and periodic maintenance requirements.

The intensity of long-term impacts under Alternative C relative to potential removal of remobilized sands from public roadways and other park facilities would probably remain very similar to those discussed under Alternative B, even though the scale of restoration within each of the project areas would increase.

Based on these factors, potential long-term adverse effects to park operations from dune restoration would range from no effect to negligible, with negligible impacts occurring where dune restoration efforts would occur closer to park facilities such as at Limantour, North Beach, and A Ranch. Under all action alternatives, active revegetation would be conducted in backdune areas, which would help minimize sand movement. At AT&T and B Ranch, dune restoration would either have no effect on park facilities or the potential for only a very negligible effect.

Implementation-Related and Short-Term Effects

Impacts to park operations during implementation would be expected to be very similar to those discussed under Alternative B, although the intensity would increase due to the expanded scale of restoration efforts. Overall, base-funded support during implementation would be expected to result in negligible adverse impacts on park operations and management.

Possible Additional Mitigation Measures: No mitigation measures would be proposed under this alternative.

Effectiveness of Possible Additional Mitigation Measures: Not applicable

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative would be the same as those discussed under Alternative A. Based on the scale of projects that could be conducted in the park, these projects could cumulatively have very negligible adverse long-term effects on park operations and maintenance.

Conclusions

Restoration efforts under Alternative C would primarily use herbicide control methods to remove non-native or invasive species such as European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour, although it would also incorporate manual and mechanical removal potentially. Alternative C would result generally in negligible adverse effects on park operations during implementation and over the long-term, largely related to incidental administrative support and periodic maintenance requirements. In terms of maintenance, sands that have been accumulated over decades can be remobilized after restoration, resulting in sands being blown inland and possibly onto public roadways depending on how close dunes are to roads and other park facilities. Restoration activities at AT&T and B Ranch would not occur near any park facilities such as roads and parking lots. Dunes at A Ranch are closer than AT&T and B Ranch ones to Sir Francis Drake Boulevard. Davis Property adjoins a park road only used by personnel. Proposed restoration areas at Limantour Spit and North Beach do partially adjoin restroom facilities and parking lots, although, at Limantour, dunes are separated from these facilities by Limantour Pond and Limantour Marsh, which would reduce the amount of impact that any sand remobilization would have on park operations and maintenance. In addition, under Alternative C and other action alternatives, active revegetation would be conducted in backdune areas, which would help minimize sand movement.

Most of the potential for cumulative effects on park operations and maintenance would come from other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration projects. Cumulative impacts on park operations would be expected to be very negligible both on a short- and long-term basis.

Impact of Alternative D

Analysis

Alternative D would restore dune habitat by using primarily a mechanical approach to remove European beachgrass at AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Long-Term Effects

A more complete description of the long-term impacts associated with restoration on park operations and maintenance can be found under Alternative B. In general, Alternative D would also have the potential for few long-term effects on park operations and maintenance. Dune restoration would not involve construction of any new facilities that would need to be maintained. Once dune restoration is completed, most of the recurring costs associated with this alternative would come from incidental administrative and staff support and periodic maintenance requirements.

The intensity of long-term impacts under Alternative D relative to potential removal of remobilized sands from public roadways would probably remain very similar to the other alternatives, although the impact intensity may increase slightly due to the fact that mechanical removal would be the primary removal method, and, generally, that approach may result in more sand remobilization. Restoration activities at AT&T and B Ranch would not occur near any park facilities such as roads and parking lots. Dunes at A Ranch are closer than AT&T and B Ranch ones to Sir Francis Drake Boulevard. Davis Property adjoins a park road only used by personnel. Proposed restoration areas at Limantour Spit and North Beach do partially adjoin restroom facilities and parking lots, although, at Limantour, dunes are separated from these facilities by Limantour Pond and Limantour Marsh, which would reduce the amount of impact that any sand remobilization would have on park operations and maintenance. In addition, under Alternative D and other action alternatives, active revegetation would be conducted in backdune areas, which would help minimize sand movement.

Based on these factors, potential long-term adverse effects to park operations from dune restoration would range from no effect to possibly minor, with potential minor impacts occurring where dune restoration efforts would occur closer to roads and parking lots such as at Limantour, North Beach, and A Ranch. Impacts could be minimized further by leaving a buffer of iceplant near the road or installing sand fence, which could reduce potential impacts to negligible.

Implementation-Related and Short-Term Effects

Impacts to park operations during implementation would be expected to be very similar to those discussed under Alternative B: there would potentially be fewer projects under this alternative, but more of them would require preparation and execution of construction-scale contracts. Overall, base-funded support during implementation would be expected to result in a negligible adverse impact on park operations and management.

Possible Additional Mitigation Measures: No mitigation measures would be proposed under this alternative.

Effectiveness of Possible Additional Mitigation Measures: Not applicable

Cumulative Impacts

Projects with the potential to have cumulative impacts with those under this alternative would be the same as those discussed under Alternative A. Based on the scale of projects that could be conducted in the park, these projects could cumulatively have very negligible adverse long-term effects on park operations and maintenance.

Conclusions

Restoration under Alternative D would primarily use mechanical removal to eradicate European beachgrass at AT&T/Davis Property, B Ranch/A Ranch/Davis Property, and Limantour. Herbicide or manual removal would be used to re-treat resprouts of European beachgrass in mechanical removal areas or in wetlands or other species such as iceplant.

Alternative D would result generally in negligible to possibly minor adverse effects on park operations during implementation and over the long-term, largely related to incidental administrative support and periodic maintenance requirements. In terms of maintenance, sands that have been accumulated over decades can be remobilized after restoration, resulting in sands being blown inland and possibly onto public roadways depending on how close dunes are to roads. There is a higher propensity with mechanical removal projects for sands to be remobilized. Restoration activities at AT&T and B Ranch would not occur near any park facilities such as roads and parking lots. Dunes at A Ranch are closer than AT&T and B Ranch ones to Sir Francis Drake Boulevard. Davis Property adjoins a park road only used by personnel. Proposed restoration areas at Limantour Spit and North Beach do partially adjoin restroom facilities and parking lots, although, at Limantour, dunes are separated from these facilities by Limantour Pond and Limantour Marsh, which would reduce the amount of impact that any sand remobilization would have on park operations and maintenance. In addition, under Alternative D and other action alternatives, active revegetation would be conducted in backdune areas, which would help minimize sand movement.

Most of the potential for cumulative effects on park operations and maintenance would come from other park projects, including routine and non-routine ranch maintenance projects, maintenance and upgrade projects for park facilities, and other habitat restoration projects. Cumulative impacts on park operations would be expected to be very negligible.

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Consultation and Coordination

Public Involvement and Scoping

Prior Related EA Efforts

Starting in 2005, the Seashore initiated internal scoping for the largest dune restoration conducted at the Seashore – the Abbotts Lagoon Coastal Dune Restoration Project. A decision was made at that time to prepare an EA to complete the environmental planning process required by NEPA for this project, which would remove invasive species from approximately 300 gross acres of dunes just south of Abbotts Lagoon. A scoping letter was sent to approximately 300 parties on the park's mailing list, and three (3) letters were received. Two were supportive of dune restoration, but had concerns about potential direct and indirect impacts to rare plant species. There was also concern expressed about noise and adverse impacts of heavy equipment in the dune area to wildlife. These concerns were addressed in the EA.

The EA for Abbotts Lagoon project was released to the public in February 2009 for 45 days. A letter was sent to approximately 300 people noticing them of the availability of the document for review and the time and date of the public meeting, which was held on March 11, 2009, and attended by one member of the public and two reporters. The EA was also noticed by the State Clearinghouse and through direct mailings to agencies. Seven (7) comment letters were received by the end of the comment period.

Issues raised in these letters included: concerns about and requests for more information on the use of herbicide; concerns about the impacts of mechanical removal on wildlife and visitation by birders; concerns about the impacts of dune restoration on rare plants and dune swale wetlands; requests for more detailed information on iceplant removal, restoration timelines, and cost estimates; requests for better protection of dune and wetland habitats on ranchlands from grazing impacts; and requests for improvement of fencing to allow better public access.

These concerns and others raised after release of the EA were addressed in the Finding of No Significant Impact and the errata sections for the EA, which were approved by the Regional Director on June 25, 2009. The selected alternative was the alternative identified as the preferred one in the EA – Alternative C – which primarily relied on mechanical methods for removal of European beachgrass, but included spot treatment of regrowth with herbicides. A copy of the signed FONSI, which includes the errata sections, was mailed to permitting agencies and commenters on July 9, 2009. A copy of the FONSI and errata sections was also posted on the Seashore's website.

The Seashore conducted internal scoping as well. Through internal scoping, the park examined potential environmental issues that were raised by park staff that are relevant to the proposal. Those issues with potential for effect were addressed as part of this EA.

In addition to public scoping, a site visit was conducted with U.S. Fish and Wildlife Service (USFWS) on August 12, 2008. A subsequent site visit with USFWS staff occurred during project implementation on April 20, 2011.

Current EA Efforts

The success of the Abbotts Lagoon Coastal Dune Restoration Project has encouraged the Seashore to pursue additional dune restoration efforts where resource needs are highest. Following some initial internal scoping discussions and discussions with regulatory agencies, the park elected to focus on removal of European beachgrass and iceplant from three dune systems within the Seashore – AT&T/North Beach, B Ranch/A Ranch/Davis Property, and Limantour.

This compliance effort has very similar purpose, need, objectives, and, to some extent, proposed alternatives to conducting dune restoration as the original compliance 2009 EA effort. One of the primary differences will be in the geographic scope of potential restoration efforts covered under this document. The scope of this document is larger than the previous EA. In addition, while alternatives will still analyze different approaches to restoring the dunes, the type of techniques or combination of techniques proposed have been altered to reflect current information on the best methods for performing large-scale removal of these invasive species with the least impact to existing natural, cultural, and adjacent land use resources.

A scoping letter was sent to the public on December 6, 2012, to solicit comments on dune restoration within the Seashore, the proposed compliance route, range of alternatives, and topics to be analyzed as part of the EA. At the time of this letter, the proposed compliance route was preparation of a programmatic compliance document that would have covered dune restoration throughout the Seashore, but the broader scope of this type of document was judged to better handled by future compliance efforts. Two of the three high priority dune restoration areas were proposed for evaluation at project- or site-specific detail in that proposed document (AT&T; B Ranch). These project areas, along with North Beach, A Ranch, Davis Property, and Limantour, are now the focus of this EA.

The scoping period closed on January 15, 2013. The Seashore received 12 letters. Concerns or comments expressed in these letters included:

- *support for dune restoration;*
- *general concerns about herbicide use;*
- *concern about impacts to park agriculture from sand movement;*
- *concern about herbicide use adjacent to organic pastures;*
- *concerns about long-term management of invasives;*
- *concerns about use of a programmatic approach rather than a project-by-project*
- *approach; and*
- *request to evaluate use of hydromulch obliteration as a possible removal technique*.

Concerns or comments expressed in these letters – in addition to issues identified during internal scoping with Park Service staff – were used to develop program alternatives and impact topics for this EA.

The review deadline for this EA is available by accessing the park's website (*www.nps.gov/pore*) or the Park Service planning and environmental compliance website, PEPC (*parkplanning.nps.gov*). The commenting procedure is described on these two websites. The EA will be posted for public review and comment on the Park Service's PEPC website. The Park Service will consider all comments received in making a decision on alternatives selection. The Park Service may modify its EA following public comment if new information or concerns are raised, and the combination of the EA, public comments, and other information (such as cost, logistics, etc.) will be used to make a final decision on how to proceed.

The decision will be documented in a Finding of No Significant Impact (FONSI), and a notice will be distributed when the FONSI published on the PEPC website. However, if the impact assessment determines that the implementation of the selected alternative would have potential for significant environmental impacts, the Park Service would either modify the alternative, develop mitigate sufficient to minimize impacts to a less than significant level, or prepare an EIS. The EIS would be circulated for additional public review and input.

Compliance Status

Documentation of Park Service compliance with federal and state laws and regulations is incorporated into the text of the EA. Compliance with relevant federal environmental and cultural resource protection laws, regulations and executive orders, is summarized here.

National Environmental Policy Act (NEPA) of 1970. PL 91-190, 83 Stat. 852, 42 USC §4341 et seq.

The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences and take actions that protect, restore, and enhance the environment. Regulations implementing NEPA are set forth by the Council on Environmental Quality (CEQ). Additional regulations are provided by the Park Service, including Park Service Director's Order #12, which ensures that the document meets Department of Interior and Park Service standards. The Park Service is the lead NEPA agency and the primary project proponent and manager.

Endangered Species Act of 1973, as amended, PL 93-205, 87 Stat. 884, 16 USC §1531 et seq.

The Endangered Species Act protects threatened and endangered species, as listed by the U.S. Fish and Wildlife Service, from unauthorized take, and directs federal agencies to ensure that their actions do not jeopardize the continued existence of such species. Section 7 of the act defines federal agency responsibilities for consultation with the U.S. Fish and Wildlife Service and National Marine Fisheries Service (for marine life) and requires preparation of a Biological Assessment to analyze impacts to any threatened or endangered species that is likely to be affected by the proposal. The Park Service has been conducting its restoration at Abbotts Lagoon under an existing Biological Opinion (BO) with USFWS, as well as several amendments to that BO. These amendments included the proposal to revise the primary approach from mechanical removal to chemical control in some of the backdune and foredune areas not restored under Phase I. The Park Service received a list of species with potential to occur in the project area on October 3, 2012, and this was forwarded to USFWS with a request to initiate consultation (Appendix A). A copy of the scoping notice was sent to the USFWS on December 6, 2012. No comment was received.

Archaeological Resources Protection Act of 1979, PL 96-95, 93 Stat. 712, 16 USC §470aa et seq. and 43 CFR 7, subparts A and B, 36 CFR.

This act secures the protection of archeological resources on public or Indian lands and fosters increased cooperation and exchange of information between private, government, and the professional community in order to facilitate the enforcement and education of present and future generations. It regulates excavation and collection on public and Indian lands. It requires notification of Indian tribes who may consider a site of religious or cultural importance prior to issuing a permit. Park Service staff consulted with Nick Tipon and Peter Nelson of the Federated Indians of Graton Rancheria (FIGR) on August 28, 2013, to discuss the tribe's position on some of the proposed treatment methodologies. The Park Service will meet its obligations under this Act in all activities conducted.

National Historic Preservation Act of 1966, as amended, PL 89-665, 80 Stat. 915, 16 USC §470 et seq. and 36 CFR 18, 60, 61, 63, 68, 79, 800.

The National Historic Preservation Act requires agencies to take into account the effects of their actions on properties listed in or eligible for listing in the National Register of Historic Places. The Park Service sent a scoping notice to the state historic preservation officer and the Advisory Council for Historic Preservation to initiated consultation. Consultation will continue throughout the planning process. The Park Service has been conducting its restoration at Abbotts Lagoon under an existing Section 106 agreement with the State Historic Preservation Officer (SHPO). A copy of the scoping notice was sent to the SHPO on December 6, 2012. No comment was received. Applications for Section 106 compliance under SHPO would be submitted concurrent with production of the final environmental document.

Coastal Zone Management Act of 1972, as amended through PL 104-150, The Coastal Zone Protection Act of 1996 (16 U.S.C. §1451 et seq.).

This act protects coastal environments and transfers regulatory authority to the states and excludes federal installations from the definition of "coastal zone." Within California, the California Coastal Commission (CCC) administers the state program (California Coastal Act) for implementation of the federal Coastal Zone Management Act (CZMA). Any action by a federal agency such as the Park Service requires a federal consistency determination by the CCC as required by CZMA. The CCC manages fill, dredge, and other non-point activities affecting wetlands within the Coastal Zone. This project falls within the Coastal Zone and has areas that would be subject to oversight under the Coastal Act. Resources that might be on concern to the CCC are wetlands, environmentally sensitive habitats, natural resources on parklands, and archaeological and cultural resources. The Park Service has been conducting its restoration at Abbotts Lagoon under an existing consistency determination with the CCC and several subsequent negative determinations issued for latter phases of the project. A copy of the scoping notice was sent to the CCC on December 6, 2012. No comment was received. The Park Service would make a determination regarding consistency and submit to the CCC for concurrence subsequent to production of the final environmental document.

Federal Water Pollution Control Act (Clean Water Act) and subsequent amendments of 1977 (33 USC §1251 et seq.).

The Clean Water Act provides for the restoration and maintenance of the physical, chemical, and biological integrity of the nation's waters. Section 404 (33 U.S.C. 1344) of the Act prohibits the discharge of fill material into navigable waters, tributaries to navigable waters, and special aquatic sites of the United States, including wetlands, except as permitted under separate regulations by the U.S. Army Corps of Engineers (the Corps) and U.S. Environmental Protection Agency (USEPA). Under Section 401 (33 U.S.C. 1341), states and tribes can assume responsibility for Section 401 oversight and can review and approve, condition, or deny all Federal permits or licenses that might result in a discharge to state or tribal waters, including wetlands. The Park Service conducted Phase I of restoration at Abbotts Lagoon under a Corps' permit for possible temporary fill of a drainage swale to allow equipment access to the southern portion of the project area. Restoration activities since then have not required a Corps' permit, as there has been no discharge of fill materials into navigable waters or special aquatic sites such as wetlands. For Phase I, the Regional Water Quality Control Board, which oversees Section 401 of the Act, issued a waiver on July 29, 2010. A copy of the scoping notice was sent to the State Clearinghouse on December 6, 2012: the State Clearinghouse forwards all project-related materials to federal and state agencies. No comment was received. The Park Service would evaluate the need for CWA permitting and certification/waiver on an individual project basis and submit the necessary documentation accordingly.

Any construction activity that includes clearing, grading, excavation, stockpiling, or reconstruction of existing facilities involving removal and replacement, resulting in land disturbance of 5 acres or greater, must be conducted in accordance with the **National Pollution Discharge Elimination System General permit** for Discharges of Storm Water Runoff Associated with Construction Activity (referred to as the Construction Activities Storm Water General Permit). The permit prohibits the discharge of materials other than storm water and states that storm water discharges shall not cause pollution. Non-storm water discharges are allowed only if they: 1) do not contribute to a violation of a water quality standard, 2) controlled through implementation of Best Management Practices; and 3) are infeasible to eliminate. The permit requires that construction related activities that cause or contribute to exceedance of a water quality standard must be corrected immediately and a report made to the RWQCB within 14 days. Each permitted construction site must prepare a site specific Stormwater Pollution Prevention Plan (SWPPP) prior to disturbing the site. The SWPPP must include a site description and identify BMPs that address erosion and sediment controls and management of construction waste. The SWPPP must also include post-construction controls and management of non-storm water. Applications for a NPDES would be submitted on an individual project basis depending on size and proposed approach of the project.

In addition to the CWA, wetlands are also regulated under **Executive Order 11990 (Protection of Wetlands)**. This Executive Order established the protection of wetlands and riparian systems as the official policy of the federal government. It requires all federal agencies to consider wetland protection as an important part of their policies and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. Section 6 of E.O. 11990 directs federal agencies to issue procedures to implement the Executive Order. The Park Service wetland protection procedures were originally adopted together with E.O. 11988 (Floodplain Management) procedures in the 1980 " Park Service Floodplain Management and Wetland Protection Guidelines," however, in 1998, wetlands were split off from floodplains with development of Director's Order #77-1: Wetland Protection. The latest revision of this D.O. was issued in 2012. Under this policy, the Park Services requires a Statement of Findings for any proposed action that would have adverse impacts on functions and values of wetlands. These adverse impacts may be direct (e.g., placement of fill in a wetland) or indirect (e.g., secondary or offsite impacts that reach into wetlands). Some impacts associated with ecosystem restoration and certain other activities are excepted from regulation. The Park Service would evaluate the need for a Statement of Findings on an individual project basis and submit the necessary documentation accordingly.

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Distribution List

List of agencies and organizations to which copies of Notice of the EA have been sent. Approximately 416 individuals were also mailed notices.

Federal Agencies
U.S. Army Corps of Engineers
U.S. Geological Survey
U.S. Fish and Wildlife Service
U.S. National Marine Fisheries Service
U.S. National Park Service – Denver Service Center
U.S. Environmental Protection Agency

Federal Advisory Groups
Advisory Council for Historic Preservation

Elected Officials
Marin County Supervisor Steve Kinsey
California State Assemblyperson Jared Huffman
U.S. Representative Lynn Woolsey
U.S. Senator Barbara Boxer
U.S. Senator Dianne Feinstein

State Agencies
Bay Area Air Quality Management District
California Coastal Commission
California Coastal Conservancy
State of California Department of Fish and Wildlife
State of California Department of Health Services
State of California Department of Parks and Recreation
State of California Office of Planning and Resources State Clearinghouse
State Historic Preservation Office
State Lands Commission
University of California, Davis, Bodega Marine Laboratory
University of California Cooperative Extension

Regional, County, and Municipal Agencies
Bolinas Community Public Utility District
Inverness Public Utilities District
Marin County Community Development Agency
Marin County Fire Department
Marin County Open Space
Marin County Sheriff's Office
Marin County Resource Conservation District
North Marin Water District
San Francisco Regional Water Quality Control Board
Sonoma County Agriculture Preservation and Open Space District

Non-Governmental Organizations, Non-Profit Organizations, etc.
Audubon Canyon Ranch & Cypress Grove Preserve
Bay Institute
Bluewater Network

California Native Plant Society
Defenders of Wildlife
Earthjustice
East Shore Planning Group
Environmental Action Committee of West Marin
Environmental Forum of Marin
Federated Indians of Graton Rancheria
In Defense of Animals
Inverness Association
Inverness Ridge Association
Marin Agricultural Land Trust
Marin Audubon Society
Marin Conservation League
Marin County Farm Bureau
Mow our Weeds
National Parks and Conservation Association
National Resource Defense Council
National Trust for Historic Preservation
National Wildlife Federation
Nature Conservancy
Point Reyes Light
Point Reyes Village Association
PRBO Conservation Science
Sierra Club, Marin Group
Sonoma County Farm Bureau
Sonoma County Conservation Action
Tomales Bay Advisory Committee
Tomales Bay Association
Trust for Public Land
West Marin Chamber of Commerce
West Marin Citizen
West Marin Community Radio (KWMR, 90.5 FM)
West Marin Paths
West Marin Rancheria Area Sanctuary
Wilderness Society

Libraries
Bolinas Library
Inverness Library
Marin County Library
Point Reyes Library
Stinson Beach Library
Marin County Civic Center Library
San Francisco Main Public Library

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APPENDIX A

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825

October 3, 2012

Document Number: 121003025434

Cicely Muldoon
Point Reyes National Seashore
1 Bear Valley Road
Point Reyes Station, CA 94956

Subject: Species List for Programmatic Dune Restoration at Point Reyes National Seashore

Dear: Ms. Muldoon

We are sending this official species list in response to your October 3, 2012 request for information about endangered and threatened species. The list covers the California counties and/or U.S. Geological Survey 7½ minute quad or quads you requested.

Our database was developed primarily to assist Federal agencies that are consulting with us. Therefore, our lists include all of the sensitive species that have been found in a certain area *and also ones that may be affected by projects in the area*. For example, a fish may be on the list for a quad if it lives somewhere downstream from that quad. Birds are included even if they only migrate through an area. In other words, we include all of the species we want people to consider when they do something that affects the environment.

Please read Important Information About Your Species List (below). It explains how we made the list and describes your responsibilities under the Endangered Species Act.

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be January 01, 2013.

Please contact us if your project may affect endangered or threatened species or if you have any questions about the attached list or your responsibilities under the Endangered Species Act. A list of Endangered Species Program contacts can be found here.

Endangered Species Division

TAKE PRIDE IN AMERICA

U.S. Fish & Wildlife Service

Sacramento Fish & Wildlife Office

Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 121003025434

Database Last Updated: September 18, 2011

Quad Lists

Listed Species

Invertebrates

Haliotes cracherodii
black abalone (E) (NMFS)

Haliotes sorenseni
white abalone (E) (NMFS)

Speyeria zerene myrtleae
Myrtle's silverspot butterfly (E)

Syncaris pacifica
California freshwater shrimp (E)

Fish

Eucyclogobius newberryi
tidewater goby (E)

Hypomesus transpacificus
delta smelt (T)

Oncorhynchus kisutch
coho salmon - central CA coast (E) (NMFS)
Critical habitat, coho salmon - central CA coast (X) (NMFS)

Oncorhynchus mykiss
Central California Coastal steelhead (T) (NMFS)
Central Valley steelhead (T) (NMFS)
Critical habitat, Central California coastal steelhead (X) (NMFS)

Oncorhynchus tshawytscha
California coastal chinook salmon (T) (NMFS)

Amphibians

Rana draytonii
California red-legged frog (T)
Critical habitat, California red-legged frog (X)

Reptiles

Caretta caretta
loggerhead turtle (T) (NMFS)

Chelonia mydas (incl. agassizi)
green turtle (T) (NMFS)

Dermochelys coriacea

leatherback turtle (E) (NMFS)

Lepidochelys olivacea

olive (=Pacific) ridley sea turtle (T) (NMFS)

Birds

Brachyramphus marmoratus

Critical habitat, marbled murrelet (X)

marbled murrelet (T)

Charadrius alexandrinus nivosus

Critical habitat, western snowy plover (X)

western snowy plover (T)

Diomedea albatrus

short-tailed albatross (E)

Pelecanus occidentalis californicus

California brown pelican (E)

Rallus longirostris obsoletus

California clapper rail (E)

Sternula antillarum (=Sterna, =albifrons) browni

California least tern (E)

Strix occidentalis caurina

northern spotted owl (T)

Mammals

Arctocephalus townsendi

Guadalupe fur seal (T) (NMFS)

Balaenoptera borealis

sei whale (E) (NMFS)

Balaenoptera musculus

blue whale (E) (NMFS)

Balaenoptera physalus

finback (=fin) whale (E) (NMFS)

Eubalaena (=Balaena) glacialis

right whale (E) (NMFS)

Eumetopias jubatus

Critical Habitat, Steller (=northern) sea-lion (X) (NMFS)

Steller (=northern) sea-lion (T) (NMFS)

Physeter catodon (=macrocephalus)

sperm whale (E) (NMFS)

Plants

Alopecurus aequalis var. sonomensis

Sonoma alopecurus (E)

Chorizanthe robusta var. robusta

robust spineflower (E)

Chorizanthe valida

Sonoma spineflower (E)

Delphinium bakeri

Baker's larkspur (E)

Delphinium luteum
Critical habitat, yellow larkspur (X)
yellow larkspur (E)

Hesperolinon congestum
Marin dwarf-flax (=western flax) (T)

Layia carnosa
beach layia (E)

Lupinus tidestromii
clover lupine [Tidestrom's lupine] (E)

Trifolium amoenum
showy Indian clover (E)

Quads Containing Listed, Proposed or Candidate Species:

DOUBLE POINT (467E)
TOMALES (485B)
DRAKES BAY (485C)

County Lists

Marin County

Listed Species

Invertebrates

Branchinecta conservatio
Conservancy fairy shrimp (E)

Haliotes cracherodii
black abalone (E) (NMFS)

Haliotes sorenseni
white abalone (E) (NMFS)

Icaricia icarioides missionensis
mission blue butterfly (E)

Speyeria callippe callippe
callippe silverspot butterfly (E)

Speyeria zerene myrtleae
Myrtle's silverspot butterfly (E)

Syncaris pacifica
California freshwater shrimp (E)

Fish

Acipenser medirostris

green sturgeon (T) (NMFS)

Eucyclogobius newberryi

critical habitat, tidewater goby (X)

tidewater goby (E)

Hypomesus transpacificus

delta smelt (T)

Oncorhynchus kisutch

coho salmon - central CA coast (E) (NMFS)

Critical habitat, coho salmon - central CA coast (X) (NMFS)

Oncorhynchus mykiss

Central California Coastal steelhead (T) (NMFS)

Central Valley steelhead (T) (NMFS)

Critical habitat, Central California coastal steelhead (X) (NMFS)

Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha

California coastal chinook salmon (T) (NMFS)

Central Valley spring-run chinook salmon (T) (NMFS)

Critical habitat, winter-run chinook salmon (X) (NMFS)

winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense

California tiger salamander, central population (T)

California tiger salamander, Sonoma Co. pop (E)

Rana draytonii

California red-legged frog (T)

Critical habitat, California red-legged frog (X)

Reptiles

Caretta caretta

loggerhead turtle (T) (NMFS)

Chelonia mydas (incl. agassizi)

green turtle (T) (NMFS)

Dermochelys coriacea

leatherback turtle (E) (NMFS)

Lepidochelys olivacea

olive (=Pacific) ridley sea turtle (T) (NMFS)

Masticophis lateralis euryxanthus
Alameda whipsnake [=striped racer] (T)

Birds

Brachyramphus marmoratus
Critical habitat, marbled murrelet (X)
marbled murrelet (T)

Charadrius alexandrinus nivosus
Critical habitat, western snowy plover (X)
western snowy plover (T)

Diomedea albatrus
short-tailed albatross (E)

Pelecanus occidentalis californicus
California brown pelican (E)

Rallus longirostris obsoletus
California clapper rail (E)

Sternula antillarum (=Sterna, =albifrons) browni
California least tern (E)

Strix occidentalis caurina
northern spotted owl (T)

Mammals

Arctocephalus townsendi
Guadalupe fur seal (T) (NMFS)

Balaenoptera borealis
sei whale (E) (NMFS)

Balaenoptera musculus
blue whale (E) (NMFS)

Balaenoptera physalus
finback (=fin) whale (E) (NMFS)

Enhydra lutris nereis
southern sea otter (T)

Eubalaena (=Balaena) glacialis
right whale (E) (NMFS)

Eumetopias jubatus
Critical Habitat, Steller (=northern) sea-lion (X) (NMFS)
Steller (=northern) sea-lion (T) (NMFS)

Physeter catodon (=macrocephalus)
sperm whale (E) (NMFS)

Reithrodontomys raviventris
salt marsh harvest mouse (E)

Plants

Alopecurus aequalis var. sonomensis
Sonoma alopecurus (E)

Arctostaphylos hookeri ssp. ravenii
Presidio (=Raven's) manzanita (E)

Arenaria paludicola
marsh sandwort (E)

Calochortus tiburonensis
Tiburon mariposa lily (T)

Castilleja affinis ssp. neglecta
Tiburon paintbrush (E)

Chorizanthe robusta var. robusta
robust spineflower (E)

Chorizanthe valida
Sonoma spineflower (E)

Clarkia franciscana
Presidio clarkia (E)

Cordylanthus mollis ssp. mollis
soft bird's-beak (E)

Delphinium bakeri
Baker's larkspur (E)
Critical habitat, Baker's larkspur (X)

Delphinium luteum

Critical habitat, yellow larkspur (X)
yellow larkspur (E)

Hesperolinon congestum

Marin dwarf-flax (=western flax) (T)

Holocarpha macradenia

Santa Cruz tarplant (T)

Lasthenia conjugens

Contra Costa goldfields (E)
Critical habitat, Contra Costa goldfields (X)

Layia carnosa

beach layia (E)

Lessingia germanorum

San Francisco lessingia (E)

Lilium pardalinum ssp. pitkinense

Pitkin Marsh lily (E)

Limnanthes vinculans

Sebastopol meadowfoam (E)

Lupinus tidestromii

clover lupine [Tidestrom's lupine] (E)

Pentachaeta bellidiflora

white-rayed pentachaeta (E)

Potentilla hickmanii

Hickman's potentilla (=cinquefoil) (E)

Streptanthus niger

Tiburon jewelflower (E)

Trifolium amoenum

showy Indian clover (E)

Proposed Species

Plants

Arctostaphylos Franciscana

Critical Habitat, Franciscan Manzanita (X)

Cordylanthus mollis ssp. mollis
Critical habitat, soft bird's-beak (PX)

Key:

(E) *Endangered* - Listed as being in danger of extinction.

(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.

(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.

(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.

Critical Habitat - Area essential to the conservation of a species.

(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.

(C) *Candidate* - Candidate to become a proposed species.

(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.

(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list.
See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

> Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be January 01, 2013.

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