

Conservation Strategy for *Abronia umbellata* ssp. *breviflora* in Oregon, 2022-2032



Prepared for USFS Siuslaw National Forest as an update to the 2006 Conservation Strategy

Denise E. L. Giles, Thomas N. Kaye, Scott Harris
Institute for Applied Ecology



PREFACE

IAE is a non-profit organization whose mission is conservation of native ecosystems through restoration, research and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations and the private sector. IAE aims to link its community with native habitats through education and outreach.



Questions regarding this report or IAE should be directed to:

Thomas Kaye (Executive Director)
Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, Oregon 97333

phone: 541-753-3099
fax: 541-753-3098
email: info@appliedeco.org

CONSERVATION STRATEGY APPROVAL

The following collaborating entities agree to implement this Conservation Strategy for pink sand verbena as available funding permits.

United States Forest Service (USFS):

Forest Supervisor, Siuslaw, Robert Sanchez

District Ranger, Michele Jones

Oregon Bureau of Land Management:

District Manager, Steve Lydick (Routed to Eric Baxter)

Oregon State Parks and Recreation Department:

Director

Oregon Department of Agriculture:

Agency Director

Oregon Tribal Affiliates:

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Cover photographs:

Cover photograph by Denise Giles; pink sand verbena near mouth of the Siltcoos River. All other photographs by Denise Giles or IAE staff.

SUGGESTED CITATION

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EXECUTIVE SUMMARY

This Conservation Strategy for pink sand verbena describes the status of populations in Oregon and summarizes recent and recommended actions to restore currently and potentially occupied habitats for this species. The purpose of this Conservation Strategy is to identify and support management and restoration actions that will remove or limit threats to pink sand verbena and provide for its long-term survival range-wide, and thus reduce the need to federally list the species as threatened or endangered.

- Pink sand verbena (*Abronia umbellata* ssp. *breviflora*) is a northwestern United States regional endemic of shoreline habitat along the Pacific Coast of North America, from British Columbia to California. Pink sand verbena (*Abronia umbellata* ssp. *breviflora*) is listed as endangered in the State of Oregon, as a species of concern by the USFWS, and is on the BLM and USFS Sensitive Species lists. These listings are due to its steady decline in geographic range and the numerous threats posed to a very small number of extant populations.
- Pink sand verbena is predominantly an annual and occurs on beaches and foredunes, it has a long-lived seedbank with seed dispersal via wind and ocean. Population dynamics are highly stochastic for this disturbance-adapted and reliant species making it sensitive to competition (particularly from invasive perennial grasses). These life history traits are especially relevant for conservation and habitat management for pink sand verbena.
- Populations in Oregon occur on lands managed by multiple state and federal agencies. There are approximately 26 sites with a record of pink sand verbena over the last 21 years in Oregon, of which less than 10 have had more than 100 plants in any given year. The largest and most consistent populations are at sites that are actively managed to decrease cover of European beachgrass and to facilitate or imitate natural dune processes.
- Primary threats include competition and habitat alteration by invasive plants such as European beachgrass, low population numbers, and genetic isolation . Other threats include disturbance by off-road vehicles and winter storms, herbivory by wildlife and insects, and climate change (especially sea-level rise).
- Seeding and active habitat management have demonstrated success for establishing and maintaining populations, although European beachgrass limits the species longevity and spread from these efforts. Therefore, recommended actions include controlling European beachgrass via chemical and mechanical methods and restoring natural disturbance and dune destruction/building processes, and then seeding into managed habitats and pocket beaches and at the mouths of tributaries where natural disturbance regimes are still in place. Increasing the number of populations will increase the redundancy and resiliency of the species.
- The life of this Conservation Strategy will be ten years (through 2032), after which time the status of pink sand verbena, along with the objectives and methods included in the strategy, will be re-evaluated, and if necessary, extended. At three-year intervals the participating parties will review progress achieved at each managed population. Because information on this species will continue to accumulate and new populations may be discovered, this document may be amended at intervals as needed.

Conservation Strategy for *Abronia umbellata* ssp. *breviflora* in Oregon, 2022-2032

PURPOSE OF THIS CONSERVATION STRATEGY

The purpose of this Conservation Strategy is to detail potential actions necessary to facilitate the restoration and maintenance of pink sand verbena and its habitat in Oregon. This strategy provides updates to the 2006 Conservation Strategy (Kaye et al. 2006), summarizes recent conservation actions, provides a summary of occupied and potential habitat along the Oregon coastline, and makes recommendations for habitat management and introduction of *Abronia umbellata* ssp. *breviflora* in Oregon. While most actions recommended are consistent with ongoing restoration activities conducted under existing resource management plans, management activities including ground disturbance, herbicide application, and seeding of pink sand verbena may require additional actions by land managers prior to implementation of the recommended actions.

BIOLOGICAL INFORMATION

Species Description and Taxonomy

Pink sand verbena (*Abronia umbellata* Lam. ssp. *breviflora* [Standley] Munz) (Figure 1) is a low-growing annual to short-lived perennial forb in the four-o'clock family (Nyctaginaceae) that blooms from July through October. Technical descriptions are provided in Tillet (1967) and Hitchcock and Cronquist (2018). The following general, non-technical description was modified from both of those sources and from field observations (Figure 1, Figure 4).

Pink sand verbena is a tap-rooted annual to short-lived perennial with sticky glands on the stems, leaves, and especially in the flower clusters. The main stems are typically 30 cm to 150 cm long, bearing alternate leaves, and growing close to the ground. The plant does not root at the nodes. There are 2-5 branches emanating from the central node. The leaves are roughly spoon-shaped and green to dull-green in color and 2-6 cm long. The 8-10 mm long flowers are pinkish purple, covered with sticky glands on the outside, and borne in clusters of 10-20 at the tips of branches borne along the main stalks. Each flower produces a single-seeded fruit (achene), with 5 prominent, broad wings that are often wider than the body of the fruit; the fruit is often tapered towards the tip and roughly 0.5-1 cm long. The cover of the fruit is extremely durable and cannot be broken

open with the bare hand. Inside each fruit is a single oblong reddish brown to black seed roughly 1mm wide and 3-4mm long (Figure 3).

In this document, pink sand verbena includes populations from British Columbia to northern California, following the treatment of the species in *Flora of the Pacific Northwest*, and the *Jepson Manual of Vascular Plants of California* and the USDA plants database (Hitchcock et al. 2018, Baldwin et al. 2012). A study of chloroplast DNA found no difference between British Columbia plants and those in Oregon and northern California (Karoly 2001, Van Notta 2020). While a 2003 treatment of the genus (Flora of North America North of Mexico Project) changed the subspecies of *A. umbellata* to varieties to improve nomenclatural consistency (Spellenberg and Poole 2003), throughout this document we utilize the more recent treatments from the aforementioned references.

Range and Distribution

In this document, we consider the range of *Abronia umbellata* ssp. *breviflora* to be from Marin County, CA to Clo-oose Bay, BC based on the work by Van Notta 2020, which showed that populations through this range are the same species. Pink sand verbena historically occurred in British Columbia, Washington, Oregon, and California in coastal locations. Although formerly widespread in Oregon, currently pink sand verbena generally occurs in scattered populations composed of few individuals. Populations in Oregon are small and extremely variable, sometimes occurring for only one or a few years at a time at any given location. Only three populations in Oregon have more than a thousand individuals; Overlook North (USFS), Overlook South (USFS), and Coos Bay North Spit (BLM). These sites are currently under active management for beachgrass control. In Washington, pink sand verbena is found only on West Sand Island near the mouth of the Columbia River, on land managed by USFWS and U.S. Army Corps of Engineers. This Washington population was first noted in 2006 after restoration at the site exposed an apparently buried seed bank.

Two British Columbia populations were known from the west side of Vancouver Island, but until recently the plant had not been seen in the area since 1927 (Douglas, Straley, and Meidinger 1998). In 2000, two plants were discovered in Pacific Rim National Park (Douglas 2000), re-establishing the plant in Canada for the first time in over 70 years. Genetic samples from the collection in 2000 were analyzed by Van Notta 2020 and these samples were determined to be genetically similar to *Abronia umbellata* ssp. *breviflora* in Oregon and northern California.

The contemporary population at Clo-oose Bay (British Columbia) has been maintained by a planting program initiated in 2007. Extant plants were derived from only two individuals grown from seed collected from the original plants observed in 2000. Since the initiation of the propagation program, there have been regular (mostly bi-annual) plantings at four sites in British Columbia between 2008 and 2018 (Fairbarns et al 2018).

Scattered populations in Oregon are found from Lincoln County south to Port Orford, with historic populations observed further south at the Winchuk river mouth near Gold Beach. Historically in Oregon, pink sand verbena has occurred from as far north as Gearhart in Clatsop County; but the current

northernmost population was observed in 2020 at Heceta Head (Lincoln County). Most populations in Oregon are small and extremely variable, sometimes occurring for only one or a few years at a time. Over the last twenty-five years, the number of wild pink sand verbena populations observed in Oregon in any given year has ranged from one to five, although comprehensive surveys have not occurred in each year. Wild populations are defined here as sites which have received minimal (or no) seeding and no transplanting or habitat management efforts. Ongoing reintroduction for pink sand verbena combined with habitat management in Oregon has resulted in the establishment of five relatively stable populations at managed sites (see [Reintroduction](#), below).

The California populations are more numerous and occur primarily in Humboldt and Del Norte counties, as well as Mendocino, Sonoma, and Marin counties. These populations also vary in size and presence from year to year, though are generally larger than populations observed throughout the rest of the range.



FIGURE 1. PINK SAND VERBENA (*ABRONIA UMBELLATA* SSP. *BREVIFLORA*) PLANT (LEFT) AND FRUIT (RIGHT), FROM HITCHCOCK ET AL. (1964).

Species Status

This species is listed as Endangered by the Oregon Department of Agriculture [OAR 603-73-070 (1)] and listed as a species of concern by the USFWS (ORBIC 2019). Pink sand verbena is listed as endangered because of its steady decline in geographic range and the numerous threats posed to a very small number of extant populations. In Canada, the species is on the British Columbia Red List, indicating that it is extremely rare (British Columbia Conservation Data Centre 2022). Pink sand verbena is also on the BLM and USFS Sensitive Species lists.

Habitat

Beaches and foredunes of the Pacific Coast of North America are the primary habitat of pink sand verbena. In Oregon and northward, the species is restricted to beaches, and rarely occurs in foredune environments. In this region, pink sand verbena plants generally occur on fine sand between the high-tide line and the long-term driftwood zone, below the foredune. Pink sand verbena plants appear to be

restricted to areas of active sand movement, mostly by wind but also by ocean waves during winter storms, or the shifting mouths of tributaries as they reach the ocean. The largest populations occur on broad beaches and/or near the mouths of creeks and rivers. Occasionally, small ephemeral (1-3 years) populations are observed near rocky headlands or along isolated pocket beaches which host small dune habitats.

Often the only associated species are European and American sea rocket (*Cakile maritima* and *C. edentula*, respectively) and yellow sand verbena (*Abronia latifolia*), but other dune-associated plants commonly in the vicinity, especially on adjacent foredunes, include European beachgrass (*Ammophila arenaria*), American dunegrass (*Leymus mollis*), beach pea (*Lathyrus japonicus* and *L. littoralis*), sea purslane (*Honkenya peploides*), beach morning-glory (*Convolvulus soldanella*), and silver burrweed (*Ambrosia chamissonis*) and beach primrose (*Chamissoniopsis cheiranthifolia*). No other rare plants occupy this same habitat type (open beaches) in Oregon, but Wolf's evening primrose (*Oenothera wolfii*) and silvery phacelia (*Phacelia argentea*) may occur on adjacent upland slopes in southern Oregon and northern California. These species are both listed by the Oregon Department of Agriculture as Threatened. In addition, many-leaf gilia flower (*Gilia millefoliata*), yellow sand verbena, swaying bulrush (*Schoenoplectus subterminalis*), and coastal cryptantha (*Cryptantha leiocarpa*) can occur in the vicinity in wetlands, uplands, or adjacent dunes. An infrequently observed plant species on Oregon beaches, beach saltbush (*Atriplex leucophylla*), is not currently considered rare or endangered, but it could deserve this status if additional information becomes available.

The plant associations of foredunes and vegetated upper beaches in this region can generally be classified as Seashore bluegrass or Seashore lupine alliance as described by Christy, Kagan, and Wiedemann (1998). This vegetation type is composed of plants that occupy recently and chronically disturbed sandy habitats adjacent to or near beaches. Typical disturbances that maintain them are erosion and sand deposition due to oceanic processes and wind. Restoration in these habitats often involves disturbance with heavy equipment, herbicides, or manual removal of invasive species. Recreation and off-road vehicle use can also keep some coastal habitats open, but may result in establishment of invasive weeds or indiscriminate destruction of native plants in sensitive areas. These vegetation types do not usually include the beach itself, which pink sand verbena predominantly occupies, but they are closely associated with beaches and shore processes.

In California, pink sand verbena also occupies open beaches and it is capable of growing on dunes and dune openings away from the beach, especially in the southern portion of its geographic range. Various observers (e.g., Tillet 1967, Imper 1987, Kaye pers. Obs.) have noted that pink sand verbena (specifically *A. umbellata* ssp. *breviflora*) may be found in foredunes and more stabilized sand in California, and that this tendency increases from northern California southward, concomitant with the presence of continuous hummocky dune topography.

Population Biology

Life History

Pink sand verbena has a predominantly annual life cycle and individuals reproduce by seed only. The plants are tap-rooted and do not root adventitiously from the stems. Most individuals observed in demographic studies behave as annuals, flowering and dying in their first year of growth (Giles-Johnson 2014, Kaye 1999; Kaye, Kirkland and Testa 1999). However, a small percentage of individuals in populations at Port Orford, Overlook North and Overlook South, New River ACEC, Coos Bay North Spit and Siltcoos have been observed to 'overwinter'; growing and flowering for two years. At Port Orford, transplanted individuals on dredged sand had a high probability of living for two seasons (Kaye 2006). Pink sand verbena appears to be capable of growing for more than one year if protected conditions are available – from winter storms, shifting sands related to wind, or disturbance by discing or bulldozing.

Several other *Abronia* species are described as being both annual or perennial, or biennial and perennial; perennation of *A. angustifolia*, for example, is possible only when individuals occur in highly favorable locations, such as protected micro-sites with high moisture availability (Royce and Cunningham 1982). Such flexibility can improve the ability of pink sand verbena to persist at a given site or disperse seeds to new locations, since individuals that live for more than one season may be very large, produce thousands of fruits, and therefore contribute a large proportion of a population's annual seed production (Kaye, Kirkland and Testa 1999). In 2014, overwintering plants were observed to be larger and produced more seeds than their annual cohorts, in some cases producing an order of magnitude more flowers (and presumably seeds) than their annual cohorts (Giles-Johnson 2014, 2015).

Population Dynamics

Because pink sand verbena populations typically occur on beaches, generally at or below the zone of driftwood accumulation, most are obliterated each winter by storms that reshape the shore. Each spring, populations re-establish from seeds that persist in the sand or that are washed into the site from another location. Because oceanic processes may result in sand being removed from beaches and stored in off-shore sand deposits during winter, then re-deposited on beaches during summer (Orr and Orr 2002), pink sand verbena seeds may be stored in this way for one or more years at a time.

Because of the highly stochastic nature of its habitat, population sizes of pink sand verbena are variable from one year to the next (Figure 2). Long-term monitoring of a wild population at Otter Point, Oregon, has documented this type of annual variation: the population had nearly 200 plants in 1997, but declined to zero individuals in 2000, then recovered to three plants the following year, and no plants observed in 2018 nor 2020. At some sites, such as Ona Beach, Oregon, only one or a few plants have been observed, and only in one year. At others, such as Cape Blanco, Oregon, several years may pass between observations of individuals. Long distance dispersal of seeds by ocean currents (Wilson 1976) to suitable habitat and exchange of seed between a long-lived, persistent seed bank and mature plants are significant processes in the dynamics of pink sand verbena populations (see Seed Bank, below).

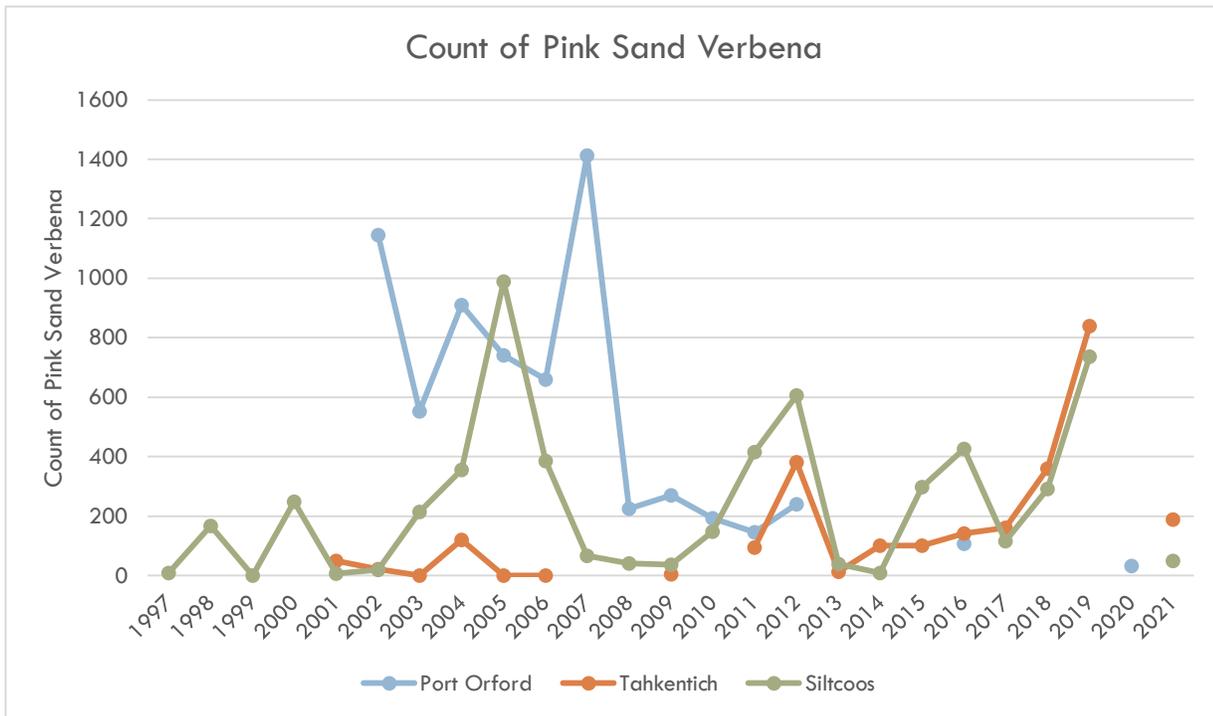


FIGURE 2. COUNT OF PINK SAND VERBENA AT THREE SITES ON THE OREGON COAST; PORT ORFORD, TAHKENITCH AND SILTCOOS. DATA WAS NOT COLLECTED AT EACH SITE IN EACH YEAR.

The observation of plants at Clo-oose Bay in 2000, very close to where they grew in the early 1940’s, strongly suggests that the species is also capable of “dispersing in time” – that is, persisting in a soil seed bank until circumstances allow it to successfully regenerate in place. There is independent evidence that the seeds may remain viable for long periods. The observance of a plant at Heceta Head more than 15 years after a single seeding event in 2006 also highlights the potential for seedbank persistence of the species.

Pollination and Breeding Systems

Pink sand verbena produces 8-20 (average 14-15) flowers in hemispheric clusters. An individual plant may produce from one to thousands of these clusters, depending on growing conditions. The flower tubes are approximately 6-7 mm deep, and long-tongued insects such as bumblebees, skippers and other butterflies visit the unscented flowers and probe for small amounts of nectar (Kaye pers. Obs.). Some observers (Tillet 1967) have noted nocturnal pollinators like noctuid and sphingid moths on *ssp. umbellata*. Pink sand verbena is fully self-compatible and will self-pollinate in the absence of insect visitors, suggesting that the taxon has a mixed-mating system (VanNotta 2020).

Fruits and Seeds

Each pink sand verbena flower produces a single-seeded fruit (achene), which is broadly 3 to 5-winged, presumably to promote dispersal by wind (Wilson 1976). These wings may also facilitate long-distance dispersal by ocean waves and currents. Fruit set is generally very high in pink sand verbena; observations from Port Orford, Oregon in 1998 found that 13 out of an average 14 flowers per flower-cluster formed fruits, and plants grown in a garden setting in 2001 yielded 13 out of an average 15 flowers, for a fruit-set rate of approximately 85% to 95% (Kaye unpubl. Data, Figure 5). Typically, 80% to 90% of the fruits contain a seed (Kaye unpubl. Data, Figure 3). Darling et al. (2008) found that the seeds of *A. umbellata* are able to float in saltwater for at least 14 days.



FIGURE 4. FLOWER AND SEEDS OF PINK SAND VERBENA. SEEDS MATURE IN LATE SUMMER TO EARLY FALL.



FIGURE 3. SEEDS OF PINK SAND VERBENA ARE OBLONG, 3-5MM, AND CONTAINED IN A WINGED FRUIT.

Seedbank

Long-term persistence of pink sand verbena populations may depend on the development and maintenance of a long-lived persistent seed bank. Results from germination tests with seeds of various ages (stored in paper sacks at room temperature) show that seeds of this species can remain viable for long periods of time. Loss of viability over time appears to be very slow, and even seeds stored for ten years retained over 90% viability (Kaye 2001; Figure 5). Although environmental conditions of seeds stored in paper sacks are not the same as those buried in sand in a wild state, these results are consistent with the hypothesis that pink sand verbena seeds are capable of persisting in the sand for extended periods of time.

Furthermore, the appearance of some populations of pink sand verbena long distances from natural populations, such as at Tenmile Creek, Oregon in 1995, Gearhart, Oregon in 1993, and Vancouver Island in 2000 (after over 70 years of absence) and Heceta Head in 2020 (after a single seeding event in 2006), suggest that some populations may establish from seed many years after the presence of adult plants were noted.

And finally, the stochastic behavior of natural populations, such as Otter Point, Oregon, can result in a decline to zero plants in some years, followed by the re-emergence of the species the following years, which suggests that the species can re-colonize sites from a local seed pool when habitat conditions are conducive. Taken together, these lines of evidence provide strong support for the notion that pink sand verbena is capable of maintaining a persistent seed bank, and that buried seeds may play an important role in the population dynamics of this species and should be fostered in reintroduction attempts.

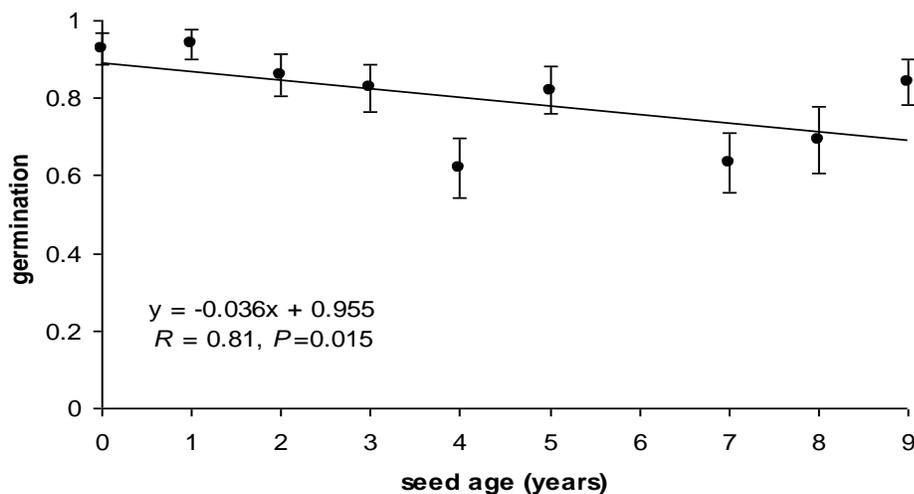


FIGURE 5. GERMINATION RATE OF SEED FROM ZERO TO NINE YEARS OF AGE. SEED VIABILITY REMAINED RELATIVELY STABLE OVER THE STORAGE LIFE OF THE SEED.

Substrate

Recently disturbed or deposited sand is a more suitable substrate for pink sand verbena than older substrates (Kaye 1998). This has been observed at Port Orford, where initially large plants flourished in the newly exposed dredge spoils in the mid-90’s but has since declined to less than 100 individuals in 2021 (Figure 2). Similarly, at Overlook North and South as new areas are treated for beachgrass control and the potentially occupied habitat expanded, robust pink sand verbena plants are noted in the newly disturbed habitat. It is unclear if these plants are establishing from the seedbank, as a result of recent seeding efforts, or a combination thereof. A similar pattern is observed at the Coos Bay North Spit where the population has continued to grow on the western portion of the population (Figure 6).



FIGURE 6. PINK SAND VERBENA ARE OFTEN FOUND FOLLOWING THE DISC LINES POST-MANAGEMENT ACTIONS. IN THIS PHOTO, THE LARGE PINK SAND VERBENA PLANTS ARE FOUND ALONG THE DISC LINE IMPLEMENTED TO CONTROL EUROPEAN BEACHGRASS (RIGHT) IN THE WESTERN PORTION OF THE POPULATIONS ON THE COOS BAY NORTH SPIT.

Addition of oyster shells to provide habitat for snowy plovers has occurred in managed pink sand verbena habitat. This practice has the potential to introduce weedy species into sensitive habitats if material is sourced from areas where introduced species are present. Pink sand verbena are not found in areas where shells make up a large percentage of the exposed substrate, but are found in areas of mixed shell and sand, or bare sand alone (Figure 7).



FIGURE 7. PINK SAND VERBENA ON THE COOS BAY NORTH SPIT. AT THIS SITE, OYSTER SHEELS WERE ADDED TO IMPROVE PLOVER HABITAT. PINK SAND VERBENA WERE NOT FOUND IN AREAS WITH HIGH DENSITIES OF OYSTER SHELS.

Limiting Factors and Threats

Introduced Species and Loss of Habitat

One of the primary threats to pink sand verbena is competition from the invasive European beachgrass (*Ammophila arenaria*), a species that stabilizes foredunes and destroys the low-hummocky, discontinuous nature of the foredune system in which pink sand verbena and other native species once thrived. European beachgrass was introduced to the coastal dunes of Oregon in the early 1900s and now covers vast expanses of prime pink sand verbena habitat and easily outcompetes this and other native forbs. Habitat disturbance by off road vehicles and heavy trampling by humans also threatens pink sand verbena.

A four-year experiment in Oregon with pink sand verbena and exotic dune species like European beachgrass showed that pink sand verbena is a poor competitor (Kaye 1999), which might explain its exclusion from sand dunes over part of its range. Increases in interspecific competition and decreases in soil fertility as substrates age are both likely contributors to the observed decline in pink sand verbena,

but competition had the greater impact over soil fertility (Kaye 1999) (Figure 8). At the Coos Bay North Spit, as the number of plants has increased, the size of the plants have generally decreased, indicating that even intraspecific competition may play a role in plant size and vigor (Giles 2021).



FIGURE 8. COMPETITION BY NON-NATIVE SPECIES PLAYS A ROLE IN THE SUCCESS OF PINK SAND VERBENA POPULATIONS. PINK SAND VERBENA GROWING WITH EUROPEAN BEACHGRASS (LEFT). PINK SAND VERBENA INTERGROWN WITH DOCK (*RUMEX ACETOSELLA*) AND HAIRY CAT'S EAR (*HYPOCHAERIS RADICATA*) (RIGHT).

Geomorphic changes

The introduction of European beachgrass has resulted in the loss of the low, hummocky, discontinuous foredune which once characterized beaches throughout the range of pink sand verbena and provided habitat for many native plants and animals. The presence of European beachgrass builds up the foredune and decreases the ability for winter storms and wave action to rework and mobilize sand across the coastline. In many areas of potential habitat, the foredune is more than 10 feet tall and creates a barrier that eliminates the natural dune processes. The natural low foredune has been widely replaced by a high, steep, primary foredune dominated by a thick growth of European beachgrass (Pickart and Sawyer 1998, Figure 9). Remaining dune habitats are often fragmented and experience heavy use by recreational users which can result in the disturbance of the remaining suitable habitat.



FIGURE 9. THE EXTENSIVE ROOT STRUCTURE OF EUROPEAN BEACHGRASS STABILIZES THE FOREDUNE AND RESULTS IN SOME OF THE GEOMORPHIC CHANGES SEEN ABOVE WHERE THE FOREDUNE IS MORE THAN 10 FT. TALL.

Winter Storms

Winter storms are capable of scouring and building beaches and foredunes on the Pacific Coast in the range of pink sand verbena (Maun 2009). These storms can directly alter beach topography through wave action and indirectly through flooding of creeks and rivers. High tides combined with high water levels in streams may result in the shifting of the mouths of these waterways, which alters the position of foredunes and causes large scale reworking of beach sand. In addition, high tides and strong winds during winter months can result in substantial beach erosion and breaching of sand spits, especially in areas where rip currents develop embayments, which allow high energy waves to reach the upper beach and foredune (Maun 2009). During such storm events beach vegetation, including pink sand verbena, is typically destroyed, contributing to the strong swings in populations of this species (Figure 2). However, strong winter storms and shifting creeks and rivers may also unearth buried seeds of pink sand verbena, thus creating areas of open sand with little competition, which may result in the reappearance of plants and populations in areas where they had not been reported for some years or reinvigorate existing populations (see [Population Dynamics](#), above). It is within and along the margins of these winter storm overwashes that pink sand verbena is commonly observed at New River ACEC and Tahkenitch. At Siltcoos a winter storm in 2012/2013 washed away a portion of the occupied habitat. In the subsequent years, sand has filled in and the population has re-established into the area affected by these winter storms (Figure 10).



FIGURE 10. A WINTER STORM RESULTED IN CHANGES TO THE OUTLET OF THE SILTCOOS RIVER IN 2013-2014 (TOP). SINCE THAT TIME, THE AREA HAS BEEN COLONIZED BY EUROPEAN BEACHGRASS (BOTTOM).

Herbivory

Herbivory by small mammals and insects has been observed on natural and introduced populations of pink sand verbena throughout its range. The microtopographic variations created by mounded plants, also act to trap seeds and small debris of other plant species that may be eaten or cached by rodent species. Snowy plovers and other shorebird species have been observed foraging and sheltering in areas occupied by pink sand verbena (Figure 11). Larvae of noctuid moths, and *Sphingidae* (Hawkmoths) have been observed eating pink sand verbena at sites in Oregon (Figure 12).



FIGURE 11. TRACKS FROM SNOWY PLOVERS WHICH WERE OBSERVED FORAGING AND SHETLERING IN PINK SAND VERBENA AT SILTCOOS AND OVERLOOK NORTH AND SOUTH.



FIGURE 12. LARVAE OF A SPHINGINIDAE MOTH ON PINK SAND VERBENA.

Collecting

The charismatic and showy nature of this prostrate dune flower, combined with the small size of remnant populations make the possibility of trampling, collection and recreational activities a hazard to this species. Since most populations occur on state or federally managed lands and the species is considered sensitive or endangered (depending on the authority), collecting activities require a permit. Collection of this species for scientific purposes is not likely to contribute to its decline. Collection of seed for restoration on BLM sites from Coos Bay North Spit has not caused any apparent decline in the population which continues to be the largest population of the species in Oregon.

Hybridization

In Oregon, pink sand verbena often co-occurs with yellow sand verbena (Figure 13), and purported hybrids of *A. umbellata* ssp. *breviflora* x *A. latifolia* are occasionally observed in wild populations. Hybridization among species of *Abronia* has been documented in various locations and apparent hybrids have been occasionally observed in Oregon. However, there is no evidence that hybrid individuals have entered the gene pool of *A. umbellata* ssp. *breviflora* (VanNotta 2020). In a sample across the range of the species, <3% of the population sampled showed any evidence of hybridization, and evidence of hybridization was not present in the larger gene pool; indicating that any purported hybrids have not crossed back with their parental lineage. Based on these empirical observations hybridization of the two species is not a concern at this time. Both species *A. latifolia* and *A. umbellata* ssp. *breviflora* should be considered as candidates for introduction at dune restoration sites across the range of *Abronia umbellata* ssp. *breviflora* without concern for hybridization.



FIGURE 13. YELLOW SAND VERBENA (LEFT) AND PINK SAND VERBENA (RIGHT). HYBRIDIZATION OF THE TWO SPECIES IS NOT A CONCERN.

Sea Level Rise and Climate Change

Climate-induced sea-level rise will impact the long-term viability of dune-associated plants and habitats, mostly but not entirely in negative ways. The primary processes influencing global sea-level rise (SLR) are thermal expansion of the oceans and increased runoff from Antarctic and Greenland ice sheets (Thorne et al. 2018), with additional minor contributions from changes in groundwater sources (National Resource Council 2012). Due to uncertainties with modeling these mechanisms (particularly the contribution of meltwater), estimates of global SLR are inconsistent. Global SLR by 2021 has been estimated at 0.65 m at the low end (Nerem et al. 2018) and 0.75 to 1.90 m at the high end (Vermeer and Rahmstorf 2009). Many sources estimate that SLR is accelerating and that previous measures of SLR can only be used as initial guides (Nerem et al. 2018).

Sea-level rise is not uniform across the globe. Regional variations are due to wind and currents, large-scale weather pattern such as El Nino and the Pacific Decadal Oscillation, deformational effects on land and sea surfaces due to changing ice sheets, geology, and human activity (e.g., groundwater withdrawal). For the Oregon coast, SLR by 2100 is estimated to be 63 (\pm 28) cm with a range of 12 – 142 cm (National Resource Council 2012). SLR by 2050 is estimated to be 17 (\pm 10) cm.

The low-elevation end of pink sand verbena habitat typically starts at the extreme high tide line. Using data downloaded from the NOAA Sea Level Rise Viewer (NOAA 2017), we mapped the 4 ft sea level rise (or 122 cm, approximately the extreme high estimate of SLR) over known population boundaries of pink sand verbena. The sites shown in Figure 14 are the five largest populations of pink sand verbena surveyed within the past 5 years. SLR acting alone, by inundating portions of pink sand verbena habitat will likely have minimal impact. However, the additional processes associated with sea level rise and climate change, summarized in Table 1, could have significant impacts (Ranasinghe 2016).

TABLE 1. POTENTIAL IMPACTS TO PINK SAND VERBENA POPULATION VIABILITY DUE TO CLIMATE CHANGE, SUMMARIZED FROM RANASINGHE (2016).

<u>Main drivers</u>	<u>Time scale</u>	<u>Potential impact</u>
Sea-level rise (SLR)	Decades	Inundation of habitat Coastal recession Tidal basin infilling Altered geomorphic processes at river mouths
Changes in mean wave height and direction	Years to decades	Re-alignment of beaches
Increase in the frequency of storms and heights of storm waves and surges	Days	Rapid coastal erosion, and rebuilding of beaches (potential new habitat)

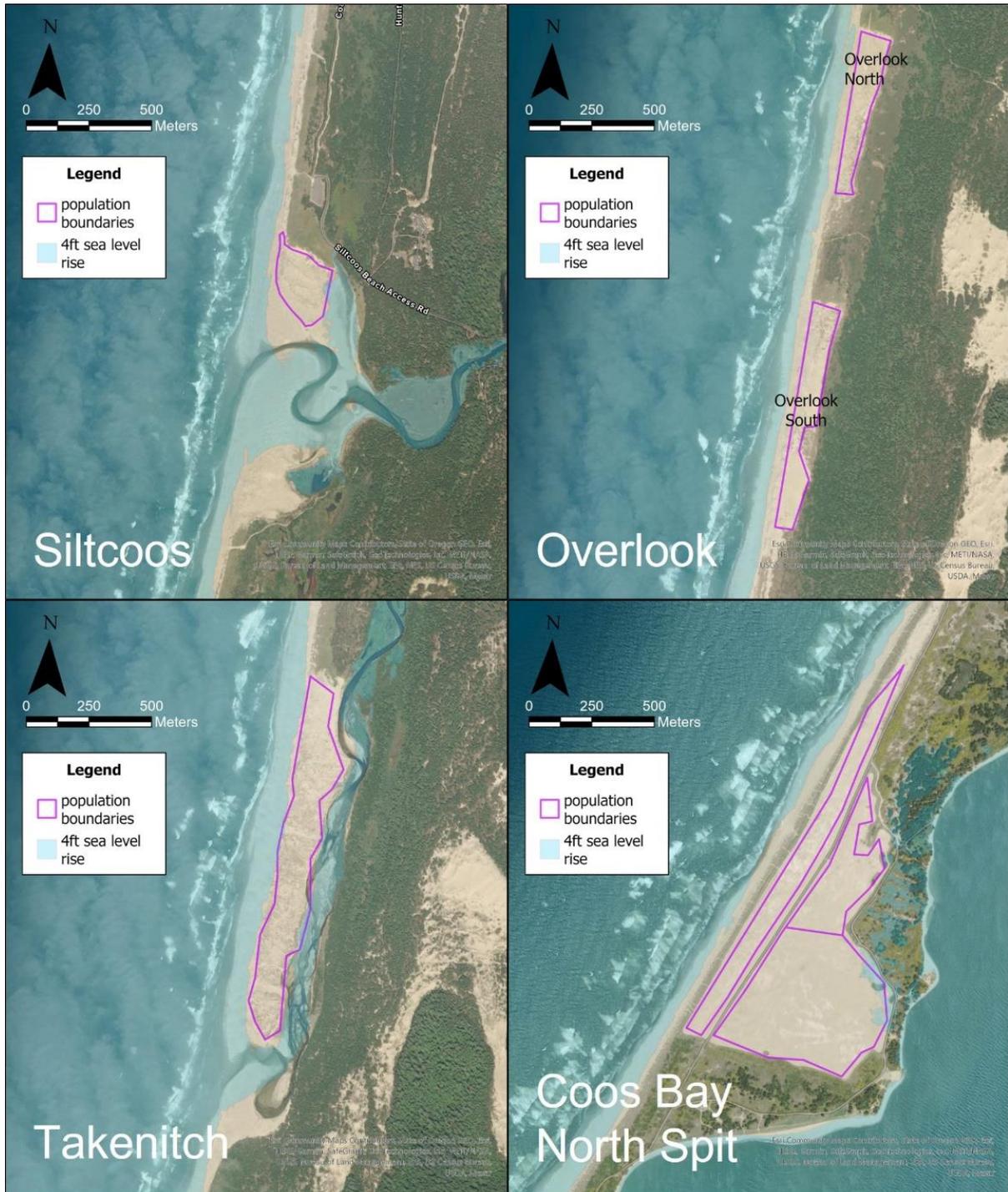


FIGURE 14. THE FIVE LARGEST POPULATIONS OF PINK SAND VERBENA (BASED ON 2018-2022 SURVEYS) OVERLAIN BY THE MODELED 4 FT SEA LEVEL RISE (THE HIGHEST RISE ESTIMATE) BY 2021. THE BASE IMAGE IS FROM 2021.

For example, SLR-induced chronic coastal recession could greatly impact pink sand verbena. A general rule of thumb (the “Bruun Rule”) is that recession will be 50-100 times the SLR amount (Bruun 1988). Like many other coastal species, the phenomenon of the ‘coastal squeeze’ may prohibit the expansion of populations eastward as the current habitat diminishes and potential future habitats are already occupied (with housing, roads, or other developments). SLR is also estimated to impact tidal basins and geomorphic processes at river mouths. Basin infilling is a phenomenon where tidal basins import sediment from beaches in order to raise the basin level to accommodate rising water levels (Stive et al. 2002). Similarly, rising water levels will alter the geomorphology of river mouths and estuaries, resulting in changes in sediment transport and delta evolution.

Forecasted changes in mean wave height and direction will impact sand verbena habitat by re-aligning beaches (Hemer et al. 2013). Because of pink sand verbena’s association with disturbance, this impact may be minimal as habitat primarily shifts location (assuming habitats have sufficient space to shift) on time-scales conducive for the species.

However, on shorter time-scales climate change is forecast to increase the frequency and intensity of storms, storm wave heights, and storm surges (Nicholls et al. 2007), resulting in episodic and potentially significant coastal erosion. While these processes could destroy pink sand verbena populations in a single event, the eventual impact on sand verbena will depend on the rate at which new habitats are created. Due to the dynamic and disturbance-associated life history of pink sand verbena, increased storm activity could increase viability of the species via increased wind and ocean-based seed dispersal, and potentially increase habitat availability. Available habitat will be influenced by the “coastal squeeze” discussed above.

Predicted SLR should be considered for site selection of future reintroduction efforts. Despite the potential for loss of habitat due to sea level rise and other processes associated with climate change, introduction efforts should continue in areas of currently suitable habitat. Areas which still currently support back dune habitats include the Coos Bay North Spit, portions to the east of the current Overlook North and South populations, and areas to the east of the Bandon Habitat Restoration Area. These areas could provide suitable habitat in the face of future climate change. Additionally, seeding along mouths of tributaries could provide a natural corridor for plants to expand into as beach processes proceed inward.

Propagation and Reintroduction

Transplanting

It is recommended that reintroduction efforts focus on seeding over transplanting. In Oregon, offspring from transplants have been relatively uncommon, with the exception of a transplanting in 1997 at Siltcoos Creek, which produced abundant plants the following year, but not the following year (Kaye 2000). Since most pink sand verbena plants are annuals, the viability of reintroduced populations started from transplants hinges on recruitment of new individuals from seed produced by those transplants (or the planting of additional transplants). Transplants could be appropriate for restoration efforts by a combination with seeding to jump-start establishment of the species into existing or restored habitat.

Efforts in Canada have had positive results utilizing transplanted individuals to establish natural generating plants at two of the four sites that have received repeated transplanting efforts (Fairbarns et al. 2018).

Seeding

Because large numbers of pink sand verbena seeds are available from some populations (e.g., Coos Bay North Spit), these can be used in direct-seeding, possibly outweighing any transplant advantage. Seeding experiments on 13 beaches on the Oregon Coast in 1995 resulted in establishment of at least one plant at six locations (Kaye 1998). In subsequent years with an increased seeding rate of 50,000 seeds per site, an average of 254 plants were observed within one year of seeding, with at least one plant at 26 of 27 sites (Kaye 2003). Seeding efforts from 2006 to the present are summarized in Giles 2020. Since 2006, all seeding efforts have resulted in at least some plants observed in the following year.

Based on observations at many sites including Coos Bay North Spit, Siltcoos, Overlook North and South, and Tahkenitch, direct seeding in appropriate habitat is an effective strategy. Seeding efforts at the Coos Bay North Spit from 1996-2018 have resulted in the largest population of pink sand verbena on the Oregon coast with an estimated 400,000 reproductive plants in 2020. Seeding efforts were discontinued at the site in 2019 and only scheduled to be resumed if the population dips below 100,000 reproductive plants. Despite the success of seedings at Coos Bay North Spit and the presence of plants in the first year post seeding at many sites, other seeding attempts have failed to produce self-perpetuating populations of the same size or scale as those observed at the Coos Bay North Spit.

Observations at sites that have been seeded multiple times have produced positive signs that repeated introductions may result in populations that return from seed in later years. For example, seeding in 2002 at three reintroduction sites, Siltcoos Creek, Bastendorff Beach and Bandon Beach, resulted in low plant establishment (fewer than 20 plants each) that year, but much higher populations (>100 plants) in 2003 without additional seeding. Similarly, following transplanting at Floras Lake in 1995, a handful of plants were observed in 2008 despite no further input of plant materials. These observations suggest that the species can recolonize sites from a local seed pool after reintroduction but may also benefit from more regular input of seed.

Seeding efforts at New River ACEC (BLM) and USFS sites including Overlook North and South, Tahkenitch and Siltcoos have resulted in relatively large populations that have continued to expand in conjunction with habitat management activities (control of beachgrass and protection of areas during snowy plover nesting season).

Habitat Restoration Activities

A study at Coos Bay North Spit showed that the growth and reproduction of pink sand verbena was negatively correlated with the abundance of beachgrass (Kaye 1998), showing a clear connection between the success of a rare species and the elimination of an invasive exotic. This pattern was again observed in 2013 when dips in the population were observed in areas that had not received beachgrass

control, while the population remained stable in treated areas (Giles-Johnson 2014). This study also looked at the effects of salt spray on the establishment of pink sand verbena from seed and found that all treatments that included salt spray had higher establishment than plots without. This result highlighted that overwashes and salt spray play a role in the success of the species, either through a decrease in competition from other species or some other physiologic advantage.

SUMMARY OF NATURAL AND INTRODUCED POPULATIONS

At this time, the largest populations of pink sand verbena are found at sites that are consistently managed to decrease cover of European beachgrass and to facilitate or imitate natural dune processes. Managed populations of pink sand verbena like the Coos Bay North Spit, and those at Overlook are an order of magnitude larger in number than the small natural population observed at Port Orford. While the total number of populations may change from year to year due to the stochastic nature of small pink sand verbena populations, there are approximately 26 sites with any record of pink sand verbena in the last 21 years in Oregon (Figure 15 and Appendix A). Of these sites, since 2006, less than 10 have had more than 100 plants in any given year. There are very few areas of suitable habitat which have not received some form of augmentation through transplanting or seeding in the last 30 years, thus it is difficult to apply the nomenclature of 'natural' populations to any of the extant populations of pink sand verbena in Oregon at this time.

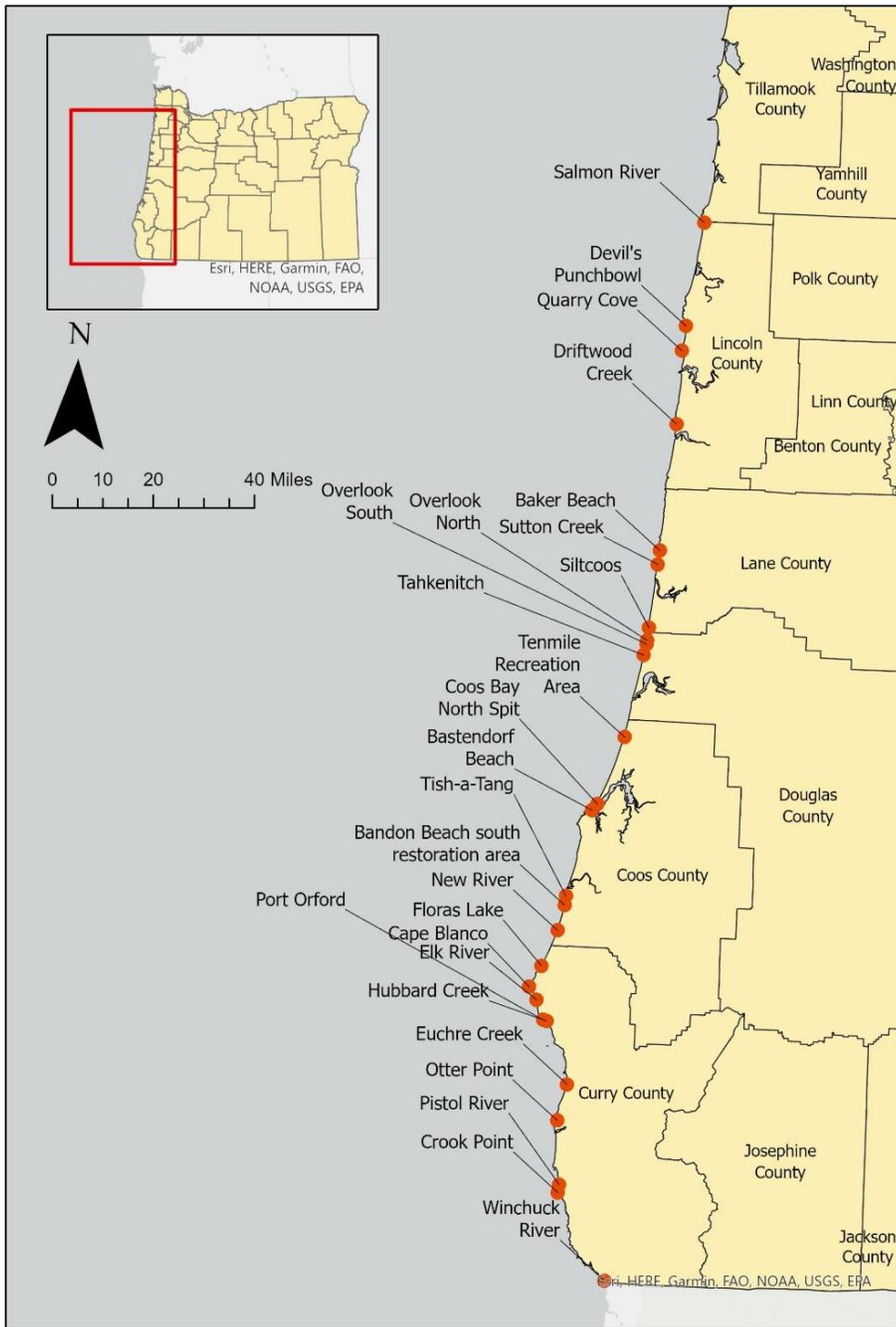


FIGURE 15. HISTORICAL AND CURRENT POPULATIONS OF PINK SAND VERBENA IN OREGON, BASED ON SURVEYS CONDUCTED BETWEEN 2000 AND 2021.

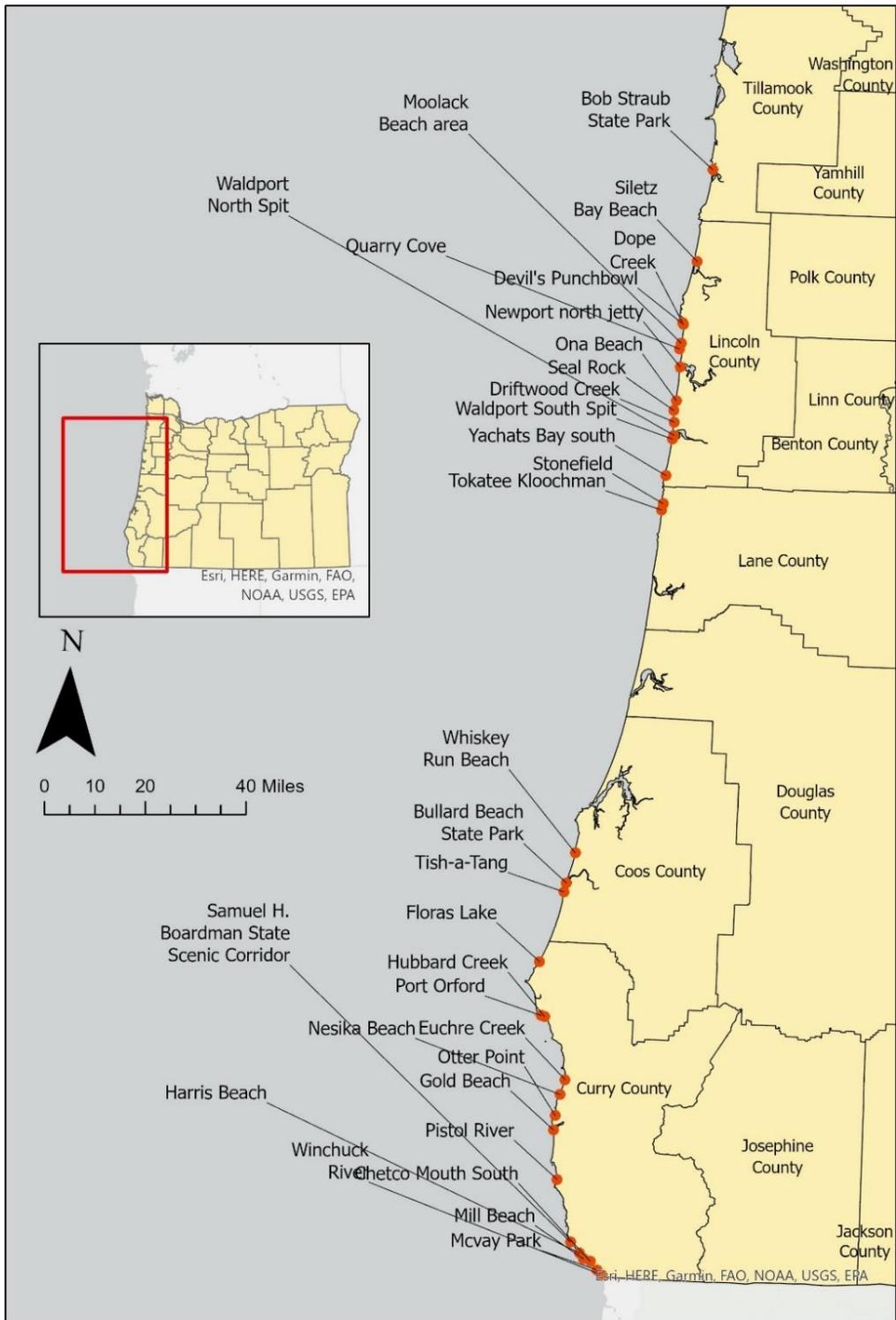


FIGURE 16. SITES COMPRISING THE 2020 RANGEWIDE (OREGON) SURVEY OF POTENTIAL PINK SAND VERBENA POPULATIONS.

Population Surveys

The IAE has conducted surveys and monitoring for pink sand verbena in partnership with state, federal and local agencies throughout Oregon over the past 23 years. See Appendix A and B for a summary of pertinent survey information. In the fall of 2020 IAE staff conducted surveys along the Oregon coastline to look for the presence of pink sand verbena populations not recently observed, or in areas of potential habitat (Figure 16).

For the 2020 survey, the first step was to use Google Earth and ESRI basemap imagery to identify stretches or pockets of beach that may provide suitable habitat. Areas assessed met one (or more) of the following criteria; 1) historic natural populations, 2) seeded populations not visited in the last five years, 3) pockets or stretches of beach near the mouths of creeks or tributaries, 4) pockets or stretches of beach with apparently suitable habitat, 5) pockets or stretches of beach with habitat that appeared to be suitable with management. Areas that had been surveyed in the last three years were not prioritized as data is already available for those sites.

Notable observations from the 2020 survey include: a plant observed at Heceta Head (Devil's Elbow) – the first observation for this site since seeding in 2006; and plants observed near the Yaquina lighthouse near Newport. Plants were also observed along the beaches between Seal Rock south to Waldport (historically known as the Driftwood Creek population).

The 2006 Conservation Strategy described six extant natural populations which had been surveyed in the prior five years. Natural populations were described as having received little intervention through either seeding efforts or habitat treatments efforts. In 2020, during habitat assessment and monitoring surveys for pink sand verbena, no pink sand verbena plants were observed at four of these sites; Ona Beach, Cape Blanco, Otter Point and Winchuk River (Figure 16). Tenmile Creek (Coos County) was not surveyed; a handful of plants were noted at Port Orford.

At the time of surveys in 2020, nearly all suitable pink sand verbena habitat had received either seeding or transplants at some point in time, and thus the distinction of 'natural' or 'augmented' sites is ambiguous and inconsequential to ongoing efforts for species recovery. Appendices A and B show the most recent data for each of the historically occupied or previously augmented sites along the Oregon coastline. During surveys in 2020, suitable (or potentially suitable) habitat was located at a number of locations along the coastline including both stretches of beach and 'pocket' beaches of smaller more isolated habitat. These areas could be seeded with pink sand verbena and other dune species to increase native plant diversity (Figure 16).

Managed and occupied sites

There are currently two BLM and five USFS sites that in the past five years have populations exceeding 500 plants (Appendices A and B). All other sites have less than 500 plants (generally less than 100 plants). Currently, the largest site is the Coos Bay North Spit which started from seeding and transplanting efforts in the 1990's and is now host to more than 100,000 plants. This site serves as the

seed source for all other seeding efforts. Overlook South and Overlook North, managed by the USFS, have populations ranging from 1,000 – 7,500, with the population at Overlook South continuing to expand as beachgrass control efforts continue. Natural dune processes at Tahkenitch, Siltcoos and New River ACEC along with some beachgrass control efforts maintain habitat for populations of pink sand verbena in the 100's.

A summary of surveys conducted in 2020 and 2021 are included below. As discussed previously, nearly all sites in Oregon have received some form of habitat management or seeding efforts and are thus not divided into 'wild' vs. 'managed' populations. Sites below are listed from north to south. Only sites at which some degree of population persistence has been detected are reported here. Some sites not included in this summary may contain suitable habitat for future restoration and augmentation efforts.

HECETA HEAD, DEVIL'S ELBOW

This site was seeded once in 2006, with no seeding efforts since that time. In 2020 one plant was observed at the site on the beach just south of the parking area.

YAQUINA HEAD

Seeding occurred at this site in 2014, and since that time a handful of plants have been observed in each year. In 2020, approximately 30 plants were observed in the pocket beach on the north side of the headland (accessible by a wheelchair ramp).

ONA BEACH

In 2000, two reproductive plants were found at Ona Beach State Park on either side of Beaver Creek (Kaye 2002). Subsequent visits to the site failed to document the populations, and no plants were found during rangewide surveys in 2020.

DRIFTWOOD BEACH

This area was seeded in 1998 with no plants found in the first few years post introduction. Surveys in 2020 found scattered plants from the Driftwood Beach State Park access point northward to the Quail Street access point; 40 plants were found on the southern end of the surveyed area and 7 plants found on the north side of Collins Creek.

BAKER BEACH

This population in Lane County (Siuslaw National Forest) was initiated in winter of 2003 through direct seeding of 50,000 seeds. In summer of 2003 a total of 55 plants were observed, approximately half of which were flowering. Seeding efforts have continued intermittently through 2022 with <100 plants observed at the site when surveys have been conducted.

SILTCOOS CREEK

Habitat at the mouth of Siltcoos Creek (Siuslaw National Forest) has received a combination of direct seeding and outplanting of greenhouse-grown starts since 1998. The population varies substantially with beach disturbance from winter weather patterns (Figure 17).

OVERLOOK SITES

The Overlook sites are located in Douglas County north of Tahkenitch Creek (Siuslaw National Forest) on foredunes subjected to bulldozing, discing and herbicide applications to reduce abundance of European beachgrass. A prescribed fire in the early spring of 2022 was implemented at Overlook North. Since 2018, treatment areas in Overlook South have doubled the potentially occupied habitat, expanding the area further south, and resulting in an increase in the population at Overlook South to nearly 3,000 plants in 2021 (Figure 17). This work is being coordinated by the Siuslaw National Forest.

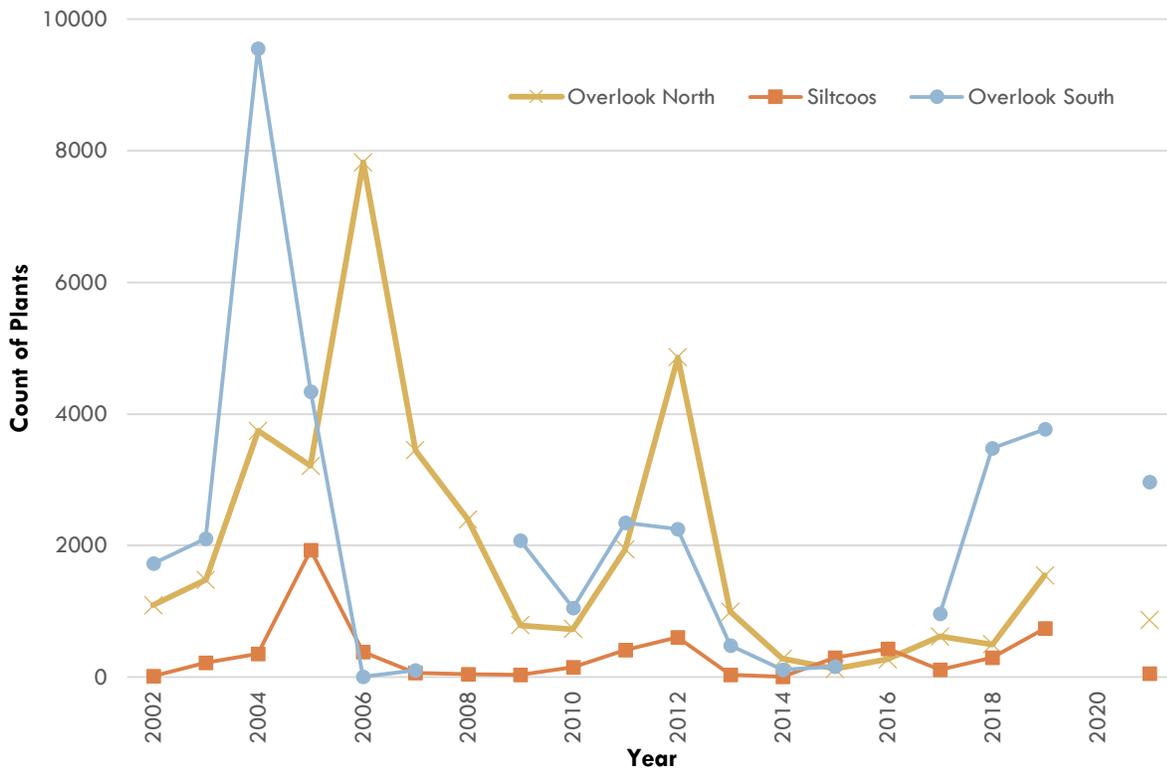


FIGURE 17. POPULATION TRENDS AT THREE FOREST SERVICE SITES FROM 2002 TO PRESENT. SEEDING HAS OCCURRED IN EACH YEAR EXCEPT 2003 AT SILTCOOS. MONITORING IN 2020 DID NOT OCCUR.

TAHKENITCH CREEK

The Tahkenitch Creek site (Siuslaw National Forest) has been seeded and planted with pink sand verbena multiple times since 1996. The habitat is subject to natural disturbances associated with winter weather events and has received beachgrass control efforts in the recent past. The count of plants observed at the site has ranged from zero to 880 in 2019. In 2021, 191 plants (117 reproductive) were counted.

TENMILE CREEK (SOUTH OF FLORENCE)

This population of pink sand verbena occurs at the mouth of Tenmile Creek, Coos County. Plants were observed at this site in 1995 and 1996, but not in subsequent years. In 1999, 150 greenhouse-starts grown from seed collected from the 1996 population were outplanted to the site to augment the natural population. Since that time, no plants have been observed (Kaye 2003). The site is managed by the Siuslaw National Forest. This site is currently managed for snowy plover habitat and has large areas of suitable habitat. This site was not surveyed in 2020 due to wildfire smoke and Covid-related contingencies.

COOS BAY, NORTH SPIT

The Coos Bay area was host to at least one documented historic population of pink sand verbena. In 1999, the 1994 Western Snowy Plover Habitat Restoration Area (HRA) received experimental control measures for European beachgrass and was seeded at that time with 50,000 pink sand verbena seeds. Since then, a population of pink sand verbena has become well established and grown steadily in size and area and represents the most successful reintroduction effort to date. In 2020 there were an estimated 400,000 reproductive plants on the Coos Bay North Spit. In 2021, there was an estimated 200,000. This is the largest known population of pink sand verbena in Oregon and currently provides the seed for other reintroduction efforts across the Oregon coastline. The population is roughly divided into three areas; 1) the western portion of the habitat in a relatively narrow strip (~200m at its widest) that is located on the west side of the sand road which extends to the southern edge of the spit, 2) the east side of the sand road, southern portion, that is managed by US Army Corps of Engineers and contains the area of original introductions and, 3) the east side of the sand road, northern portion, managed by the Coos Bay BLM (Figure 18).

This site receives annual discing, and other measures to control European beachgrass. A dramatic decrease in plants in the southern portion of the habitat was noted when discing was discontinued for a single year. The population rebounded in the following year after discing was re-initiated. The western portion of the habitat has continued to grow in recent years with increased management on that portion of the spit (Figure 19).



FIGURE 18. OCCUPIED HABITAT FOR PINK SAND VERBENA ON THE COOS BAY NORTH SPIT. RED = WESTERN PORTION, GREEN = NORTHERN BLM PORTION, PURPLE = SOUTHERN PORTION (ORIGINAL HABITAT) USACE.

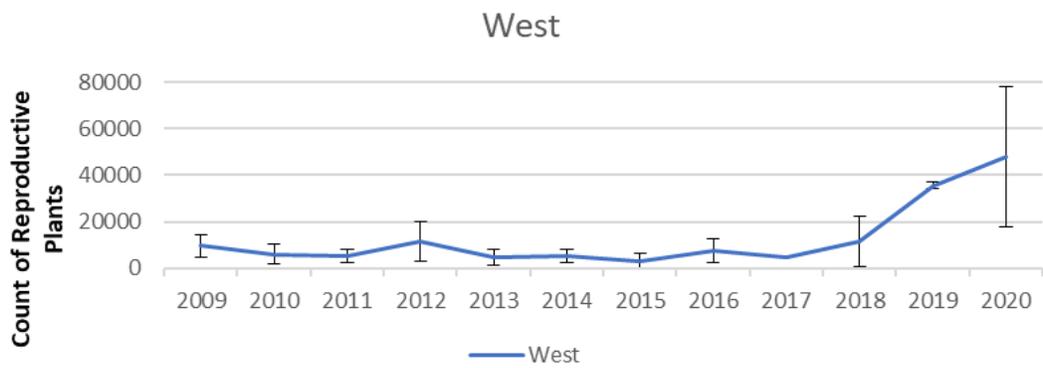
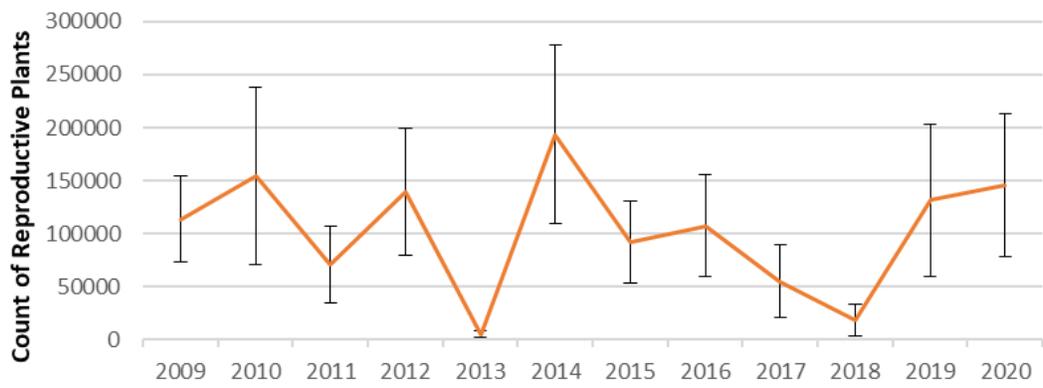
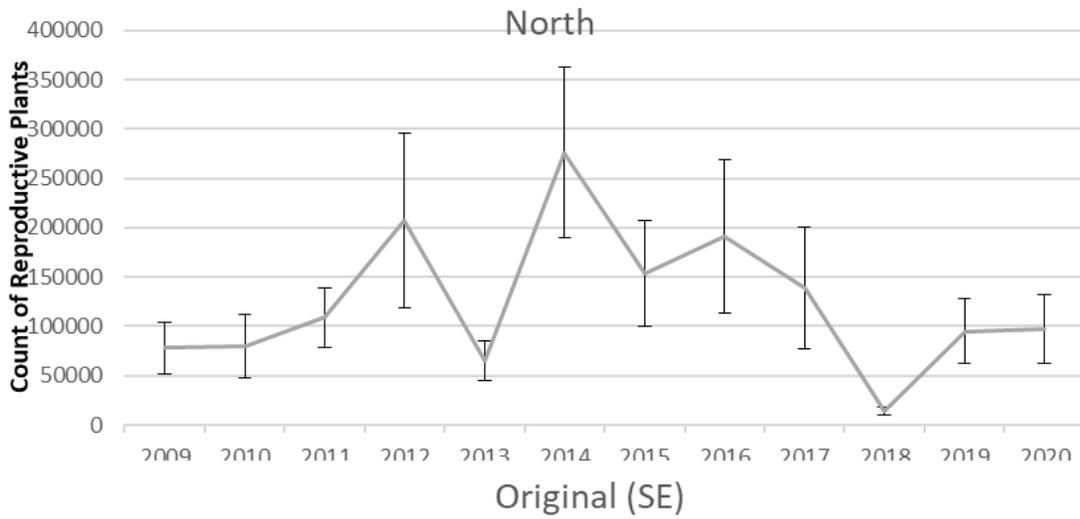


FIGURE 19. POPULATION TRENDS OF REPRODUCTIVE PLANTS AT THE COOS BAY NORTH SPIT FROM 2009-2020. NOTE THAT THE Y-AXIS SCALE VARIES IN EACH CHART.

BANDON BEACH

Reintroduction attempts at Bandon Beach, Coos County (Oregon Dept. Parks and Recreation), were initiated through direct seeding in 1998 and 2002. Few plants were located until 2003, when the population grew to 127 individuals, all of which occurred in beach habitat north and (primarily) south of Bradley Creek, as well as around the mouth of the creek. In 2005, additional seeding was conducted in a beachgrass control area about one mile south of Bradley Creek, and a total of 139 plants emerged that year. Two more recent seeding events (2013 and 2019) did not result in significant numbers of plants. In 2020 six plants were counted during rangewide surveys.

Archaeological concerns at the site currently prohibit the use of discing or other efforts to move sand at the site. Beachgrass control combined with repeated seeding efforts would be necessary for seedings or augmentations to be successful at this site.

NEW RIVER

The New River ACEC site, Coos and Curry Counties (Coos Bay District BLM) has received repeated seedings in an effort to establish a strong population on open sand on its extensive beaches and foredunes. This site is also habitat for the western snowy plover, and the Oregon tiger beetle. The site has been seeded on a near annual basis since 1997 with 50,000 to 120,000 seeds per year. Beachgrass control occurred with the use of a bulldozer in 2004, however logistics and access make these treatments difficult and beachgrass has re-established at the site. In recent years, seeding efforts have been focused on overwashes with less beachgrass where natural dune processes have kept the cover of this introduced species low. In 2005 2,172 plants were counted, in 2015 1,824 and in 2021, only 110 plants were noted. The area is scheduled to receive herbicide treatments in 2022 which are anticipated to increase the potential habitat and increase numbers back to those observed in years past.

FLORAS LAKE

This site west of Floras Lake, Curry County, crosses management boundaries, with some portions managed by BLM and other portions by the Oregon Parks and Recreation Department. The habitat is open beach and partially protected upper beach away from active tidal effects. This site received 12 transplants in 1995 (Kaye 1995), and the beach adjacent was seeded with 5,000 seeds in winter of 1995 (Kaye 1996). Plants were observed in 1995 and 1996 (Kaye 1995 and 1996), then again in 2000 (by Bruce Rittenhouse, BLM); in 2004, approximately 200 plants were observed (R. Meinke, pers. comm.) and in 2012 67 plants were counted. No plants were noted at the site in 2020 during rangewide surveys. This area is also host to other sensitive species including *Phacelia argentea*.

PORT ORFORD

The population at Port Orford, Curry County, was the subject of active research and conservation from 1992-2006. During active restoration and augmentation at this site from 1992-1999, there was a substantial expansion of habitat for pink sand verbena as European beachgrass was

buried with sand on the foredune. This activity was associated with dredging of the adjacent harbor by the Army Corps of Engineers. Since conclusion of this restoration work in 1999, the population has declined due to encroachment of competing vegetation onto previously open areas. The site is managed by the Oregon Parks and Recreation Department. In 1998 and 1999 there were more than 7,000 plants observed at the site (Figure 20). In 2020, only 33 (4 reproductive) plants were counted during surveys conducted by IAE.

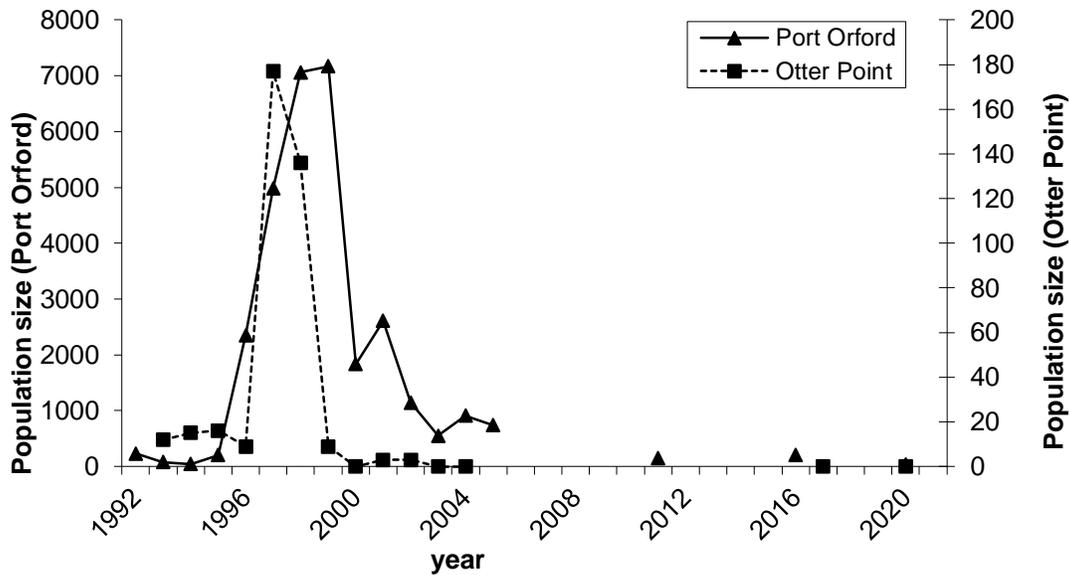


FIGURE 20. POPULATION TRENDS AT OTTER POINT AND PORT ORFORD FROM 1992 TO PRESENT. SURVEYS WERE NOT CONDUCTED IN EACH YEAR. THE DRAMATIC INCREASE IN PLANTS COINCIDED WITH THE ADDITION OF DREDGED SUBSTRATE MATERIAL. NO HABITAT MANAGEMENT OR SEEDING ACTIVITIES HAVE OCCURRED IN THE RECENT PAST AT EITHER LOCATION.

OTTER POINT

The population of pink sand verbena at Otter Point, Curry County, was observed every year from 1993 through 2002, except for 2000, when no plants were observed (Figure 20). Although generally small (fewer than 20 plants), the population was relatively large (>100) in 1997 and 1998. The plants have occurred strictly on the upper beach, and in most years have been concentrated south of the trail that leads from the headland to the beach. The site is managed by the Oregon Parks and Recreation Department. No plants were observed during surveys in 2020.

CAPE BLANCO

The small population at Cape Blanco State Park in Curry County has been observed intermittently since 1984. In recent years, one plant was found in 1999 and two were located in 2000. No plants were observed during surveys in 2020. In 2000, plants were observed growing on the upper beach just below the foredune south of the main access road to the beach from the campground.

GREGGS CREEK (ADJACENT TO EUCHRE CREEK)

Two sites are closely adjacent, one at Greggs Creek (Coos Bay District, BLM and The Nature Conservancy), and one at Euchre Creek (Oregon Parks and Recreation Department). Both are in Curry County. No plants are currently known from BLM-managed lands at Greggs Creek, but past reintroduction activities here and on adjacent lands at Euchre Creek have shown promise. The Euchre Creek site occupies beach and foredune habitat. Beginning in 1995, Euchre Creek has been seeded and received transplants multiple times. Population sizes have typically been small, ranging from 1 to 9 plants since 2000. The individual plants typically have occupied the beach as well as occasionally some unvegetated, low foredune areas. No plants were located during the 2020 rangewide surveys in any portion of these populations.

WINCHUK RIVER

First discovered in 2000, the population at Winchuk River, Curry County, occurs approximately ½ mile north of the Oregon-California border. The population numbered five plants in 2000 and six in 2002. The individuals occurred on the beach on both the north and south sides of the mouth of the Winchuk River. No plants were observed at this site during surveys in 2020.

RECOMMENDED ACTIONS

Augmentations and Introductions

Seeding efforts for pink sand verbena should include 1) continued seeding into managed habitats, 2) seeding into pocket beaches and at the mouths of tributaries where natural disturbance regimes are still in place, and 3) seeding into newly managed habitat (after beachgrass control has been initiated).

Seeding into existing occupied or historically occupied habitat in areas that require little management leverages the conservation actions we can take. In pocket beaches and currently managed or occupied habitats, (continued) seeding efforts are recommended. Spreading seed at pocket beaches, and at beaches along the mouths of streams and tributaries take advantage of the natural disturbance which keeps the cover of beachgrass relatively low. Given the stochastic nature of these populations, increasing the number of sites occupied increases the likelihood of persistence of the species across the landscape. Resources for beachgrass control, can then be focused on targeted stretches of beaches which may require consistent efforts to control this introduced species through chemical and/or mechanical efforts.

Habitat management

Habitat management for pink sand verbena should focus on efforts that restore natural dune processes. Control of European beachgrass may include chemical and mechanical methods to lower the foredune, and breakdown the extensive root structures of this introduced species.

Habitat management may also include the seeding or augmentation of other native dune species, as well as actions to enhance habitat for other rare insect and bird species which also occupy these dune habitats including the Oregon plant bug (*Lygus oregonae*), the tiger beetle (*Cicendela oregana*) and the western snowy plover (*Charadrius nivosus nivosus*).

Site Specific Recommendations

FOR ALL SITES:

- Ensure that activities are compatible with archeological resources and other sensitive plants known to occur at the site
- Coordinate pink sand verbena conservation activities with management of Western Snowy Plover, or other sensitive fauna (if appropriate) and implement beach and dune ecosystem restoration for multiple species.
- Coordinate with adjacent landowners to accommodate or enhance their species and habitat management efforts when the species occurs on adjacent lands.
- Consider opportunities for collaborative habitat management on public and private land to increase the amount of habitat suitable for the species, connect and expand adjacent populations, and link isolated populations with one another.
- Conduct control activities for European beachgrass (where feasible, reasonable, and compatible with other resource needs) in order to maintain open beach and foredune conditions and facilitate over-washing of the sand spit by winter storms and tidal events. Document the effectiveness of beachgrass control and habitat enhancement value.
- Monitor pink sand verbena plants to determine population trends and effects of management treatments and practices.
- In areas where European beachgrass is treated to produce an approximation of historic beach conditions, consider reintroduction of pink sand verbena and/or a natural (historic) dune and beach native plant community consistent with the species outlined in Table 2.

TABLE 2. COASTAL PLANT SPECIES THAT COULD BE INCLUDED IN RESTORATION EFFORTS FOR PINK SAND VERBENA.

Common name	Latin name
yellow sand verbena	<i>Abronia latifolia</i>
beach pea	<i>Lathyrus littoralis</i>
maritime pea	<i>Lathyrus japonicus</i>
beach morning-glory	<i>Convolvulus soldanella</i>
silver bursage	<i>Ambrosia chamissonis</i>
American beach-cup	<i>Camissonia cheiranthifolia</i>
black knotweed	<i>Polygonum paronychia</i>
American dunegrass	<i>Leymus mollis</i>
American glehnia	<i>Glehnia littoralis</i> var. <i>leiocarpa</i>
silvery phacelia*	<i>Phacelia argentea</i>
Wolf's evening primrose*	<i>Oenothera wolfii</i>
seaside dock	<i>Rumex maritimus</i>

*Listed as Threatened with the Oregon Dept. of Agriculture; Species of Concern with the U.S. Fish and Wildlife Service.

NEW RIVER ACEC

Beachgrass control and continued seeding.

COOS BAY NORTH SPIT

Continue treatments in the western portion. Maintain wildlife corridors between western and eastern portions of habitat. Continue annual discing and consider lifting the disc in areas where there is less beach grass to allow for overwintering plants to remain in place.

SILTCOOS

Continue seeding efforts. Control beachgrass.

TAHKENITCH

Continue seeding efforts. Continue beachgrass control with herbicide and mechanical methods.

OVERLOOK NORTH

Continue seeding of pink sand verbena; beachgrass control with herbicide and discing. Assess effects of burn on seedling establishment. Assess effects of weed-whacking of herbicide treated areas; are there effects of thatch on seedling establishment? Inland components of this area could provide habitat in the face of climate change.

OVERLOOK SOUTH

Continue seeding efforts. Assess effects of burn on seedling establishment. Assess effects of weed-whacking of herbicide treated areas; are there effects of thatch on seedling establishment? Inland components of this area could provide habitat in the face of climate change.

BAKER BEACH

Reinvigorate seeding and monitoring efforts at this site.

SUTTON

Reinvigorate seeding and monitoring efforts at this site.

TENMILE CREEK (FLORENCE)

Monitor habitat and assess quality of habitat for pink sand verbena. Begin seeding efforts in conjunction with beachgrass control efforts for Western Snowy Plover.

BANDON BEACH

Due to archaeological constraints at this site, beachgrass control may be limited to herbicide use. Seeding should be initiated after multiple years of beachgrass control have weakened the root mass of this introduced species which could encourage sand movement and facilitate natural dune processes. Initial seeding efforts should be focused near tributary mouths and where beachgrass cover is low. Inland components of this area could provide habitat in the face of climate change.

ELK RIVER

The extreme sand movement and dynamic nature of this site may be too dramatic for the establishment of pink sand verbena, however this site should be monitored on a 3-5 year cycle to assess the possibility of seeding and establishment of a pink sand verbena population.

WALDPORT NORTH TO SEAL ROCK

This site represents the currently largest potentially occupiable habitat of pink sand verbena along the Oregon coastline. Beaches from the mouth of the Alsea River and north to Seal Rock have relatively low cover of European beachgrass and could benefit from immediate seeding efforts to expand the small extant population at Driftwood Beach.

WINCHUK RIVER/GOLD BEACH

Past seeding efforts have been successful at this site, and management efforts to control beachgrass are currently underway in portions of this area. Working with local city/county agencies as well as local private landowners could allow for immediate seeding efforts and beachgrass control efforts to commence.

POCKET BEACHES AND TRIBUTARY MOUTHS: PORT ORFORD, SUNSET BAY (AND NEARBY POCKET BEACHES), HECETA HEAD, YAQUINA HEAD, CROOK POINT, TENMILE CREEK (SOUTH OF YACHATS), AND ONA BEACH

Any of these areas not listed above could be seeded without any additional habitat management efforts. Seeding of pink sand verbena requires no ground disturbance and could be implemented at these sites without additional compliance-related restrictions related to ground disturbance or herbicide use. While these sites are generally small, increasing the number of populations across the range of the species would increase the resiliency of the species, and previous work has shown that even single seeding efforts can result in populations that persist through time. Repeated seeding efforts particularly in areas that are successful in the first years post-seeding should be continued as plant materials are available. Once a population has more than 100 reproductive plants for 3 out of the previous five years, seeding could be discontinued until falling below that threshold.

Plant Materials

Seed collection should be expanded to include new sites as feasible. Currently Coos Bay North Spit (BLM) is the only location where seed is collected. This seed has been used for restoration seeding at BLM and USFS sites. As the population at Overlook South (USFS) expands, this site may also be a potential site for seed collection in the future. It is also possible to grow plants of pink sand verbena in a greenhouse or other growout setting; since the plant is self-pollinating, large amounts of viable seed can be collected from plants grown in this way. Thus, seed increase efforts could also potentially provide seed for future restoration efforts.

Acquisition of Additional Information

- Continued surveys to monitor extant, augmented and introduced populations.
- Evaluation of beachgrass control methods (monitoring before and after treatments)
- Coordinate the introduction or restoration of other native dune species to leverage habitat restoration efforts. (Including into areas where foredune restoration has occurred or is planned.)
- Meta-population modeling may be an effective tool for assessing recovery objectives.

Opportunities for collaboration

Develop opportunities for collaborative habitat management on public land to increase the amount of habitat suitable for the species and to link isolated populations with one another.

- Coordinate pink sand verbena conservation activities with management of Western Snowy Plover.
- Implement beach and dune ecosystem restoration for pink sand verbena and other animal and plant species of the same habitat through beachgrass control and multiple species reintroduction or augmentation
 - Other rare species that share similar or adjacent habitat include:
 - Plant: Silvery phacelia (*Phacelia argenticia*), silver bursage (*Ambrosia chamissonis*), Wolff's evening primrose (*Oenothera wolfii*)
 - Animal: Oregon plant bug (*Lygus oregonae*), Oregon tiger beetle (*Cicindela oregana*), Western snowy plover (*Charadrius nivosus nivosus*), sand verbena moth

(*Copablepharon fuscum*) currently found in BC and WA, and the Hoary Elfin butterfly (*Incisalia polia maritima*).

Education and Outreach

Develop opportunities for collaborative management of dune habitats

- Conduct outreach activities to educate the public about pink sand verbena. Examples of such activities include: distribute the informational video (“Ecoregion DVD”) on coastal habitat conservation featuring pink sand verbena (produced by BLM and other partners) targeting the general public and school groups.
 - Post interpretive signs at popular trailheads.
 - Prepare a brochure on beach and dune conservation featuring pink sand verbena and other sensitive coastal species.
 - Distribute information and make presentations to beach conservation groups, such as those involved in annual beach cleanup activities (e.g., SOLV’s Great Oregon Beach Cleanup).
 - Conduct habitat restoration actions such as invasive grass pulling as part of National Public Lands Day.
 - Conduct hikes and field trips to view pink sand verbena and discuss conservation challenges and opportunities for public involvement.
 - Recruit schools and other groups to assist with restoration and conservation activities.

CONSERVATION STRATEGY DURATION AND REVIEW SCHEDULE

The life of this Conservation Strategy will be ten years, after which time the status of pink sand verbena, along with the objectives and methods included in the strategy, will be re-evaluated, and if necessary, extended. At three year intervals the participating parties will review progress achieved at each managed population, and amendments to the plan may be made as needed to address new information and any discoveries of additional populations.

Monitoring

In order to evaluate the efficacy of management treatments and introduction or augmentation efforts, the monitoring of pink sand verbena populations before and after treatments will be necessary. Monitoring is recommended to include a census or sub-sample of pink sand verbena individuals at each site, and an evaluation of the surrounding habitat and potential threats including cover of European beachgrass.

Monitoring Methods

Ecological status monitoring may be conducted by BLM, Forest Service, Park Service, U.S. Fish and Wildlife Service, or state agency personnel. Monitoring should be conducted according to the following procedures, depending on population size:

- A. Population monitoring: Populations with 1,000 or fewer individuals: **direct census**

- a. Small populations may be monitored effectively and efficiently through direct census. Note, however, that small populations may occasionally become too large for a direct census in just one year. In the event that the population has increased unexpectedly, field investigators should be prepared to perform a subsample (see B below) each year that monitoring is conducted. Count the number of vegetative and flowering plants, and record on a standard sighting report form.
- B. Populations with 1,000 to 10,000 individuals: random subsample
- a. Map population or subpopulation location carefully onto aerial photographs and large scale topographic maps, or GIS enabled tablet.
 - i. Locate population perimeter with GIS equipment (1 to 5-meter minimum accuracy), if available. Demarcate the sampling polygon with pin flags or flagging on surrounding vegetation and draw a sketch map of the area.
 - ii. Randomly select plots within the population. Begin with at least six plots per population, subpopulation, or stratum. Follow procedures recommended in Elzinga, Salzer, and Willoughby (1998).
 - iii. Conduct sampling when plants are in flower or early fruit; count the number of vegetative and reproductive plants and record them on a data form (September will generally be a good month for sampling, but this may be delayed until October or conducted as early as August, depending on the year and location).
 - b. Use plot data to estimate total population or subpopulation size (number of individuals), as well as standard deviations and confidence intervals.
- C. Populations with more than 10,000 individuals: perimeter mapping.
- a. Survey the perimeter of the population with a Geographic Positioning System (GPS) and provide a rough estimate of total population size (or reproductive plants only). This situation currently applies only to one known population in Oregon at Coos Bay, North Spit, at which the population exceeds (as of 2003) 100,000 reproductive individuals and covers several acres.

If populations or subpopulations decrease more than 30% in a consistent trend over a five-year period, then the cause of the decrease should be identified, and appropriate management actions recommended.

MANAGEMENT TREATMENT MONITORING

Monitoring Objective. Management treatment monitoring is an optional tool for determining the effectiveness of trial management practices, such as beachgrass removal. The objective for management treatment monitoring is to detect if there is a 30% change in the number of plants in control (untreated) versus treated plots with a 10% chance of a missed change error and a 10% chance of a false change error.

Monitoring Locations. Sites where management treatment monitoring will be implemented shall be determined on an as needed basis, but shall include all sites where management treatments are conducted on a trial basis, or as resources permit. As possible, monitoring should include assessments of sites in the season prior to habitat management treatments in order before and after effects.

Monitoring Methods. Management treatment monitoring will be proposed as administrative studies or research and accomplished by Bureau of Land Management, Forest Service, U.S. Fish and Wildlife Service, or state agency personnel. Monitoring will be conducted according to methods proposed at the time of the administrative study or research and in coordination with the collection of pink sand verbena population monitoring.

If populations or subpopulations of pink sand verbena decrease more than 30% in a consistent trend over a five-year period, then the cause of the decrease should be identified, and appropriate management actions recommended.

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APPENDIX A. HISTORICAL AND CURRENT POPULATIONS OF PINK SAND VERBENA IN OREGON.

Site	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Baker Beach				55	93	72	12	42	70	6									0			
Bandon Beach south restoration area			13	134	56	144	383	184	114		240	476	167									
Bastendorf Beach			13	110	371	536	11	2	9		2											
Cape Blanco	2	0		0	11		2						0									
Coos Bay North Spit			44728	32935	14379	31412	99357	111063	10929	201377	240488	180777	349423	74804	470092	264757	306176	194532	37084	261963	291517	371318
Crook Point											2											
Devil's Punchbowl																						7
Driftwood Creek											0											47
Elk River										389	122	307	556			5		0				0
Euchre Creek			9	7	2								0									0
Floras Lake	0				220	20	65	0		0			67									0
Hubbard Creek			0	0	4																	0
New River			524	917	1628	2172	616	480	180	62	810	237	81	33	366	1824			196		33	110
Otter Point			3	0	0		0	0										0				0
Overlook North			1091	1478	3741	3210	7825	3445	2395	789	730	1938	4860	994	281	124	269	616	497	1548	0	870
Overlook South			1726	2107	9554	4340	10	98	0	2073	1052	2349	2247	482	109	158		966	3476	3768	0	2969
Pistol River									1	0												0
Port Orford			1146	552	909	740	660	1412	226	269	194	146	240				107					66
Quarry Cove																5		3				15
Salmon River		741	163		1	92				0												
Siltcoos			19	215	355	1932	385	66	41	36	148	415	605	38	10	298	427	116	292	737	0	50
Sutton Creek					150	0	0	0											28			
Tahkenitch		50	22	0	121	0	1			4		95	381	13	100	100	141	160	361	840	0	188
Tenmile Recreation Area				1																		
Tish-a-Tang										45												6
Winchuck River			6	2		0																0

Numbers indicate either a census, or estimate based on subsampling, or incidental observation (denoted by the 'a' superscript) of the total number of vegetative and reproductive plants. Blank cells indicate no survey was conducted at that site-year or no data was available. Even though some populations indicate zero individuals for the most recent survey, a population should not be considered extirpated until surveyed for at least three consecutive years.

APPENDIX B. 32 SITES COMPRISING THE 2020 OREGON RANGE-WIDE SURVEY

Site
Bob Straub State Park
Bullard Beach State Park
Chetco Mouth South
Devil's Punchbowl
Dope Creek
Driftwood Creek
Euchre Creek
Floras Lake
Gold Beach
Harris Beach
Hubbard Creek
Mcvay Park
Mill Beach
Moolack Beach area
Nesika Beach
Newport north jetty
Ona Beach
Otter Point
Pistol River
Port Orford
Quarry Cove
Samuel H. Boardman State Scenic Corridor
Seal Rock
Siletz Bay Beach
Stonefield
Tish-a-Tang
Tokatee Kloochman
Waldport North Spit
Waldport South Spit
Whiskey Run Beach
Winchuck River
Yachats Bay south