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A CONSERVATION ASSESSMENT FOR *CASTILLEJA GRISEA* (SAN CLEMENTE ISLAND PAINTBRUSH, OROBANCHACEAE)

SULA VANDERPLANK, KIMBERLY O'CONNOR, BRYAN MUNSON AND DAWN LAWSON

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Dr. Sula Vanderplank: Research Associate and Postdoctoral Scholar, San Diego State University Research Foundation, San Diego, California 92182 (sula.vanderplank@gmail.com)

Ms. Kimberly O'Connor: Natural and Cultural Resources Program Manager, Commander, U.S. Pacific Fleet, U.S. Department of the Navy, San Diego, California 92135

Mr. Bryan Munson: Botany Program Manager, Naval Base Coronado, U.S. Department of the Navy, San Diego, California 92135

Dr. Dawn Lawson: Ecologist, Space and Naval Warfare Systems Center Pacific, U.S. Department of the Navy, San Diego, California 92152

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by Sula Vanderplank, Kimberly O'Connor, Bryan Munson and Dawn Lawson

1.0 EXECUTIVE SUMMARY

This report summarizes the best available scientific information relevant to assessing the conservation status of *Castilleja grisea* (San Clemente Island paintbrush), which was listed as federally endangered in 1977 by the United States Fish and Wildlife Service (USFWS) under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) and was downlisted to threatened in 2012. *Castilleja grisea* is a hemiparasitic perennial subshrub in Orobanchaceae. It grows primarily in coastal sage scrub and maritime desert scrub throughout San Clemente Island, and its numbers have risen dramatically from just 19 occurrences at the time of listing to more than 336 occurrences and 31,694 individuals based on surveys conducted from 2011 through 2012 (Map 1). At the time of listing, the major threat to this taxon was herbivory by non-native mammals. The eradication of the last feral mammalian herbivores in the early 1990s has resulted in a significant population increase in *C. grisea*. In the federal listing, downlisting, and status reviews for *C. grisea*, land use, non-native species, fire, fire management and erosion were identified as threats under Factor A of the five-factor analysis, and climate change was identified under Factor E. These threats are evaluated in detail within this report and are currently determined to be minimal. *Castilleja grisea* is not likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Based on the recovery of the taxon to date, ongoing conservation by the United States Department of the Navy (US Navy), which promotes the continued survival and expansion of *C. grisea* on San Clemente Island, and the existence of regulatory mechanisms other than the Endangered Species Act (ESA), the protections afforded to the taxon as federally threatened under the ESA no longer appear to be warranted.

2.0 SCOPE AND PURPOSE

Castilleja grisea (San Clemente Island paintbrush) was selected as the focus of this conservation assessment due to its range expansion and population size increases following significant efforts by the US Navy to aid its recovery. The purpose of this conservation assessment is to compile and synthesize the best available scientific information about *C. grisea* to document its current conservation status. Discussion in this review highlights changes in this plant's demography since the time of listing and focuses on modern distribution patterns (including evidence of natural recruitment) and the likelihood of its long-term survival.

3.0 METHODS

Taxonomic and life history data were compiled from multiple scientific publications. Current and historical data on the occurrences were retrieved from the US Navy, the US Fish and Wildlife Service (USFWS), the Consortium of California Herbaria (CCH), and the California Natural Diversity Database (CNDDB). Recent demographic data were furnished by the Soil Ecology and Restoration Group (SERG) of the San Diego State University Research Foundation and confirmed through the Commander US Pacific Fleet Environmental Readiness Division and the Naval Base Coronado Natural Resources Office. Field visits to several occurrences were made in December 2016 and February, April, and July of 2017 to corroborate available data. Notes were taken on associated species and evidence of recruitment at the sites visited. Data on phenology, floral visitors and potential threats come from published literature, personal observations, previous legal documentation and internal reports. Maps were generated by Tierra Data, Inc., based on the most recent extensive survey data from SERG collected from 2011 through 2012 (US Navy 2017). Surveys covered as much suitable habitat as was feasible given access, survey, and timing constraints. Extensive surveys have not been conducted in the past five years because the high numbers of occurrences and individuals have greatly increased the level of effort required for monitoring, and the significant recovery of this taxon has made it a lower priority for frequent monitoring.

The term "occurrence" is used throughout to denote biologically contiguous clusters of plants and is distinct from "Element Occurrences" (EOs) as defined by CNPS and employed in CNDDB. See Section 6.1 for a detailed explanation.

4.0 BACKGROUND

4.1 *Taxonomic Description*

The description presented below is drawn from data adapted from Dunkle (1943), Munz (1974), Junak and Wilken (1998) and Wetherwax et al. (2012).

Castilleja grisea Dunkle is a hemiparasitic perennial herb in Orobanchaceae. This subshrub is generally 40–60 cm in height and readily detected due to its gray foliage and stems, which are densely stellate-hairy. The leaves are generally 10–50 mm long, alternate along the stems, and linear to lanceolate in shape. They may be 3-lobed or entire and may be crowded on sterile shoots. The inflorescences are 3–10 cm long with bracts that are 8–10 mm long, 3-lobed, and brownish. The bisexual flowers are borne in terminal spikes and primarily flower from February to May. The floral calyces are 10–20 mm long, with one third of the length divided

abaxially and adaxially, often with a notch on the sides. The calyx becomes inflated as the fruit ripens. The corolla is 15–25 mm with a beak that is generally larger than the tube, and a dull yellow to green color with pale yellow margins. The lower lip is exserted, 2 mm long and dark green, and the stigma is club-shaped and also exserted. The fruits are semi-woody capsules, 10–12 mm long, with many seeds 1–1.5 mm in diameter and a seed coat that is deeply netted/ornamented (an adaptation that causes the seed to float). Chromosome number $2n = 24$.

4.2 *Taxonomic History and Genetics*

Current name: *Castilleja grisea* Dunkle, *Bull. S. Calif. Acad. Sci*. 42 (1): 31–32 (1943)

Synonyms: *Castilleja hololeuca* Greene subsp. *grisea* (Dunkle) Munz, *Aliso* 4 (1): 97 (1958)

Common name: San Clemente Island paintbrush

Current family name: Orobanchaceae (broomrape family)

Former family name: Scrophulariaceae (figwort family)

Castilleja grisea was first collected above Pyramid Cove on San Clemente Island on 2 Apr 1939 (*Dunkle 7201*; holotype RSA5955, isotype SD292, JEPS80931). It was published as *Castilleja grisea* in 1943 in an article titled "*Three new plants from San Clemente Island*," which appeared as a special note on contributions from the Los Angeles Museum—Channel Islands Biological Survey in the *Bulletin of the Southern California Academy of Sciences*. The author noted that grazing by sheep and goats was heavy and that other plants probably new to science lacked sufficient material for scientific description.

Castilleja grisea is noted as most closely related to *C. hololeuca* Greene (a species from the Northern Channel Islands) but distinct in its general appearance (noted as "more straggly" with a distinctly gray appearance) and having dull yellow flowers. Dunkle also noted that *C. hololeuca* and *C. foliolosa* were more similar to one another than either was to *C. grisea*. Fifteen years after first being published by Dunkle (1943), *C. grisea* was reduced to a subspecies of *C. hololeuca* by Philip A. Munz without explanation (Munz 1958), stating that "various nomenclatural changes and novelties are herewith presented in order to be used in the forthcoming book *A California flora* by Munz and Keck." No justification of the new combination [*Castilleja hololeuca* Greene subsp. *grisea* (Dunkle) Munz, comb. nov.] was included, and it has not been accepted in major floristic works since that time (Chuang and Heckard 1993; Wetherwax et al. 2012).

The genus *Castilleja* has around 200 currently recognized species worldwide, primarily distributed in Western North America, with occasional species in Asia (Wetherwax et al. 2012). All members of the genus are hemiparasitic (meaning that they are capable of parasitism but also have chlorophyll present in their tissues) (Atsatt and Strong 1970), with spike-like inflorescences and zygomorphic flowers. The etymology of the name *Castilleja* honors Spanish botanist Domingo Castillejo (1744–1793). The taxonomy of the genus *Castilleja* has long been confusing because many characters are difficult to observe in pressed specimens, and the characters chosen to distinguish species, particularly calyx characters, are often very plastic (Anderson and Taylor 1983).

Wetherwax et al. (2012) include a key to all 64 taxa from the State of California, but *C. grisea* is the only member of the genus found on San Clemente Island. Seven other species of *Castilleja* can be found on the remaining California Channel Islands (*C. affinis*, *C. attenuata*, *C. densiflora*, *C. exserta*, *C. foliolosa*, *C. hololeuca* and *C. mollis*). *Castilleja attenuata* and *C. hololeuca* are the only other yellow-flowered species in the archipelago, and both are found only on the Northern Channel Islands (Table 1). While hybridization is

Table 1. Presence of *Castilleja* species on the California Channel Islands (excluding San Clemente Island).

	Catalina	San Nicholas	Santa Rosa	Santa Cruz	Anacapa	San Miguel
Castilleja affinis Hook. & Arn. subsp. *affinis*	x		x	x	x	x
Castilleja attenuata (A. Gray) T.I. Chuang & Heckard				x		
Castilleja densiflora (Benth.) T.I. Chuang & Heckard		x	x	x		x
Castilleja exserta (A. Heller) T.I. Chuang & Heckard	x		x	x		x
Castilleja foliolosa Hook. & Arn.	x					
Castilleja hololeuca Greene			x	x	x	x
Castilleja mollis Pennell			x			x

common in genus *Castilleja* (Wetherwax et al. 2012), it is not a concern for *C. grisea*.

In 1999, genetic evidence showed that contrary to popular opinion at the time, the evolution of holoparasitism (obligate parasitism) was not a linear process but had occurred multiple times, and the split between Scrophulariaceae and Orobanchaceae was not monophyletic (Young et al. 1999). In 2001, family Scrophulariaceae was reclassified based on DNA evidence and members of the family were reassigned to several other families (Olmstead et al. 2001). Genus *Castilleja* was moved to Orobanchaceae, a family which now includes all the hemiparasitic taxa that were formerly in Scrophulariaceae. These changes have been broadly accepted by the botanical community and are reflected in the online Jepson eFlora (Wetherwax et al. 2012). In 2012, this change in family affiliation was recognized in the Federal Register (title 50 in Code of Federal Regulations 17.12).

Despite the history of herbivory and resultant decline of *C. grisea* on San Clemente Island, the species maintains surprisingly high genetic variation for an insular endemic plant (Helenurm et al. 2005). In a study of 19 occurrences of *C. grisea* on San Clemente Island, genetic variation was consistent with an outcrossing breeding system, with genetic variation higher within than among occurrences (Helenurm et al. 2005). This suggests that substantial genetic variation remained in the population despite over-grazing and that gene flow between occurrences was high historically, maintaining fitness through time (Helenurm et al. 2005).

4.3 *Regulatory Status History*

- *Castilleja grisea* was listed as federally endangered on 11 Aug 1977 (USFWS 1977).
- *Castilleja grisea* was listed as state endangered in April 1982 (CNDDB 2017).
- A Recovery Plan for Channel Islands species, including *C. grisea*, was finalized in 1984 (USFWS 1984).
- A 5-year status review was completed in 2007 and recommended reclassification of *C. grisea* from endangered to threatened (USFWS 2007).
- On 18 May 2010, USFWS received a petition, dated 13 May 2010, from the Pacific Legal Foundation to downlist *C. grisea* from endangered to threatened under the Endangered Species Act (USFWS 2013).
- On 19 Jan 2011, a 90-day finding was published, announcing the initiation of a status review of *C. grisea* (USFWS 2011).
- The second 5-year status review for *C. grisea* was completed in 2012 and recommended reclassification of the species from endangered to threatened (USFWS 2012).
- On 16 May 2012, a proposed rule to reclassify *C. grisea* from federally endangered to threatened was issued (USFWS 2012).
- On 19 Feb 2013, *C. grisea* was changed from California Rare Plant Rank 1B.2 to 1B.3 (Slakey et al. 2013)
- On 26 July 2013, the final rule to reclassify *C. grisea* from federally endangered to threatened was issued (USFWS 2013).

5.0 BIOLOGY, ECOLOGY, HABITAT AND HUMAN USES

5.1 *Biology and Ecology*

Castilleja grisea is a hemiparasitic plant, meaning that it is capable of photosynthesis and can live without a host but usually derives water, nutrients and sugars from another species. It enters a host through haustoria that form when its roots enter those of the host plant. *Castilleja* species are capable of forming these haustorial connections with more than one host (Atsatt and Strong 1970), and in greenhouse studies those that did not form connections were short-lived and died shortly after germination (Junak and Wilken 1998). *Castilleja grisea* is reported to be capable of forming haustorial connections with a range of plant species, and potential hosts have been reported to include *Opuntia littoralis* (prickly pear), *Stipa* [*Nasella*] *pulchra* (purple needlegrass), *Calystegia macrostegia* subsp. *amplissima* (island morning glory), and *Constancea* [*Eriophyllum*] *nevinii* (Nevin's eriophyllum) (Heckard 1962; Atsatt and Strong 1970; Marvier 1996; Adler 2003; R. N. Muller, pers. comm. 2009 in USFWS 2012). Muller and Junak (2011) reported 12 plant taxa that are consistently found within *C. grisea* occurrences, but further study is needed to determine whether they are host plants and whether host connections shift throughout different seasons or growth stages (Marvier and Smith 1997).

Castilleja grisea generally flowers between February and May, producing yellow bisexual flowers (Chuang and Heckard 1993; US Navy 2002; Fig. 1–2). It

Fig. 1–2. *Castilleja grisea*.—1. Close-up of flower.—2. Habit.

is assumed to be self-incompatible (requiring outcrossing to set seed), as observed in other species of the genus (Junak and Wilken 1998). Junak and Wilken (1998) examined four populations of *C. grisea* and found that an average of 67–71% of flowers produced fruits, with large variation in seed set between fruits, but an average of 150 seeds per fruit. Seed viability and germination were found to be very similar in germination trials, suggesting that most viable seeds are able to germinate immediately and do not require a period of dormancy to induce their germination (Junak and Wilken 1998). The seed bank at Rancho Santa Ana Botanic Garden (RSABG) has a single accession of *C. grisea* that was collected in 1989 and contains 6622 seeds. In 2007 (after 18 years in storage) germination tests resulted in 97% germination, suggesting that seed longevity is very high in this taxon (Cheryl Birker, Seed Curator, RSABG, pers. comm. July 2017).

Castilleja grisea has a large number of floral visitors (putative pollinators and predators; SERG 2015*a*). Hummingbirds have been observed visiting flowers (Bryan Munson, Naval Base Coronado Botany Program Manager, pers. obs. 2018), but it is assumed to be pollinated by bees (USFWS 2012). While *C. grisea* does not require a host plant, parasitic individuals of *Castilleja* spp. attract more pollinators and produce more seeds than non-parasitic individuals (Adler 2003). Putative floral predators include caterpillars, thrips and aphids. Putative pollinators were similar in their species diversity across sites, but pollinator abundance varied considerably. Eight bee species in six genera and 14 flies in four genera were observed to visit flowers (SERG 2015*a*).

Little is known about the fire tolerance of *C. grisea*, although it has been seen to survive and expand its distribution in areas that have previously burned (see Section 6.4, Factor A, 3. Fire and Fire Management below).

5.2 *Habitat*

Castilleja grisea is associated with numerous habitats and is found in most of the vegetation types on the island (Map 2). Data from the Integrated Natural Resource Management Plan (INRMP; US Navy 2013) give a sense of the local climatic conditions in areas occupied by *C. grisea*. Based on data from Peak Weather Station, which is located mid-island on the eastern side where *C. grisea* is present, average monthly temperatures range from 53°F (12°C) to 70°F (21°C). Average monthly maximum temperature is 80°F (27°C) in August, and the monthly minimum temperature reaches 48°F (9°C) in March, which is cooler than other areas of the island. Average monthly relative humidity has been documented to vary from 54% to 86% across the island, but at Peak Weather Station it varies from 38% to 95% throughout the year. San Clemente Island has a precipitation regime with dramatic fluctuations in annual rainfall. The average annual rainfall is 6.6 inches (16.8 cm). Precipitation is received mainly from November through April, with little from May through October. In addition to precipitation, fog drip during the dry season is a vital source of moisture to the San Clemente Island ecosystem (US Navy 2013).

Early vegetation mapping on San Clemente Island (Sward and Cohen 1980) associated *C. grisea* with two major vegetation types: canyon woodland (which

encompasses approximately 696 acres [282 ha]), and maritime desert scrub (which encompasses approximately 6228 acres [2520 ha]). Over time, the range of *C. grisea* has expanded, and it now occupies a broad range of habitats within the same general vegetation types and is widespread across the island (Map 2). The vast majority of *C. grisea* occurrences are found in vegetation types dominated by *Artemisia californica* (159 with 23,011 individuals), with significant numbers also found in *Cylindropuntia prolifera* (39 occurrences with 1659 individuals), *Opuntia littoralis* (36 occurrences with 2161 individuals), and *Rhus integrifolia* (48 occurrences with 3380 individuals), although *C. grisea* also is found in nine additional vegetation types (e.g., 11 occurrences have been documented in both the *Stipa* sp. vegetation type and in the *Lycium californicum* vegetation type).

Castilleja grisea grows at elevations between 0 and 2000 ft (600 m) (US Navy 2017). Occurrences on both escarpments are generally found on slopes and in rocky canyons. They occur also on coastal bluffs, slopes, terraces and swales (Junak and Wilken 1998; SERG 2012). Plants are found on flats and steep rocky slopes from 0 to 70 degrees (US Navy 2017). *Castilleja grisea* occurs almost exclusively on non-clay soils and rocky outcrops (Map 3) and on slopes of all aspects (CNDDB 2017). The species is capable of colonizing disturbed areas and has the potential to continue to expand its range on San Clemente Island (US Navy 2008).

The considerable habitat diversity and wide range of suitable habitat of *C. grisea* is reflected in the large number of associated species with which it has been documented. Table 2 lists associated species reported in the EO records of the California Natural Diversity Database (CNDDB, accessed 9 Jan 2017). Note: nomenclature has been updated, non-native plants are indicated with an asterisk*, and family names have been added in this report. Updates to CNDDB records have not been made since 2012 (Kristi Lazar, CNDDB Botany Data Manager, pers. comm. 2019).

5.3 *Human Uses*

No specific uses are documented for *Castilleja grisea*, although the genus has broad accounts of ethnobotanical uses. Several species are noted as dermatological aids (*C. affinis*, *C. angustifolia*, *C. hispida*, *C. sessiliflora*) and others as gastrointestinal medicines (*C. angustifolia*, *C. linariifolia*, *C. parviflora*). Additional usage reports include teas, nectar, poisons, blood purification and contraception (Moreman 2003). *Castilleja* species are known to facultatively accumulate selenium (Mauldin and Peters-Kennedy 2016). Selenium is a metalloid that acts as an antioxidant with toxic potential. It has chemical properties similar to sulfur and is widely distributed in soils at concentrations ranging from <0.01 parts per million (ppm) to >500 ppm. Selenium toxicosis occurs in horses, cattle, sheep and pigs, chiefly as a result of the ingestion of seleniferous plants that have accumulated toxic levels of selenium. Seleniferous plants selectively concentrate selenium in their foliage and seeds, and two different syndromes—blind staggers and alkali disease—have been described as "chronic selenium poisoning" (Mauldin and Peters-Kennedy 2016). Although *C. grisea* was previously part of the diet of introduced grazers and browsers on San Clemente Island, it is not likely to have been an intentional forage species. Human uses are not considered a threat to *C. grisea* and it seems unlikely that they would become so in the future, in part due to the restricted human access to the island.

6.0 DISTRIBUTION, ABUNDANCE AND POPULATION TRENDS

6.1 *Distribution and Abundance*

Castilleja grisea is endemic to San Clemente Island, the southernmost of the California Channel Islands, which is located 64 miles (103 km) west of San Diego, California. The island is owned by the US Navy and encompasses 36,073 acres (14,598 hectares) (US Navy 2013). *Castilleja grisea* was listed as federally endangered in 1977 and state endangered in 1982, but it was downlisted in 2013 (USFWS 2013) and is currently considered threatened at the federal level, though it remains endangered at the state level. In addition to federal and state processes that have resulted in legal protection of *C. grisea*, conservation stakeholders and the non-profit community have also evaluated the conservation status of the taxon (Table 3).

Castilleja grisea is widely distributed throughout much of San Clemente Island (Map 1). Large occurrences are found on the eastern escarpment and the canyons on the west side of the island. Occurrences documented by the US Navy from 2011 through 2012 (US Navy 2017) consisted of contiguous biologically relevant clusters that were unbroken within a line of sight and did not include any obvious barriers to dispersal, pollination, or recruitment. Notably (and positively), as these occurrences continue to expand and recruit over time, they are approaching one another in some areas, making a more specific geographic definition challenging. Occurrences continue to expand toward one another and could merge and be reclassified in the future. Map 4 shows the distribution of *C. grisea*

Table 2. Associated species of *Castilleja grisea* taken from CNDDB 2017.

Associated species	Family
Achillea millefolium L.	Asteraceae
Acmispon argophyllus (A. Gray) Brouillet var. *argenteus* (Dunkle) Brouillet [syn. *Lotus argophyllus* (A. Gray) Greene subsp. *ornithopus* (Greene) P.H. Raven]	Fabaceae
Amblyopappus pusillus Hook. & Arn.	Asteraceae
Artemisia californica Less.	Asteraceae
*Atriplex semibaccata** R. Br.	Chenopodiaceae
*Avena barbata** Pott ex Link	Poaceae
*Avena fatua** L.	Poaceae
Baccharis pilularis DC.	Asteraceae
Bergerocactus emoryi (Engelm.) Britton & Rose	Cactaceae
Brodiaea kinkiensis T.F. Niehaus	Themidaceae
*Bromus diandrus** Roth	Poaceae
*Bromus hordeaceus** L.	Poaceae
*Bromus madritensis ** L.	Poaceae
Calystegia macrostegia (Greene) Brummitt subsp. *amplissima* Brummitt	Convolvulaceae
Constancea nevinii (A. Gray) B.G. Baldwin [syn. *Eriophyllum nevinii* A. Gray]	Asteraceae
Cylindropuntia prolifera (Engelm.) F.M. Kunth [syn. *Opuntia prolifera* Engelm.]	Cactaceae
Daucus pusillus Michx.	Apiaceae
Deinandra clementina (Brandegee) B.G. Baldwin [syn. *Hemizonia clementina* Brandegee]	Asteraceae
Dichelostemma capitatum (Benth.) Alph. Wood	Themidaceae
Dudleya virens (Rose) Moran subsp. *virens*	Crassulaceae
Epilobium canum (Greene) P.H. Raven subsp. *canum* [syn. *Zauschneria californica* C. Presl]	Onagraceae
Eriogonum giganteum S. Watson var. *formosum* K. Brandegee	Polygonaceae
Eriophyllum confertiflorum (DC.) A. Gray	Asteraceae
*Festuca myuros** L.	Poaceae
Galium catalinense A. Gray subsp. *acrispum* Dempster	Rubiaceae
Gambelia speciosa Nutt.	Plantaginaceae
Hazardia cana (A. Gray) Greene	Asteraceae
Heteromeles arbutifolia (Lindl.) M. Roem.	Rosaceae
Jepsonia malvifolia (Greene) Small	Saxifragaceae
Juncus bufonius L.	Juncaceae
*Lamarckia aurea** (L.) Moench	Poaceae
Lasthenia gracilis (DC.) Greene	Asteraceae
Lathyrus vestitus Nutt.	Fabaceae
Lupinus bicolor Lindl.	Fabaceae
Lycium californicum Nutt.	Solanaceae
Melica imperfecta Trin.	Poaceae
Mirabilis laevis (Benth.) Curran var. *crassifolia* (Choisy) Spellenb. [syn. *Mirabilis californica* A. Gray]	Nyctaginaceae
Munzothamnus blairii (Munz & I.M. Johnston) P.H. Raven	Asteraceae
Nassella cernua (Stebbins & Love) Barkworth [syn. *Stipa cernua* Stebbins & Love]	Poaceae
Nassella lepida (Hitchc.) Barkworth [syn. *Stipa lepida* Hitchc.]	Poaceae
Nassella pulchra (Hitchc.) Barkworth [syn. *Stipa pulchra* Hitchc.]	Poaceae
Opuntia littoralis (Engelm.) Cockerell	Cactaceae
Pellaea andromedifolia (Kaulf.) Fée	Pteridaceae
Pentagramma triangularis (Kaulf.) Yatsk., Windham & E. Wollenw.	Pteridaceae
Pholistoma auritum (Lindl.) Lilja	Boraginaceae
Poa secunda J. Presl.	Poaceae
Prunus ilicifolia (Nutt. ex Hook. & Arn.) D. Dietr. subsp. *lyonii* (Eastw.) P.H. Raven [syn. *Prunus lyonii* (Eastw.) Sarg.]	Rosaceae
Pseudognaphalium biolettii Anderb. [syn. illeg. *Gnaphalium bicolor* Bioletti]	Asteraceae
Pseudognaphalium californicum (D.C.) Anderb. [syn. *Gnaphalium californicum* D.C.]	Asteraceae
Rhus integrifolia (Nutt.) Benth. & Hook. F. ex Rothr.	Anacardiaceae
Rumex salicifolius Weinm. [*nativity unclear without subspecific identification]	Polygonaceae
Selaginella bigelovii Underw.	Selaginellaceae
Senecio lyonii (A. Gray)	Asteraceae
Trifolium willdenovii Spreng.	Fabaceae

Table 3. Current conservation status of *Castilleja grisea*.

Status	Significance
Federally threatened (FT)	Taxon is likely to become endangered within the foreseeable future throughout all, or a significant portion, of its range.
State endangered (CE)	Taxon is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease.
Global rank G3	Taxon is at moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
State rank S3	Taxon is vulnerable in the state due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
CNPS 1B.3	Rare throughout its range. Taxon is not very threatened in California (less than 20% of occurrences threatened/low degree and immediacy of threat or no current threats known).

in different watersheds, which may be a better way to track the geographic expansion of *C. grisea* on San Clemente Island in the future.

During surveys conducted in 2011 and 2012, *C. grisea* was mapped and documented to include 336 occurrences and 31,694 individuals (US Navy 2017). These totals do not include as many as 5000 individuals detected in 2017 in potentially overlapping locations that were deliberately excluded to avoid inflated estimates (US Navy 2017). They also do not include occurrences in the Impact Areas, which became inaccessible prior to the 2011 and 2012 surveys due to a change in policy addressing unexploded ordnance safety issues. Previous surveys had documented 52 occurrences and 14,064 individuals of *C. grisea* in Impact Area I, mainly within Horse Beach Canyon in TAR 21 (US Navy 2008). As noted in the Southern California Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement (EIS), these occurrences were generally away from targets, in locations where topography shielded them from direct hits by ordnance (US Navy 2008). The EIS noted that "[*C. grisea*] has been increasing in abundance in this area despite ongoing use of live ordnance." It is expected that many of these occurrences persist despite the inability to access them; however, they are not included in this analysis. It is important to note that all occurrences on San Clemente Island are thought to be natural and have recruited and expanded following the removal of non-native herbivores.

The Consortium of California Herbaria (2018) has a surprising paucity of data on *Castilleja grisea* from the 34 participating herbaria, including only 36 unique specimen collecting events with 8 duplicate collections by Dunkle between 1939 and 2017 (the most recent collection from 1996), documented with 44 sheets when duplicates are included (Table 4). There are perhaps more specimens in existence, but the modern distribution is poorly reflected in the state herbarium record. At the time of writing (January 2019), CNDDB included 38 records of EOs of *C. grisea*, none of which has been updated since 11 Dec 2012 (Appendix 1). All records are documented to be Native/Natural Occurrences, Presumed Extant, with population trends unknown (Appendix 1). Occurrences included in the 2012 proposal (USFWS 2012) and final downlisting rule (USFWS 2013) are listed in Appendix 2. Of all records in the CNDDB, none has any potential threats identified.

The CNDDB applies the EO definition used by CNPS, which considers an EO to be "a population or group of populations found within 0.25 miles and not separated by significant habitat discontinuities" (CNPS 2019). This definition differs somewhat from that used in the Navy's surveys, which considers occurrences to be contiguous biologically relevant clusters that are unbroken within a line of sight and lack any obvious barriers to dispersal, pollination or recruitment. Because Navy occurrences are based on biologically relevant groupings determined by surveyors in the field rather than being based on a fixed distance, a direct comparison of the number of occurrences presented in this assessment with those that follow the CNPS definition is inappropriate. It is important to note that although such a comparison is inappropriate, a comparison of occurrences through time within the Navy data set is appropriate and useful. To resolve issues arising from the lack of a standard definition of occurrences and the merging of existing occurrences that is expected as *C. grisea* continues to expand, tracking occupation by watershed and the numbers of individuals is expected to be a more useful way of assessing the species in the future than focusing on the number of occurrences.

The U.S. government adopted NatureServe's ecological classification system as the national standard

Table 4. Unique herbarium specimen collections of *Castilleja grisea* from San Clemente Island (from CCH, accessed January 2017).

Accession #	Collector & collection number	Date	Elevation	Locality	Latitude/longitude
DS728173	*M. B. Dunkle 7201*	14 Mar 1937	–	SE corner of island	32.8469, -118.4167
JEPS33786	Unknown	1 Aug 1963	–	San Clemente Island	32.9, -118.5
JEPS77654	*P. H. Raven 17735*	10 May 1962	900 ft (274 m)	Walls of deep canyon due N of Boulder	32.9057, -118.4711
JEPS80931	*M. B. Dunkle 7201*	2 Apr 1939	–	SE corner	32.9, -118.5
JEPS88978	*M. Egger & J. Stone 679*	15 Apr 1995	–	Pyramid Head area, lowest terrace, NW base of Balanced Rock, ca. 50 m from sea	32.819237, -118.35058
JEPS89138	*P. H. Raven 17735*	1962	900 ft (274 m)	Head of canyon N of Boulder	32.9057, -118.4711
RSA213393	*M. B. Dunkle 7201*	2 Apr 1939	–	SE corner of island	32.8469, -118.4167
RSA239497	*E. R. Blakley 6396*	8 Dec 1963	1000 ft (305 m)	Canyon head above Mosquito Cove and between triangulation points Malo and Chenity	32.8541, -118.4074
RSA262022	*R. M. Beauchamp & T. Oberbauer 22689*	23 Aug 1975	902 ft (275 m)	W fork of Red Rock Canyon	32.846667, -118.45833
RSA298669	*D. C. Michener & M. Beauchamp s.n.*	26 Sep 1982	50 ft (15 m)	First terrace above Sun Rock, W of Pyramid Point, E of mouth of canyon SE of Guds	32.8215, -118.3614
RSA350374	*M. B. Dunkle 7201*	2 Apr 1939	–	SE coast of island	32.8469, -118.4167
RSA350375	*M. B. Dunkle 7201*	2 Apr 1939	–	SE corner of island	32.8469, -118.4167
RSA350376	*M. B. Dunkle 7201*	2 Apr 1939	–	SE corner island	32.8469, -118.4167
RSA428381B	*F. H. Elmore 384*	18–19 Feb 1939	–	San Clemente Island	32.9079, -118.5
RSA428382A	*H. S. Gentry 411*	18 Feb 1939	–	San Clemente Island	32.9165, -118.489
RSA515112	*A. Liston, O. Mistretta, L. Rieseberg s.n.*	30 Apr 1989	50 ft (15 m)	Pyramid Head, S end of island	32.8255, -118.3826
RSA515116	*A. Liston, O. Mistretta, L. Rieseberg s.n.*	28 Apr 1989	59–69 ft (18–21 m)	Horse Beach Canyon, S end of island	32.8125, -118.413889
RSA576130	*F. H. Elmore 384*	18–19 Feb 1939	–	San Clemente Island	32.9079, -118.5
RSA582911	*M. Elvin & G. Allan 18*	21 May 1995	49 ft (15 m)	W side of island, in S branch of Horse Beach Canyon on lower terrace	32.826111, -118.413889
RSA582913	*M. Elvin & G. Allan 16*	20 May 1995	10 ft (3 m)	SW tip of island S of Guds on lowest coastal terrace	32.8302, -118.4028
RSA660877	*O. Mistretta 140*	5 Apr 1992	–	Guds	32.829, -118.3658
RSA678692	*M. Elvin & O. Mistretta 133*	24 Mar 1996	1224 ft (373 m)	Eagle Canyon	32.8731, -118.4282
SBBG105353	*H. L. Ferguson 134*	11 Mar 1980	150 ft (46 m)	N fork of Eagle Canyon	32.8738, -118.4293
SBBG109036	*S. A. Junak 556*	30 May 1996	60 ft (18 m)	Ca. 0.3 mi ESE of triangulation point	32.9462, -118.5503
SBBG118704	*O. Mistretta 140*	5 Apr 1992	–	Guds	32.8289, -118.3645
SBBG19175	*M. A. Piehl 631053*	7 Dec 1965	30 ft (9 m)	SE tip from Pyramid Head and opposite triangulation point	32.821, -118.356
SBBG20586	*E. R. Blakley 6396*	8 Dec 1963	1000 ft (305 m)	Canyon head above Mosquito Cove and between triangulation points Malo and Chenity	32.8504, -118.4063
SBBG39475	*M. B. Dunkle 7201*	2 Apr 1939	–	Lower slope bluffs, SE coast of island; ISOTYPE	32.8469, -118.4167
SD136135	*M. Elvin & G. Allan 18*	21 May 1995	–	W side of island, in S branch of Horse Beach Canyon on lower terrace	32.82617, -118.41402

Table 4 Continued

Accession #	Collector & collection number	Date	Elevation	Locality	Latitude/longitude
SD181332	*O. Mistretta 140*	5 Apr 1992	–	Guds	32.829, -118.3658
SD80904	*M. B. Dunkle 7201*	2 Apr 1939	–	SE coast of island, common on lower slope bluffs	32.8469, -118.4167
SD84804	*M. B. Dunkle 7201*	2 Apr 1939	–	Common on lower slope bluffs; SE corner of island	32.8469, -118.4167
SD92024	*R. Moran et al. 22689*	23 Aug 1975	900 ft (274 m)	On cliffs, W fork of Red Rock Canyon	32.84667, -118.45833
SDSU19652	*M. Simpson et al. 2210*	20 Jul 2000	1350 ft (411 m)	Near top of canyon running to E shore of island, ca. 4.8 miles due N of China Point	32.87139, -118.42722
UC103538	*T. S. Brandegee s.n.*	24 Aug 1894	–	San Clemente Island	32.9, -118.5
UC1430125	*R. Moran et al. 22689*	23 Aug 1975	902 ft (275 m)	W fork Red Rock Canyon	32.834446, -118.450836
UC557802	*N. Murbarger 132*	Apr 1936	–	S and E sides island	32.9079, -118.5
UCR147270	*O. Mistretta 140*	5 Apr 1992	–	[Triangulation point] Guds	32.828, -118.364
UCR204197	*M. Elvin & O. Mistretta 133*	24 Mar 1996	1224 ft (373 m)	Eagle Canyon	32.8731, -118.4282
UCR47669	*D. C. Michener & R. M. Beauchamp 4096*	26 Sep 1982	50 ft (15 m)	1st terrace above Sun Rock, W of Pyramid Point, E mouth of canyon SE of [triangulation point] Guds	32.828, -118.364
UCR65528	*A. Liston et al. 796*	28 Apr 1989	69 ft (21 m)	Horse Beach Canyon, S end of island	32.8125, -118.41389
NY28966	*P. H. Raven 17735*	10 May 1962	–	The specific locality has been removed from this record to protect this species from over-collection	–
NY68086	*M. B. Dunkle 7201*	2 Apr 1939	–	The specific locality has been removed from this record to protect this species from over-collection	–
SEINET-4095939	*M. B. Dunkle s.n.*	1939	–	–	–
UC1929460	*M. Elvin & O. Mistretta 133*	24 Mar 1996	1224 ft (373 m)	Eagle Canyon	–

for use by federal agencies in 1997. NatureServe rankings originally were based on the numbers of populations (CADFW 2019) and have been updated to refer to "populations/occurrences" (NatureServe 2019); however, definitions are not provided. Except when retaining terminology from reference sources, we have avoided using the term "populations" throughout this assessment because by biological definition, a population describes a group of interbreeding individuals (Mayer 1942), and we believe it is likely that under this definition *C. grisea* individuals on San Clemente Island constitute a single population.

6.2 *Population Trends*

Extensive data from recent years demonstrate clearly that the number of occurrences, the range, and the abundance of *C. grisea* are increasing (US Navy 2002, 2008, 2017; Junak 2006; USFWS 2008). *Castilleja grisea* is expanding in range and readily occupying previously disturbed areas as a result of eliminating the primary threat from exotic herbivores (US Navy 2002, 2008). The distribution of *C. grisea* is undoubtedly affected by the topological refugia that were inaccessible to goats and therefore survived the intense browsing. These source occurrences shaped the pattern of expansion and recolonization, although some seeds may have remained in the soil seed bank in other areas of the island. The number of documented occurrences since the time of listing has increased by 317 (336 occurrences today) and the number of individuals has risen from approximately 1000 around the time of listing to at least 31,694 individuals in 2011–2012 (US Navy 2017).

San Clemente Island has a long history of human occupation, starting with Gabrielino people, whose

presence on the island has been documented in shell middens dating back approximately 3000 years (Yatsko and Raab 2009). Some reports suggest that goats were first introduced on the island in 1827 (Dunkle 1950 in USFWS 2012), and the first documented grazing lease for sheep was awarded in 1848 (Schoenherr et al. 1999). Sheep, goats, pigs, and cattle were ranched on the island until 1934, when the island was transferred to the jurisdiction of the US Navy (US Navy 2008; USFWS 2012). These introduced herbivores severely impacted the vegetation of San Clemente Island, as described by Dunkle (1943), "*The heavy grazing of sheep and goats in the past gave such a desolate appearance to the island that it seemed superficially of but little interest to the botanist*." Feral herbivores were mentioned in the original listing rule (USFWS 1977) and the final downlisting rule (USFWS 2013) as the main cause of decline for *C. grisea*. Cattle and sheep were removed from San Clemente Island by 1935 (Bruce 1994). In 1991, feral goats and pigs were finally eradicated by the US Navy after a lengthy effort to protect the endemic biota that was being pushed toward extinction (Keegan et al. 1994).

The earliest published information regarding population size for *C. grisea* can be found in the San Clemente Island INRMP, which states that the population declined from the 1930s to the 1970s as the feral goat population increased, until only a few individual plants remained (US Navy 2013). From approximately 1000 individuals at the time of listing (1977), 19 occurrences and 1340 individuals of *C. grisea* were present on the island in 1980 (US Navy 2002), and by 1984, the population had recovered to an estimated 1500 individuals (USFWS 1984).

Comprehensive data are available beginning with surveys conducted in 1996 and 1997, which documented a total of 77 occurrences comprising over 3500 individual plants (Junak and Wilken 1998). These occurrences ranged from isolated individuals to populations of 600 plants. More surveys for *C. grisea* were conducted from 2003 through 2006, with 198 occurrences mapped and estimates of 9718 individuals documented (Junak 2006; USFWS 2008; US Navy 2008). Occurrences ranged from isolated plants to areas occupied by 1400 individuals, for an average of 49 individuals. The consolidated survey data from 2011 through 2012 documented 336 occurrences and 31,694 individuals, with a maximum and a mean of 5000 individuals and 94 individuals, respectively (US Navy 2017). The 2011–2012 survey data demonstrate an 18-fold increase in the number of occurrences and a 24-fold increase in the number of individuals since 1980.

The precise abundance of this taxon is difficult to determine because time, budget, resources, access, and terrain limit the feasibility of an exhaustive survey of all 36,073 acres (14,598 hectares) on the island, particularly due to the increasingly high abundance and widespread distribution of this taxon. The baseline data are challenging because it is impossible to assess the intensity of historical survey efforts and estimate the number of previously undetected individuals (USFWS 2012). New occurrences typically are documented only during focused surveys, but despite uncertainty in precise numbers, the data display a strong trend of increasing numbers (Table 5; Fig. 3).

The increase in the numbers of occurrences and individuals on San Clemente Island is a result of recruitment from the seed bank, recolonization associated with dispersal events, and the Navy's management efforts (USFWS 2012). However, even without a full and current census for all individuals on San Clemente Island, it is clear that *C. grisea* has steadily increased in total number of individuals and number of occurrences. As *C. grisea* continues to expand its range on the island, it may well go on to colonize new habitats or occupy larger areas within existing habitat. An assessment of the potential range of *C. grisea* on San Clemente Island can be obtained from assessing the full acreage of the habitats that it currently occupies (Table 6).

Table 5. Increasing population trend in *Castilleja grisea.*

Survey year	Occurrences	Individuals
1977	?	1000
1980	19	1340
1984	?	1500
1996–1997	77	3500
2003–2006	198	9718
2011–2012	336	31,694

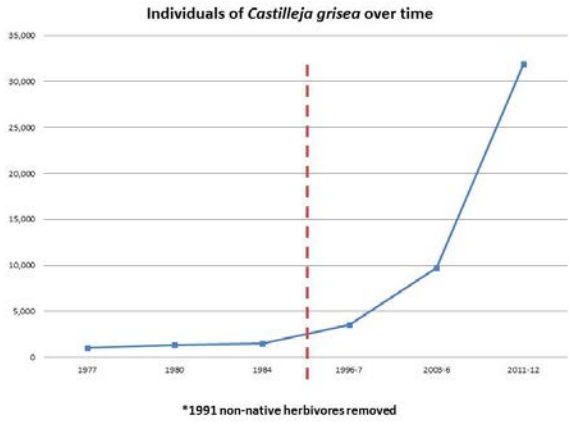

Fig. 3. Increasing population trend in *Castilleja grisea* after removal of non-native herbivores.

Table 6. Estimated area of potential habitat for *Castilleja grisea* on San Clemente Island (using vegetation data from the Integrated Natural Resources Management Plan [US Navy 2013: 3–59] and current distribution [US Navy 2017]).

Vegetation type	Acres	%
Rhus integrifolia	1232.4	3.4%
Quercus tomentella	3920.7	10.9%
Avena sp.	2213.5	6.1%
Stipa sp.	2533.7	7.0%
Cylindropuntia prolifera	1134.8	3.1%
Lycium californicum	6458.8	17.9%
Opuntia littoralis	9441.8	26.2%
Opuntia littoralis/Artemisia californica	5340.9	14.8%
Artemisia californica	173.6	0.5%
Baccharis pilularis	22.1	<0.1%
Senecio lyonii	21.4	<0.1%
Unvegetated-coastal	318.1	0.9%
Total	32,811.8	90%

Castilleja grisea currently occurs within vegetation types that occupy 90% of the island (see Table 6), which can be considered its potential habitat. This estimate of potential habitat is inflated because *C. grisea* is not ubiquitous throughout these vegetation types; however, it also underestimates the potential range and habitats of *C. grisea*, which may expand into additional vegetation types and disturbed areas.

6.3 *Threats and Limiting Factors*

The major threat to *C. grisea* historically was direct impacts to individuals and occurrences as a result of grazing and browsing by non-native mammalian herbivores introduced to the island prior to its acquisition by the US Navy in 1934 (USFWS 1977, 2012). The eradication of the last feral herbivore in 1991 removed the major limiting factor to the proliferation of *C. grisea*. Presently, the CNDDB notes all recorded EOs of *C. grisea* as presumed extant with no current threats documented. The Navy implements an Integrated Natural Resources Management Plan (INRMP) on San Clemente Island and undertakes routine monitoring and extensive restoration efforts to conserve rare, threatened, and endangered species on the island (US Navy 2013). On all islands, biosecurity is a continuous potential concern, but the military control of San Clemente Island means that the island's biosecurity plan (US Navy 2016) can more effectively control the arrival of potentially invasive propagules than on non-military islands. Threats to *C. grisea* are currently minimal, and as noted in the USFWS (2012) downlisting proposal "the threats to the habitat of *C. grisea* will not likely impact most of the known occurrences both now and into the future".

6.4 *Threats with Regard to Listing Requirements*—FIVE-FACTOR ANALYSIS (Threats, Conservation Measures and Regulatory Mechanisms)

The threats to *C. grisea* are classified and assessed here according to the five factors identified in Section 4(a)(1) of the Endangered Species Act for consideration in listing, delisting and reclassification decisions.

Factor A: Present or Threatened Destruction, Modification or Curtailment of Habitat or Range

Previously cited: In the down-listing proposal of 2012 (USFWS 2012), threats to the populations under Factor A were noted to include the following: (1) land use, (2) non-native species, (3) fire, (4) fire management, and (5) erosion. (We have combined fire and fire management in our analysis.)

1. Land Use

Potential indirect effects and associated issues (including soil erosion, non-native invasive plant species, fire, and access to restricted areas) are addressed separately in this document to parallel the structure of the analysis of threats in the 5-Year Review (USFWS 2012).

San Clemente Island is part of the Southern California Range Complex, which is the most capable and heavily used Navy range complex in the eastern Pacific region (US Navy 2008: ES-3). Of the terrestrial training areas, the Shore Bombardment Area (SHOBA), which supports a diversity of military training (including Anti-Surface Warfare, Amphibious Warfare, Naval Special Warfare, Bombing Exercises, and Combat Search and Rescue) is the largest, occupying roughly the southern third of the island (US Navy 2008: 2–7). Not all areas within SHOBA are intensively used for training, however. Some, particularly the escarpment along the eastern coast, have limited training value because precipitous terrain hinders ground access. Areas of intensive use within SHOBA include the two Impact Areas and three Training Area Ranges (TARs). Impact Areas support naval gun firing, artillery firing, and air-to-ground bombing (US Navy 2008: 2–7). TARs are littoral operating areas that support demolition, over-the-beach training, and tactical ingress and egress training for Naval Special Warfare personnel (US Navy 2008: 2–7). Collectively, the TARs and Impact Areas encompass 3400 acres, which amounts to 24.5% of the area within SHOBA. Outside SHOBA, San Clemente

Island supports 18 additional terrestrial TARs, four Assault Vehicle Maneuver Areas (AVMAs) which are designated for off-road vehicle use, including by tracked vehicles, and the Infantry Operations Area (IOA) which is designated for dispersed foot traffic by military units in support of a battalion-sized landing (US Navy 2008: 2–37). All training areas described in this paragraph are collectively referred to in this document as "focal training areas" because their locations, extent, and uses warrant their evaluation for potential land use impacts on *C. grisea*.

Land use was identified as one of the primary threats to *C. grisea* at the time of listing (USFWS 1977), and the final rule to downlist (USFWS 2013) noted that land use appeared to pose a high-magnitude threat to the habitat of many occurrences on San Clemente Island. Potential threats from land use exist primarily where *C. grisea* occurs within focal training areas. Surveys in 2011 and 2012 detected 143 *C. grisea* occurrences and 11,170 individuals inside SHOBA, which constitutes 43% of occurrences and 35% of individuals island-wide (Map 5). Most of the SHOBA occurrences are located along the east slope drainages away from focal training areas and below the elevation of the IOA. Only 16 occurrences and 376 individuals of *C. grisea* are documented inside the IOA (US Navy 2017). The likelihood of *C. grisea* being subjected to even minimal impacts from foot traffic within the IOA is very low because, as a suffrutescent shrub, it is fairly resilient to occasional physical disturbance. Trampling effects on individual plants would be temporary, as the affected plants would be expected to recover, even if individual stems were broken (US Navy 2008). No occurrences of *C. grisea* were documented in the TARs or the AVMAs (US Navy 2017). Within these areas, military training has the potential to directly affect *C. grisea* only in the three Impact Area TARs, which were inaccessible to surveys due to a change in policy associated with unexploded ordnance safety issues, as noted in Section 6.1. Previous surveys had documented 52 occurrences and 14,064 individuals of *C. grisea* in Impact Area I, mainly within Horse Beach Canyon in TAR 21. Though these are not included in current population estimates, many are expected to persist based on the analysis in the EIS (US Navy 2008), which reported increases in *C. grisea* in the Impact Areas despite their long history of use. Individuals that persist within the Impact Areas could be subject to direct impacts from ordnance, though, as noted in the EIS, they generally occurred away from targets in locations shielded by topography.

2. Non-Native [Invasive] Plant Species

Non-native plants were listed as a threat in the original 1977 listing of *C. grisea* and have been cited in both the 12-month finding on the petition to downlist (USFWS 2012) and the final downlisting rule (USFWS 2013) as a persistent low-level threat. Species of particular concern were noted to include *Foeniculum vulgare* Mill. (sweet fennel) and *Mesembryanthemum crystallinum* L. (crystalline iceplant). However, the 2013 downlisting rule (USFWS 2013) acknowledged that the threat had been reduced and recognized the US Navy's reduction in the prevalence of particularly destructive species, citing *Foeniculum vulgare* as a specific example (USFWS 2013). *Castilleja grisea* occurrences near roads were noted to be potentially subject to diffuse disturbance that promotes the establishment and spread of invasive species and degrades habitat quality.

Not all non-native plants present a threat to *C. grisea*, but invasive plants can directly impact native plant populations through competition for space and resources, potentially out-competing seedlings for light or moisture (Eliason and Allen 1997; see also DeSimone and Zedler 2001). Invasion is essentially a function of (1) propagule pressure and dispersal ability, (2) abiotic and habitat factors, and (3) the biotic characteristics of the taxa, but also varies with a community's position in time and space (Catford et al. 2009). For invasion to occur, all three factors must be accommodating, if not favorable (Catford et al. 2009). As the native plant communities recover, the vegetation continues to change and no longer consists of the early seral communities that first recolonized the island following the removal of non-native mammalian herbivores (Stratton 2005).

As the flora of San Clemente Island recovers, the conditions also become less favorable to invasion, with more intact habitats and reduced erosion, a stronger suite of native competitor species, and a progressive reduction in propagule pressure when the invasive species are targeted and controlled. Many habitats underwent considerable invasion historically, and some, such as the central grasslands, continue to be heavily dominated by non-native species. *Castilleja grisea* frequently occurs in areas with rocky soils, which are less susceptible to invasion by annual grasses (Allan 1999; Navy 2002). Surveys conducted in 2011 and 2012 found just 4 occurrences (170 individuals) of *C. grisea* in communities dominated by invasive grasses (Map 2).

The 12-month finding on the petition to downlist (USFWS 2012) states that the restoration of the island's vegetation communities carried out by the US Navy is expected to help improve habitat suitability by reducing the spread of invasive non-native plants and restoring ecological processes. Navy management continues to reduce invasion pressure, and there is no evidence that invasive plants are leading to reductions in abundance of *C. grisea*. The recently completed Naval Auxiliary Landing Field San Clemente Island Biosecurity Plan (2016) focuses on prevention of and response to introductions of non-native species and bio-invasion

vectors, including the arrival of any new propagules of invasive plants and animals (US Navy 2016). The current threat from invasive species comes from indirect effects on habitat. In a meta-analysis of the impacts of alien plants, they were found to decrease native plant abundance and diversity indirectly by reducing the fitness and growth of native plant species and promoting shifts in plant community structure (Vilá et al. 2011). The invasive species already present on San Clemente Island could be indirectly affecting the fitness of *C. grisea*, although this does not appear to be an impediment to recovery.

Invasive species present on San Clemente Island are managed following the Biological Opinion (USFWS 2008) and the INRMP (US Navy 2013) (Table 7). Currently, all five strategic goals identified in the 2008–2012 National Invasive Species Management Plan are being implemented at San Clemente Island. The basic seven-step framework below is well established on a national level and is also reflected in California's existing Pest Prevention Program and Weed Plan:

1) Prevention (most cost-effective and environmentally beneficial)
2) Monitoring and early detection
3) Rapid response and eradication (see Table 3-49 in the INRMP (US Navy 2013) for species treated on San Clemente Island 2000–2009).
4) Long-term control and management
5) Education and outreach
6) Restoration of high value ecosystems across scales
7) Organizational collaboration

The continual expansion of *C. grisea* on San Clemente Island, including into disturbed areas (US Navy 2002), suggests that the indirect impacts of invasive plants are currently minimal, and though they may slow range expansion, they are not a barrier to recovery.

3. Fire and Fire Management

The original listing rule did not identify fire as a threat *to C. grisea* (USFWS 1977); however, the final downlisting rule mentioned that 50% of the island had burned at some point prior to listing (USFWS 2013). The final downlisting rule identified the potential depletion of the seedbank if frequent fires occurred before seed-drop as the primary concern associated with the potential effects of fire on *C. grisea*, but the rule also noted that the US Navy's annual reviews of fire management and fire occurrences allowed for adaptive management to minimize the threat of fire. The final downlisting rule concluded that the threat of fire was limited to occurrences of *C. grisea* within SHOBA, and the potential for frequent fires to affect these occurrences was reduced by their location on the eastern escarpment, away from Impact Areas I and II (USFWS 2013). Fire history has been recorded on San Clemente Island since 1979, and most documented fires with known ignition sources have been of anthropogenic origin. The US Navy's fire suppression efforts have been identified as key in the prevention of fire spread and ignition (USFWS 2008).

Fire is not always a threat to native plants. Many ecosystems, including those where *C. grisea* is found (Map 6), have some adaptation and resilience to fire. The presence of *C. grisea* in areas that have previously burned is evidence it can survive and increase in abundance despite occasional fires. This was also acknowledged in the 2013 downlisting rule (USFWS 2013), which mentions the significant amelioration of the threat by the San Clemente Island Wildland Fire Management Plan (US Navy 2009). The San Clemente Island Wildland Fire Management Plan follows an adaptive management strategy that sets average fire return interval thresholds within different plant communities to minimize potential adverse effects of fire.

A fire return interval of three years or less has been documented to negatively impact woody shrubs such as *C. grisea* (Brennan and Keeley 2015), although it is unlikely that *C. grisea* would ever experience such a short return interval due to the Navy's fire management practices (US Navy 2009). Since 1979, fire return intervals have not exceeded the postulated ecological tolerance of *C. grisea* (US Navy 2009); 2011–2012 survey data show that 142 occurrences and 20,948 individuals occur in areas that have not burned since fire records began in 1979, 4460 individuals of *C. grisea* occur in areas that have burned once, 4791 individuals occur in areas that have burned twice, 1395 in areas that have burned three times, and a single occurrence of 100 individuals occurs in an area that has burned four times in the last 38 years (Map 6). The areas of highest fire frequency on San Clemente Island are restricted to the center of SHOBA, primarily to the north of the western Impact Area, where there are no *C. grisea* occurrences. The vast majority of *C. grisea* individuals (28,631 individuals, of 31,694 [90%]) have not experienced a fire in 20 years or more (Map 7). As of the end of the most recent survey period (2012), no individuals of *C. grisea* had been affected by fire for at least three years (Map 7).

Table 7. Conservation measures for terrestrial plants on San Clemente Island (SCI) as relevant to *Castilleja grisea*. Sources: the Biological Opinion (BO; USFWS 2008) and Table 3-48 of the Integrated Natural Resources Management Plan (INRMP; US Navy 2013).

Source	Measure	Requirements
INRMP and BO	AVMC-M-7	Require the following measures to reduce the potential for transport of invasive plants to the island. Prior to coming to SCI, military and non-military personnel will be asked to conduct a brief check for visible plant material, dirt or mud on equipment and shoes. Any visible plant material, dirt or mud should be removed before leaving for SCI. Tactical ground vehicles will be washed of visible plant material, dirt and mud prior to embarkation for SCI. Additional washing is not required for amphibious vehicles after 15 minutes of self-propelled travel through salt water prior to coming ashore on SCI.
INRMP and BO	G-M-1.	Continue invasive species control on an island-wide scale, with emphasis on the AVMC, IOA, TARs and other operations insertion areas such as West Cove, Wilson Cove and the airfield. A pretreatment survey to identify areas needing treatment, one treatment cycle and a retreatment cycle (when necessary) will be planned each year to minimize the distribution of invasive species. Where feasible, the Navy will include future construction sites in a treatment and retreatment cycle prior to construction.
INRMP and BO	G-M-9.	Conduct monitoring and control activities for invasive non-native plant species outside of the Impact Area boundaries. Navy installations will prevent the introduction of invasive species and provide for their control per Executive Order 13112. The Navy will identify actions that affect the introduction of invasive species, prevent their introduction, respond rapidly to their control, monitor populations, restore affected native species and their habitat, conduct research and develop technologies to prevent further introductions, and promote public education of the issue.
BO 2008		A goal will be reducing the percent cover of invasive plants from the 1992–1993 baseline of 41% on terrace faces and 53% on terrace flats.
INRMP and BO	FMP-M-10.	Conduct prescribed fire experiments to evaluate their effectiveness in controlling non-native annual plants.
INRMP and BO	FMP-M-11.	Establish post-fire recovery plots to monitor recovery and identify new infestations of non-native invasive plants associated with both wildfire and prescribed fire.
INRMP and BO	FMP-M-12.	Evaluate burn areas and prioritize them, as appropriate, for inclusion in the weed eradication program.
INRMP		To prevent the transfer of invasive species from the mainland to SCI, soil and fill brought to the island are treated with herbicide before importation (INRMP 2012).
INRMP		Further prevention for the transfer of invasive species to the island is established through the *Do Not Plant* list maintained by the Naval Facilities Engineering Command, Southwest Botanist and Landscape Architect (INRMP 2012).
INRMP		The NRO participates in a Channel Islands biosecurity working group which meets quarterly to discuss and develop measures to prevent non-native species from invading Channel Islands ecosystems, and to share resources and knowledge of potential threats to the islands (INRMP 2012).

AVMC: Assault Vehicle Maneuver Corridor; FMP: Fire Management Plan

It is important to consider whether the prevalence of *C. grisea* occurrences in areas with low fire frequencies is a result of the species' inability to become established or persist where fire frequencies are higher, or whether the distribution *C. grisea* may be the result of other factors. The persistence of *C. grisea* in areas subject to periodic fire has been documented in the Impact Areas, where fires are more frequent due to the abundance of ignition sources and where ground surveys to monitor the species have been precluded since 2007 due to safety concerns associated with the presence of unexploded ordnance. Although occurrences of *C. grisea* within the Impact Areas are not included in the abundance and distribution data within this document, as the USFWS noted in the Biological Opinion (USFWS 2008), "Periodic fires have occurred in occupied habitat in Horse Beach Canyon in Impact Area I and China Canyon in Impact Area II. Portions of these canyons that are inhabited by [*C. grisea*] have burned one to three times since 1979, and [*C. grisea*] has persisted and increased under this fire regime in Horse Beach Canyon. Occurrences in China Canyon have not been recently monitored, so effects of the fires on this population are not known." The documented persistence of occurrences and increases in abundance of *C. grisea* in Horse Beach Canyon for approximately 30 years, despite its location within in Impact Area I, suggests that populations are likely to persist into the present within

the Impact Areas, despite an inability to monitor *C. grisea* in these areas.

On San Clemente Island, past grazing and browsing by non-native mammalian herbivores has affected the abundance of vegetation and the balance between native and non-native vegetation. The intense grazing also significantly reduced fire frequency on San Clemente Island as a result of the reduced biomass available for ignition (Westman 1983). While fire is a natural part of these ecosystems, it has been infrequent within the range of *C. grisea*, and therefore a limited amount is known about the species' fire tolerance, survival, and recovery. The Fire Management Plan (US Navy 2009) lists *C. grisea* as a suffrutescent, smaller, short-lived shrub that is killed by fire. Seedling establishment may be fire-stimulated and germination is heat or charate stimulated although a portion of the seed bank will germinate without exposure (Keeley et al. 1985). Observations made following the Canchalagua fire suggest that while adult individuals may be killed by the fire, there was high seedling recruitment after the fire, resulting in a similar number of individuals (US Navy 2002; USFWS 2012). The growth characteristics and distribution of *C. grisea* suggest that it is resilient to at least occasional fire (USFWS 2012). The apparent ability of *C. grisea* to recover after fire and its distribution on the eastern side of the island suggest that it was not significantly impacted by the habitat conversion that occurred on the plateau. With a predominant fire return interval in *C. grisea* occurrences of more than 20 years (see Map 7), fire is not currently a threat to the species.

Map 8 shows fire severity values where they have been recorded. Fire severity is measured on a six-point scale in the US Navy's Fire Management Plan (US Navy 2009), which is based on that used by the National Park Service, in which lower numbers represent more severe fires (Table 8). Notably, only four occurrences of *C. grisea* were within a fire of severity level 3 ("moderately burned"), which was the most severe burn documented in occupied habitat, and most individuals and occurrences in burned areas (2399 individuals in 21 occurrences) were within fires mapped at severity level 4 ("lightly burned, shrubs singed/stressed, many resprout/recover") (see Map 8 and Table 8).

The Navy currently monitors live fuel moisture content of three shrub species on San Clemente Island in accordance with the Fire Management Plan (US Navy 2009; SERG 2014). As fuel moisture decreases, fire danger increases, and the US Navy typically declares fire season and places associated restrictions on training when fuel moisture drops below 200% (SERG 2014). The safeguards currently in place by the US Navy and the documented fire regime demonstrate low fire frequency, long fire return intervals, and limited severity in the range of *C. grisea* (see Maps 6–8) (US Navy 2009).

4. Soil Erosion

Though not noted as a threat to *C. grisea* in the original listing rule of 1977, soil erosion was identified as a threat in the 2007 status review (USFSW 2007). Extensive browsing by feral goats and overgrazing by other non-native herbivores greatly simplified the vegetation composition and significantly reduced the vegetation cover on San Clemente Island, increasing soil erosion (US Navy 2013*a*). Recovery of vegetation and soils on the island is a continuing process evident in residual erosion problems, including soil compaction, de-stabilization of slopes, and reduction of water infiltration (SERG 2015*b*). Following the removal of feral mammalian herbivores in 1991 and the subsequent recovery of vegetation, erosion on the island has decreased significantly. Heavy rainfall is better retained by soils with high vegetation cover and prolific root systems within the soil matrix (SERG 2015*b*). In areas with fine soils, many herbaceous natives have recovered, and on the slopes, subshrubs and herbs have spread,

Table 8. Fire severity classes and definitions, reproduced from the US Navy 2009 Fire Management Plan for San Clemente Island, with severity classes adapted from the National Park Service (1992).

Fire severity class	Effects on litter/duff	Effects on herbs/grasses	Effects on shrubs	Effects on trees
1 Completely Burned	Burned to ash	Burned to ash	Burned to ash, few resprouts	Burned to ash or killed by fire
2 Heavily Burned	Burned to ash	Burned to ash	Burned to ash, some resprouts	Killed by fire or severely stressed
3 Moderately Burned	Burned to ash	Burned to ash	Burned to singed, some resprouts	Crown damage only to smaller trees
4 Lightly Burned	Blackened, but not evenly converted to ash	Burned to ash, some resprouting	Singed/stressed, many resprout/recover	No effect on mature trees, may kill seedlings/saplings
5 Scorched	Blackened	Singed/stressed, many resprout/recover	Not affected, slight stress	No effect on trees
6 Unburned*	–	–	–	–

*Unburned inclusions within a fire should be marked as 6.

while some non-native herbs have declined (Wylie 2012).

On San Clemente Island, accelerated soil erosion resulting from historic and current land use mainly is limited to the heads of canyons, ephemeral drainages, and areas where groundwater seepage has created subsurface channels, referred to as "piping." Piping occurs in clay soils with high shrink-swell potential (US Navy 2013*a*). Areas of piping are unstable from above and prone to collapsing, creating gullies. The majority (98%) of individuals and occurrences of *C. grisea* are located on non-clay soils (Map 3), which are not reportedly prone to piping (USDA 1983). Only 2% of individuals and occurrences of *C. grisea* are located on clay soils. Although piping has been documented on several areas on San Clemente Island, specifically within the AVMAs at the Old Rifle Range and VC-3 (Merkel and Associates, Inc., 2016 and just south of Stone Field Station (US Navy 2013*a*), no soil erosion channels or pipes have been observed in locations occupied by *C. grisea*.

The Navy monitors and evaluates erosion on San Clemente Island and uses multi-year data to assess priorities for remediation (SERG 2006, 2015*b*). Potential soil erosion impacts associated with military training were analyzed in the EIS (US Navy 2008). The analysis focused on areas with the potential for significant erosion due to their designated use for battalion-sized landings, which entail the operation of tracked vehicles and the movement of up to 1500 personnel within the AVMAs, Artillery Firing Points (AFPs), Artillery Maneuver Points (AMPs), and IOA. Because the AVMAs allow for the most extensive off-road movement of tracked vehicles, these areas were anticipated to have the greatest potential impacts from soil erosion as a result of expected reductions in vegetation cover.

To address soil erosion associated with military training, the US Navy included a conservation measure in the EIS to develop an erosion control plan for the AVMAs, AFPs, AMPs, and IOA that would accomplish the following: (1) minimize soil erosion within these training areas and minimize offsite impacts; (2) prevent soil erosion from adversely affecting federally listed or proposed species or their habitats; and (3) prevent soil erosion from significantly impacting other sensitive resources, including sensitive plant and wildlife species and their habitats, jurisdictional wetlands and non-wetland waters, the Area of Special Biological Significance surrounding the island, and cultural resources. The Erosion Control Plan for San Clemente Island (US Navy 2013*a*) was developed in fulfillment of the US Navy's commitment to this conservation measure and received concurrence from the US Fish and Wildlife Service. The plan addresses all elements listed in the conservation measure and incorporates the following specifics: guidelines for the development and application of best management practices to minimize impacts to sensitive resources, including *C. grisea* and its habitat; site-specific erosion control recommendations for areas potentially affected by military operations; guidelines for restriction of vehicle maneuvering when soils are wet; operator education; vegetation management measures; methods to prevent gully development and restore existing gullies; and an adaptive management and monitoring plan to assess and modify BMPs, as needed. Incorporating recommendations from the erosion control plan and working with military operators to determine more precisely how areas would be used resulted in the delineation of unpaved roads to channel vehicle traffic through some portions of the AVMA. This is important because it will reduce loss of vegetation cover and allow for better control of erosion.

Although implementation of the Erosion Control Plan (US Navy 2013*a*) is expected to prevent erosion from adversely affecting listed species, including *C. grisea*, an evaluation of *C. grisea* within AVMA watersheds demonstrates the unlikelihood of erosion impacts to this taxon from military activities. Based on current data, *C. grisea* is known from one occurrence and 29 individuals in the AVMA watersheds (Map 9); therefore, even if the Erosion Control Plan failed to meet its objectives and erosion impacted all AVMA watersheds, just 29 individuals of *C. grisea* would be affected.

Although soil erosion monitoring is relatively recent on San Clemente Island, monitoring reveals that impacts from accelerated soil erosion currently are limited to a small number of specific point sources on San Clemente Island associated with roads, facilities, and training activities, none of which directly impact documented occurrences of *C. grisea*. The majority of *C. grisea* occurrences are located in rocky soils, which offer some stability and protection from erosion. In light of the lack of erosion problems within existing occurrences and the Navy's implementation of the Erosion Control Plan to manage erosion associated with military activities, currently erosion does not pose a threat to *C. grisea*.

FACTOR B: Overutilization for Commercial, Recreational, Scientific or Educational Purposes

There are no documented cases of overutilization of *C. grisea* for commercial, recreational, scientific or educational purposes, and this was not listed as a threat at the time of listing or in subsequent reviews (USFWS 1977, 2007, 2012, 2013). Only small numbers of specimens and seed have ever been collected, and given the current abundance of this taxon, scientific collecting of herbarium specimens and seed banking should be

encouraged. Because the distribution of *C. grisea* is limited to a military training range with restricted access, future utilization will be minimal and poses no apparent threat. As stated in the 2013 final downlisting rule (USFWS 2013), overutilization of *C. grisea* for any purpose is not currently considered a threat nor is expected to be in the future.

FACTOR C: Disease or Predation

Direct predation by non-native herbivores (goats and pigs) was identified as the primary threat to this taxon at the time of listing. This threat has been eliminated with the removal of all non-native herbivores in 1991, and no other predators or diseases on San Clemente Island are known to pose a threat to *C. grisea* now or in the future (USFWS 2012). The predation of *C. grisea* by the native fauna has been little studied. Foliar or floral predation is not apparent, but seed predation is more cryptic, and although difficult to study, it is likely that granivores are eating some quantity of seeds. Some species likely to be consuming *C. grisea* seeds include the introduced Gambel's quail (*Callipepla gambelii*) and Chukar (*Alectoris chukar*); however, seed consumption does not appear to be a threat, and given the high fecundity of this taxon, population-level impacts from granivory are unlikely. The absence of host-specific parasites on *C. grisea* is not surprising, as pathogens are less prevalent in species of restricted range (Gibson et al. 2010). Fungal pathogens such as *Phytophthora* can enter wildlands through restoration efforts and require vigilance; however, *Phytophthora* is not currently documented on San Clemente Island, and the Navy's Biosecurity Plan (US Navy 2016) will help prevent its arrival and the arrival of other potential pathogens.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms was not indicated as a threat to *C. grisea* at the time of listing (USFWS 1977) or in the most recent status review (USFWS 2013). *Castilleja grisea* currently receives regulatory protection under the Endangered Species Act (ESA) as a threatened taxon; however, ESA is not the only regulatory mechanism that affords protection to the species. *Castilleja grisea* also benefits from regulations under the National Environmental Policy Act (NEPA) of 1969 (42 United States Code § 4321 et seq.) and the Sikes Act Improvement Act of 1997 (Sikes Act [as amended]; 16 United States Code § 670a et seq.). In the event that *C. grisea* were removed from the federal endangered species list, these other mechanisms would continue to provide conservation and management benefits. Additionally, if delisted, *C. grisea* would receive strict regulatory protection associated with post-delisting monitoring requirements under ESA for a minimum of five years, which would provide safeguards to detect any unanticipated changes in population trends so appropriate management actions could be implemented.

The National Environmental Policy Act (NEPA) requires federal agencies to consider the environmental impacts of their proposed actions. Section 102 requires federal agencies to incorporate environmental considerations into their planning and decision-making through a systematic interdisciplinary approach. Specifically, federal agencies must evaluate proposed actions that may significantly impact the environment. For each major federal action determined to have significant impacts, federal agencies must prepare an Environmental Impact Statement (EIS) to evaluate the effects of and alternatives to the proposed action. As part of this process, federal agencies are required to solicit public involvement through scoping and public comment periods. Because *C. grisea* occurs exclusively on federal land, NEPA applies to all actions that could impact this taxon, and potential impacts must be evaluated as part of the environmental analysis. The Navy NEPA process is robust in addressing potentially significant impacts to species and their habitats regardless of their listing status under ESA.

The Sikes Act provides additional protection and benefits by requiring the Secretary of Defense to carry out a program for the conservation and rehabilitation of natural resources on military installations. Under the Sikes Act, natural resources management is to be guided by INRMPs, which are developed by each military installation in cooperation with the USFWS and state fish and wildlife agencies who are joint signatories of the documents. Department of Defense policy requires officials with land management responsibilities "to help ensure these natural resources are maintained in the best ecological condition possible to fully support current and future mission requirements" (US Navy 2013). INRMPs are required to take an ecosystem-based approach to natural resources management rather than focusing exclusively on federally listed species. The current San Clemente Island INRMP (US Navy 2013) includes the following objective for *C. grisea*: maintain existing populations and continue recovery efforts, where needed, while avoiding fragmentation of habitat throughout its current distribution (see conservation recommendations below for current recommendations).

In addition to management that specifically focuses on *C. grisea*, this taxon continues to benefit from many INRMP actions implemented island-wide or at the landscape-level, including invasive species management, habitat mapping, island-wide sensitive plant surveys, fire management (based on the San Clemente Island Wildland Fire Management Plan [US Navy 2009]), long

term vegetation trend analysis, and annual and perennial grassland management. Thus, even if the protections afforded by ESA were removed, the adequacy of regulatory mechanisms does not pose a threat to *C. grisea*.

FACTOR E: Other Natural or Human-Caused Factors Affecting Its Continued Existence

The final downlisting rule (USFWS 2013) lists other threats attributable to Factor E as including: (1) movement of vehicles and troops, (2) fire and (3) climate change. Threats were noted to be either of unknown magnitude (climate change), of low likelihood (hybridization), or reduced through conservation measures implemented by the Navy (fire and military activities).

1. Movement of vehicles and troops – see Factor A for a detailed review of land use and associated threats.

2. Fire—see Factor A for a detailed summary of individual and habitat responses to fire.

3. Climate change

In southern California, climate change generally is expected to result in drier and warmer conditions, with high inter-annual stochasticity and overall declines in mean seasonal precipitation (Cayan et al. 2012). Sea level may rise between 0.9 and 1.4 meters (Cayan et al. 2012), which would not directly affect *C. grisea* occurrences, but coastal ecosystem dynamics would be altered, and indirect effects are hard to predict.

Along the California coast and Channel Islands, the Pacific Ocean moderates air temperatures at low altitudes and contributes to the formation of low-level temperature inversions, in which air temperature increases with altitude. Such inversions stimulate the formation of low coastal cloud cover, also known as the marine layer, which is manifested as fog if cloud elevations are low enough. Many species are restricted to the fog belt, where low coastal cloud cover has been documented to reduce drought stress on plants through shading and fog drip (Fischer et al. 2009). The marine layer has a strong influence on coastal ecosystems, and it is an important component of weather on San Clemente Island (US Navy 2013). Fog is hypothesized to provide somewhat of a climate refugium by buffering species from extinction brought on by climatic change, as evidenced by the elevated levels of endemism along the coast of Baja California and on the Channel Islands (Vanderplank 2013; Vanderplank and Ezcurra 2015). Climate on the Channel Islands continues to support paleoendemic plants, such as *Lyonothamnus*, which once was widespread in the southwest of North America (Raven and Axelrod 1978) and is thought to have been extirpated on the mainland as conditions became warmer and drier (Bushakra et al. 1999).

Despite the importance of low coastal cloud cover and fog, these phenomena are poorly addressed in climate change models (Qu et al. 2014), and it is difficult to project their future conditions. Coastal fog has been decreasing in southern California, possibly due to urbanization (Williams et al. 2015) and possibly due to climate change (Johnstone and Dawson 2010; LaDochy and Witiw 2012). Warming projections in California, particularly the possibility that the interior will experience greater warming than the coast (Cayan et al. 2008), suggest that the fate of coastal fog is uncertain (Lebassi-Habtezion et al. 2011). However, work by Iacobellis and Cayan (2013), which estimated the strength of low-level temperature inversions from climate change models, showed increasing trends in all seasons through the end of the century (confirmed using two different approaches to the estimation), suggesting that the marine layer is likely to persist and may even increase. Such a scenario would moderate the effects of climate change on the Channel Islands and would be expected to reduce its potential threat to island plants, including *C. grisea*.

Castilleja grisea occurs in a wide range of habitats on San Clemente Island. Because it does not have a particularly narrow niche and has ample genetic diversity (Helernurm et al. 2005), *C. grisea* is expected to be somewhat resilient to climate change, particularly given the buffering effect of a persistent marine layer.

7.0 RECENT CONSERVATION ACTIONS

The US Navy has a long-term commitment to conservation of its natural resources, with particular focus on its state and federally listed species (US Navy 2013). The US Navy has continued to adopt effective policies for the protection and restoration of endangered species on San Clemente Island and the integrated management of the island's natural resources. Successes are clearly evidenced in the recovery and self-sustaining occurrences of *C. grisea*. Significant conservation actions that have influenced the recovery and expansion of *C. grisea* on San Clemente Island are addressed in the INRMP (US Navy 2013) and are summarized below:

- Feral goat removal
- Annual rare plant surveys
- Genetic research
- Vegetation and habitat mapping
- Long term vegetation trend analysis
- Annual invasive plant control
- Native habitat restoration

- Annual and perennial grassland management
- Soil erosion monitoring and control
- Wildland fire management
- Fire studies

7.1 *Conservation Status*

- Current individual and population numbers (336 occurrences, and 31,694 individuals) suggest that the status warrants revision at many levels (see Table 3, Section 6).
- No criteria for delisting *C. grisea* and no quantifiable goals were established in the 1984 species recovery plan.
- The recovery plan states that *C.grisea* can be considered recovered when sufficient habitat has been restored on San Clemente Island to support viable, self-sustaining populations and when management and use of habitat is such that survivability of the populations is assured.
- At this time, *C. grisea* is not likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
- *C. grisea* is increasing in abundance and not rare throughout its range; therefore, its current federal and state listing statuses no longer appear to be warranted.
- *C. grisea* may no longer meet the criteria of a S3 or G3 (G4T3) taxon and should be reviewed.
- CNPS proposed to change the status of *C. grisea* from California Rare Plant Rank (CRPR) 1B to 4 (limited distribution/watchlist) in 2013 (Slakey et al. 2013), and intends to re-evaluate its CRPR status again, along with several other island endemics that have made a significant recovery in recent years (Aaron Sims, CNPS Rare Plant Botanist, pers. comm. 2018). California Rare Plant Rank 1B plants meet the definitions of the California Endangered Species Act of the California Department of Fish and Game Code and are eligible for state listing. Most of the plants that are ranked 1B have declined significantly over the last century (CNPS 2017), yet *C. grisea* has increased significantly in the last 20 years and is no longer rare throughout its range.

7. 2 *Conservation Recommendations*

Castilleja grisea is currently in a strong conservation state, unlikely to become endangered within the foreseeable future throughout all or a significant portion of its range. In keeping with the INRMP, it is recommended that the US Navy continue the conservation actions listed in Section 7.0. Additional conservation actions expected to benefit *C. grisea* could include:

- Banking seed of *C. grisea* collected throughout the range of the taxon could serve as a valuable ex-situ conservation resource. The single seed bank accession of *C. grisea* at RSABG was collected in 1989 and contains 6622 seeds (Cheryl Birker, Seed Curator, RSABG, pers. comm. 2017).

8.0 CONCLUSION

The recovery of *C. grisea* is remarkable in number of individuals and occurrences. *Castilleja grisea* is now broadly distributed throughout San Clemente Island and has increased from 19 occurrences at the time of listing to more than 336 occurrences and 31,694 individuals based on surveys from 2011 through 2012. Although specific quantifiable recovery goals for *C. grisea* were never identified in its recovery plan, the taxon's current abundance and distribution and the increasing trend in both indicate continuing recovery and recolonization.

The numbers of individuals and occurrences of *C. grisea* now exceed those for which conservation concern is warranted. Because the Navy has effectively addressed potential threats such that no apparent factors inhibit the taxon's range or recruitment, there is minimal risk to the current population of *C. grisea.* Although indirect effects from historical impacts to natural resources on the island from overgrazing by non-native mammals may challenge the speed of continued recovery of *C. grisea*, they have not proven to be a barrier to range expansion and population increases. Based on the taxon's abundance and distribution and the five-factor analysis of threats to its recovery, delisting under ESA appears appropriate for *C. grisea.* It should also be evaluated by CNPS for downranking from California Rare Plant Rank 1B to 4 to reflect its current status.

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REFERENCES CITED

[SERG Annual Reports: years followed by * are the years of the report data—exact date of finalization unknown.]

ADLER, L. S., 2003. Host species affects herbivory, pollination, and reproduction in experiments with parasitic *Castilleja*. *Ecology* **84**: 2083–2091.

ALLAN, G. C. 1999. Molecular systematic and biogeographic studies of the temperate herbaceous papilionoid tribes Loteae and Coronilleae (Fabaceae: Faboideae). PhD Dissertation, Claremont Graduate University, California.

ANDERSON, A. V. R AND R. J. TAYLOR. 1983. Patterns of morphological variation in a population of mixed species of *Castilleja* (Scrophulariaceae). *Syst. Bot.* **8**: 225–232. *doi:10.2307/2418476.*

ATSATT, P. R. AND D. R. STRONG. 1970. The population biology of annual grassland hemiparasites. I. The host environment. *Evolution* **24**: 278–291.

BRENNAN, T. J. AND J. E. KEELEY. 2015. Effect of mastication and other mechanical treatments on fuel structure in chaparral. *Int. J. Wildland Fire* **24**: 949–963.

BRUCE, S. C. 1994. A historical geography of San Clemente Island 1542–1935. M.A. Thesis, University Scholars Program, California State University Long Beach. [On file, Navy Region Southwest Environmental Department, Fleet ASW Training Center, San Diego, CA].

BUSHAKRA, J. M., HODGES, S. A., COOPER, J. B. AND D. D. KASKA. 1999. The extent of clonality and genetic diversity in the Santa Cruz Island ironwood, *Lyonothamnus floribundus*. *Molec. Ecol.* **8**: 471–475.

CADFW [CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE RAREFIND] 2019. *https://map.dfg.ca.gov/rarefind/view/RF_FieldDescriptions.htm* (accessed 31 Jan 2019).

CATFORD, J. A., R. JANSSON AND C. NILSSON. 2009. Reducing redundancy in invasion ecology by integrating hypotheses into a single theoretical framework. *Diversity and Distrib.* **15**: 22–40.

CAYAN, D. R., E. P. MAURER, M. D. DETTINGER, M. TYREE AND K. HAYHOE. 2008. Climate change scenarios for the California region. *Climatic Change* **87**: 21–42.

CAYAN, D., M. TYREE, D. PIERCE AND T. DAS. 2012. Climate change and sea level rise scenarios for California vulnerability and adaptation assessment. *California Energy Commission Publication CEC-500-2012-008*.

CHUANG, T. I. AND L. R. HECKARD. 1993. Chromosome numbers of neotropical *Castilleja* (Scrophulariaceae: tribe Pedicularеae) and their taxonomic implications. *Ann. Missouri Bot. Gard.* **80**: 974–986.

DESIMONE, S. A. AND P. H. ZEDLER. 2001. Do shrub colonizers of southern Californian grassland fit generalities for other woody colonizers? *Ecol. Applic.* **11**: 1101–1111.

CCH [CONSORTIUM OF CALIFORNIA HERBARIA]. 2017. *http://ucjeps.berkeley.edu/consortium/* (accessed 16 Jan 2017).

CNDDB [CALIFORNIA NATURAL DIVERSITY DATABASE]. 2017. *https://map.dfg.ca.gov/rarefind/view/RareFind.aspx* (accessed 9 Jan 2017).

CNPS [CALIFORNIA NATIVE PLANT SOCIETY]. 2017. *http://www.cnps.org/cnps/rareplants/ranking.php* (accessed 16 Jan 2017).

———. 2019. Glossary of terms. *http://www.rareplants.cnps.org/glossary.html* (accessed 31 Jan 2019).

CNPS RARE PLANT PROGRAM. 2018. Inventory of rare and endangered plants of California (online edition, v8-03 0.39). *http://www.rareplants.cnps.org* (accessed 15 Oct 2018).

DUNKLE. M. B. 1943. Three new plants from San Clemente Island. Contributions from the Los Angeles Museum-Channel Islands Biological Survey. *Bull. S. Calif. Acad. Sci.* **42**: 31.

ELIASON, S. A. AND E. B. ALLEN. 1997. Exotic grass competition in suppressing native shrubland re-establishment. *Restorat. Ecol.* **5**: 245–255.

FISCHER, D. T., C. J. STILL AND A. P. WILLIAMS. 2009. Significance of summer fog and overcast for drought stress and ecological functioning of coastal California endemic plant species. *J. Biogeogr.* **36**: 783–799.

HECKARD, L. R. 1962. Root parasitism in *Castilleja*. *Bot. Gaz.* **124**: 21–29.

HELENURM, K., R. WEST AND S. J. BURCKHALTER. 2005. Allozyme variation in the endangered insular endemic *Castilleja grisea*. *Ann. Bot. (Oxford)* **95**: 1221–1227.

IACOBELLIS, S. F. AND D. R. CAYAN. 2013. The variability of California summertime marine stratus: impacts on surface air temperatures. *Journal of Geophysical Research: Atmospheres* **118**: 9105–9122.

JOHNSTONE, J. A. AND T. E. DAWSON. 2010. Climatic context and ecological implications of summer fog decline in the coast redwood region. *Proc. Natl. Acad. Sci. U.S.A.* **107***:* 4533–4538.

JUNAK, S. 2006. Sensitive plant status survey Naval Auxiliary Landing Field, San Clemente Island, California. Draft Final Report. Prepared for Department of the Navy Southwest Division, Naval Facilities Engineering Command, and Natural Resources Office, Commander, Navy Region Southwest San Diego, California. Letter of Agreement No. N68711-02-LT-00036. Santa Barbara Botanic Garden Technical Report, December.

JUNAK, S. A. AND D. H. WILKEN. 1998. Sensitive Plant Status Survey, Naval Auxiliary Landing Field, San Clemente Island, California. Final Report. Santa Barbara Botanic Garden Technical Report No. 1 prepared for Department of the Navy, Southwest Division, San Diego, California.

KEEGAN, D. R., B. E. COBLENTZ AND C. S. WINCHELL. 1994. Feral goat eradication on San Clemente Island, California. *Wildlife Society Bulletin* **22**: 56–61.

KEELEY, J. E., B. A. MORTON, A. PEDROSA AND P. TROTTER. 1985. Role of allelopathy, heat and charred wood in the germination of chaparral herbs and suffrutescents. *J. Ecol.* **73**: 445–458.

LADOCHY, S. AND M. WITIW. 2012. The continued reduction in dense fog in the southern California region: Possible causes. *Pure and Applied Geophysics* **169**: 1157–1163.

LEBASSI-HABTEZION, B., J. GONZÁLEZ AND R. BORNSTEIN. 2011. Modeled large-scale warming impacts on summer California coastal-cooling trends. *Journal of Geophysical Research: Atmospheres, 116* (D20). *https://doi.org/10.1029/2011JD015759.*

MARVIER, M. A. 1996. Parasitic plant-host interactions: plant performance and indirect effects on parasite-feeding herbivores. *Ecology* **77**: 1398–1409.

——— AND D. L. SMITH. 1997. Conservation implications of host use for rare parasitic plants. *Conservation Biol.* **11**: 839–848.

MAULDIN, E. A. AND J. PETERS-KENNEDY. 2016. Chapter 6: Integumentary system, pp. 509–736. *In* M. G. Maxie and W. B. Saunders [eds.], Jubb, Kennedy and Palmer's pathology of domestic animals: vol. 1 (6th ed.). Elsevier, St. Louis, Missouri.

MAYR, E. 1942. Systematics and the origin of species. Columbia Univ. Press, New York.

MERKEL AND ASSOCIATES, INC. 2016. San Clemente Island (SCI) waters of the U.S. Jurisdictional Delineation of the Assault Vehicle Maneuver Corridor (AVMC) for the implementation of erosion control. Draft delineation of jurisdictional resources report and biological constraints analysis. 134 p.

MULLER, R. N. AND S. A. JUNAK. 2011. *Castilleja grisea*—Literature Review. Draft Report prepared for the Naval Facilities Engineering Command Southwest, San Diego, California.

MUNZ, P. A. 1958. California Miscellany (IV). *Aliso: A Journal of Systematic and Evolutionary Botany* **4**: 87–100.

———. 1974. A flora of southern California. University of California Press, Berkeley. 1086 p.

NATIONAL PARK SERVICE. 1992. Western Region fire monitoring handbook. Prepared by the Western Region Prescribed and Natural Fire Monitoring Task Force, San Francisco, California.

NATURESERVE 2019. *http://www.natureserve.org/conservation-tools/conservation-status-assessment* (accessed 31 Jan 2019).

QU, X., A. HALL, S. A. KLEIN AND P. M. CALDWELL. 2014. On the spread of changes in marine low cloud cover in climate model simulations of the 21st century. *Climate Dynamics* **42**: 2603–2626.

RAVEN, P. H. AND D. I. AXELROD. 1978. Origin and relationships of the California flora. *Univ. Calif. Publ. Bot*., vol. 72. 134 p.

SCHOENHERR, A. A., C. R. FELDMETH AND M. J. EMERSON. 1999. Natural history of the islands of California. University of California Press, Berkeley. 491 p.

SERG [Soil Ecology and Restoration Group]. 2006. Soil erosion control and habitat restoration plan on NALF San Clemente Island; prepared by: SERG, San Diego State University (Kim M. Klementowski, Thomas A. Zink). 46 p.

———. 2012*. 2012 Annual Report, San Clemente Island Native Habitat Restoration Program: seed collection, propagation and outplanting in support of San Clemente Island Endangered Species Programs. Prepared by SERG, San Diego State University (Emily Howe, Korie Merrill, Thomas A. Zink). 47 p.

———. 2014. Fire Management Plan Implementation Report. Naval Base Coronado Natural Resource Management: SCI Grassland Restoration, SCI Fire Management Plan Implementation, SCI Rare Plant Surveys and NBC Sensitive Species Habitat Management. Prepared by SERG, San Diego State University (Emma Havstad, Emily Howe). 17 p.

———. 2015*. 2015. Annual Report, San Clemente Island Native Habitat Restoration Program: seed collection, propagation and outplanting in support of San Clemente Island Endangered Species Programs. Prepared by SERG, San Diego State University (Emma Havstad, Stephanie Calloway, Thomas A. Zink). 79 p.

———. 2015*a*. Pollinator report. NSCI Botany Management Program, Final Report for Component 2: pollinator survey of listed plants on SCI. Prepared by Erin W. Rankin and C. Sheena Sidhu for SERG, San Diego State University. 1 p.

———. 2015*b*. Erosion control re-survey on NALF San Clemente Island. Prepared by SERG, San Diego State University (Emma Havstad, Derrick Mathews, Thomas A. Zink). 65 p.

SLAKEY, D., A. SIMS, R. BITTMAN AND K. GROSS. 2013. Rare plant status review: *Castilleja grisea*—proposed rank change from 1B.2, G3/S3 to 4.2, G3/S3. Rare Plant Program report, 10 Jan 2013 and 19 Feb 2013. California Native Plant Society, Sacramento. 4 p.

STRATTON, L. C. 2005. Santa Catalina Island experimental restoration trials: developing appropriate techniques, pp. 213–227. *In* D. K. Garcelon and C. A. Schwemm [eds.], Proceedings of the 6th California Islands Symposium, Ventura. California, 1–3 Dec 2003. National Park Service Technical Publication CHIS-05-01. Institute for Wildlife Studies, Arcata, California.

SWARD, W. L. AND R. H. COHEN. 1980. Plant community analysis of San Clemente Island. Report to Naval Ocean Systems Center, San Diego, California.

U.S. FISH AND WILDLIFE SERVICE [USFWS]. 1977. Determination that seven California Channel Island animals and plants are either endangered species or threatened species [endangered: San Clemente loggerhead shrike, *Lanius ludovicianus mearnsi*; San Clemente broom, *Lotus scoparius* ssp. *traskiae*; San Clemente bushmallow, *Malacothamnus clementinus*; San Clemente Island larkspur, *Delphinium kinkiense*; San Clemente Island Indian paintbrush, *Castilleja grisea*. Threatened: island night lizard, *Klauberina riversiana*; San Clemente sage sparrow, *Amphispiza belli clementeae*]. *Fed. Reg*. **42**: 40682–40685.

———. 1984. Recovery plan for the endangered and threatened species of the California Channel Islands. USFWS Portland, Oregon. 179 p.

———. 2007. *Castilleja grisea* 5-Year Review: summary and evaluation U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office, California, September 2007.

———. 2008. Biological Opinion, U.S. Fish and Wildlife Service. San Clemente Island Military Operations and Fire Management Plan. Los Angeles, California. 244 p.

———. 2011. Endangered and threatened wildlife and plants; 90-day finding on a petition to delist or reclassify from Endangered to Threatened six California species. *Fed. Reg*. **76**: 3069–3074.

———. 2012. 12-month finding on a petition to downlist three San Clemente Island plant species; proposed rule to reclassify two San Clemente Island plant species; taxonomic correction; proposed rule. *Fed. Reg*. **77**: 29077–29128.

———. 2013. Reclassification of *Acmispon dendroideus* var. *traskiae* (= *Lotus d*. subsp. *traskiae*) and *Castilleja grisea* as Threatened throughout their ranges. Final Rule. *Fed. Reg*. **78**: 45405–45439.

USDA [United States Department of Agriculture]. 1983. Soil survey of Channel Islands Area San Clemente Island Part Interim Report. USDA Soil Conservation Service. Prepared by David C. Estrada. 174 p.

US NAVY. 2002. Integrated Natural Resources Management Plan (INRMP) Naval Auxiliary Landing Field, San Clemente Island, California. Prepared by Tierra Data Systems. 784 p.

———. 2006. Programmatic Terrestrial Biological Assessment for the San Clemente Island Range Complex, September 2006 Final. Commander Navy Region Southwest, San Diego, California.

———. 2008. Southern California Range Complex; Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement, vol 1. (1026 p.) and vol. 2 (962 p.).

———. 2009. San Clemente Island Wildland Fire Management Plan **(**May 2009). Prepared by Tierra Data Inc. and Firewise 2000. 588 p.

———. 2013. Integrated Natural Resources Management Plan (INRMP) Naval Auxiliary Landing Field, San Clemente Island, California. Prepared by Tierra Data Inc. 784 p.

———. 2013*a*. Final erosion control plan for San Clemente Island. Prepared by SAIC. 65 p.

———. 2016. Naval Auxiliary Landing Field San Clemente Island Biosecurity Plan. Prepared by ManTech SMS Technologies Inc. 137 p.

———. 2017. Updated botanical survey results for three federally listed plants on San Clemente Island: *Acmispon dendroideus* var. *traskiae*, *Castilleja grisea* and *Delphinium variegatum* var. *kinkiense*. Prepared by Sula Vanderplank, Kimberly O'Connor, Bryan Munson and Tierra Data, Inc. 33 p.

VANDERPLANK, S. 2013. Endemism in an ecotone: from chaparral to desert in Baja California, Mexico, pp. 205–218. *In* C. Hobhom [ed.] 2013. Endemism in vascular plants. Springer-Verlag, Dordrecht, The Netherlands. 348 p.

VANDERPLANK, S. E. AND E. EZCURRA. 2015. How marine influence controls plant phenological dynamics in Mediterranean Mexico. *J. Pl. Ecol.* **9**: 410–420. *doi: 10.1093/jpe/rtv066*.

VILÀ, M., J. L. ESPINAR, M. HEJDA, P. E. HULME, V. JAROŠÍK, J. L. MARON, J. PERGL, U. SCHAFFNER, Y. SUN AND P. PYŠEK. 2011. Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities and ecosystems. *Ecol. Letters* **14**: 702–708.

WETHERWAX, M., T. I. CHUANG AND L. R. HECKARD. 2012. *Castilleja*. Jepson eFlora. *http://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=11347* (accessed 28 June 2017.)

WESTMAN, W. E. 1983. Island biogeography: studies on the xeric shrublands of the inner Channel Islands, California. *J. Biogeogr.* **10**: 97–118.

WILLIAMS, A. P., R. E. SCHWARTZ, S. IACOBELLIS, R. SEAGER, B. I. COOK, C. J. STILL, G. HUSAK AND J. MICHAELSEN. 2015. Urbanization causes increased cloud base height and decreased fog in coastal Southern California. *Geophysical Research Letters* **42**: 1527–1536. *doi: 10.1002/2015GL063266*.

WYLIE, D. D. J. 2012. Vegetation change on San Clemente Island following the release from feral grazing pressure. M.A. Thesis, Department of Geography, San Diego State University, California. 77 p.

YATSKO, A. AND M. L. RAAB. 2009. San Clemente Island, pp. 23–39. *In* L. M. Raab, J. Cassidy, A. Yatsko and W. J. Howard, California maritime archaeology. A San Clemente Island perspective. AltaMira Press, Lanham, Maryland.

APPENDIX 1

Full table of CNDDB Element Occurrences (EOs) of *Castilleja grisea* (accessed January 2017; last updated 11 Dec 2012).

EO number	Elevation	Latitude	Longitude	Threat list	Threat	Last update
1	300	32.82557	-118.3634			28 Nov 2012
2	500	32.83722	-118.37317			28 Nov 2012
3		32.8962	-118.45218	Improper burning regime; erosion/ runoff	Existing erosion, some plants burned	28 Nov 2012
13	300	32.93793	-118.50223			28 Nov 2012
14	500	32.95286	-118.51596			28 Nov 2012
17		32.84589	-118.45766			28 Nov 2012
19	1500	32.87003	-118.46493			28 Nov 2012
20	1200	32.87178	-118.47922	Improper burning regime	Some plants destroyed in fire	28 Nov 2012
22	1200	32.88446	-118.49201			13 Jul 2012
24	1200	32.87855	-118.48963			28 Nov 2012
25		32.82727	-118.41856			28 Nov 2012
26	600	32.85119	-118.47619			28 Nov 2012
28	300	32.82326	-118.42502			28 Nov 2012
29	100	32.84311	-118.3781			9 Jul 2012
34	850	32.83758	-118.40687			5 Sep 1996
36	300	32.82742	-118.43339			9 Jul 2012
38	1600	32.86465	-118.45113			9 Jul 2012
40	1750	32.88235	-118.45399			11-Dec-2012
42	1600	32.88342	-118.47109			11-Dec-2012
43	350	32.91151	-118.53003			11-Dec-2012
50	1300	32.85893	-118.41979			28 Nov 2012
52	800	32.83598	-118.44293			28 Nov 2012
53	975	32.84472	-118.40361			28 Nov 2012
55	250	32.95613	-118.55205			28 Nov 2012
56	100	32.9491	-118.54919			28 Nov 2012
57	450	32.94117	-118.54289			28 Nov 2012
58	150	32.93517	-118.54357			28 Nov 2012
59	25	32.93128	-118.54666			10 Jul 2012
60	200	32.94338	-118.50605			28 Nov 2012
61	200	32.91877	-118.5393			28 Nov 2012
62	1000	32.91909	-118.51907			28 Nov 2012
63	1300	32.90185	-118.49379			28 Nov 2012
64	1500	32.89733	-118.48725			28 Nov 2012
65	500	32.87036	-118.49715			29 Nov 2012
66	300	32.85866	-118.48751			29 Nov 2012
67	1000	32.85409	-118.46499			29 Nov 2012
68	550	32.9639	-118.52911			11 Jul 2012
69	100	32.95923	-118.55609			29 Nov 2012

APPENDIX 2

Occurrences included in the 2012 proposal (USFWS 2012) and the final rule to downgrade *Castilleja grisea* from endangered to threatened (USFWS 2013), including the value of the military areas where it occurred and the documented threats at that time. Element Occurrence (EO) numbers at the time of the petition to downlist (16 May 2012; USFWS 2012) are indicated where available. Locations are arranged in clock-wise order, starting with the first canyon south of the Shore Bombardment Area boundary on the SE side of San Clemente Island.

Location description	EO #; Point Locations (PLs)	Status at listing; year of first record; current status (reference)	Military value	Current threats
Thirst Canyon (including Vista Canyon)	EO 10, 11, 40; 21 PLs	Extant; 1980 CNDDB; Extant (SERG 2010)	Medium	A: Non-native, Fire; E: Climate
Eagle Canyon (including Grove Canyon)	EO 7, 30; 50 PLs	Extant; 1979 herbarium record; Extant (Tierra Data 2006)	Low; area recently closed	A: Land Use, Erosion, Non-native, Fire; E: Movement, Climate
Bryce Canyon	EO 3, 8, 47; 43 PLs	Extant; 1979 GIS data; Extant (SERG 2010)	Low; area recently closed	A: Land Use, Erosion, Non-native, Fire; E: Movement, Climate
Canchalagua Canyon (including south Mosquito Cove and Matriarch Canyon)	EO 4, 27; 56 PLs	Extant; 1963 herbarium record; Extant (SERG 2011)	Low; area recently closed	A: Land Use, Erosion, Non-native, Fire, Fire Management; E: Movement, Climate
Knob Canyon	EO 2, 49; 21 PLs	Extant; 1979 CNDDB; Extant (Tierra Data 2006, SERG 2008)	Low; area recently closed	A: Land Use, Erosion, Non-native, Fire, Fire Management; E: Movement, Climate
Pyramid Head	EO 1, 15; 25 PLs	Extant; 1965 herbarium record; Extant (SERG 2011)	High; partially recently closed	A: Land Use, Erosion, Non-native, Fire; E: Movement, Climate
Snake Canyon (including Sun Point)	EO 23; 4 PLs	Extant; 1939 CNDDB; Presumed Extant (Junak 1997)	High; area closed	A: Non-native, Fire; E: Fire, Climate
Upper Chenetti Canyon	EO 34; 1 PL	Unknown; –; Extant (Junak 2004)	High; area closed	A: Non-native, Erosion, Fire, Fire Management; E: Fire, Climate
Horse Beach Canyon	EO 33, 35; 49 PLs	Extant; 1939 herbarium record; Presumed Extant (Junak 2005)	High; area closed	A: Land Use, Erosion, Non-native, Fire, Fire Management; E: Movement, Fire, Climate
China Canyon	EO 25, 37, 46; 6 PLs	Extant; 1939 herbarium record; Presumed Extant (Junak 1997; SERG 2009)	High; area closed	A: Land Use, Erosion, Non-native, Fire, Fire Management; E: Movement, Fire, Climate
Red Canyon	EO 36; no PLs	Extant; 1975 herbarium record; Presumed Extant (CNDDB 1986)	High; area closed	A: Land Use, Erosion, Non-native, Fire, Fire Management; E: Movement, Fire, Climate
Kinkipar Canyon	No EO; 2 PLs	Unknown; –; Extant (SERG 2006)	Medium	A: Non-native, Fire; E: Climate
Cave Canyon	EO 17, 18, 45; 9 PLs	Extant; 1980 CNDDB; Extant (SERG 2009)	Medium	A: Non-native, Fire; E: Climate

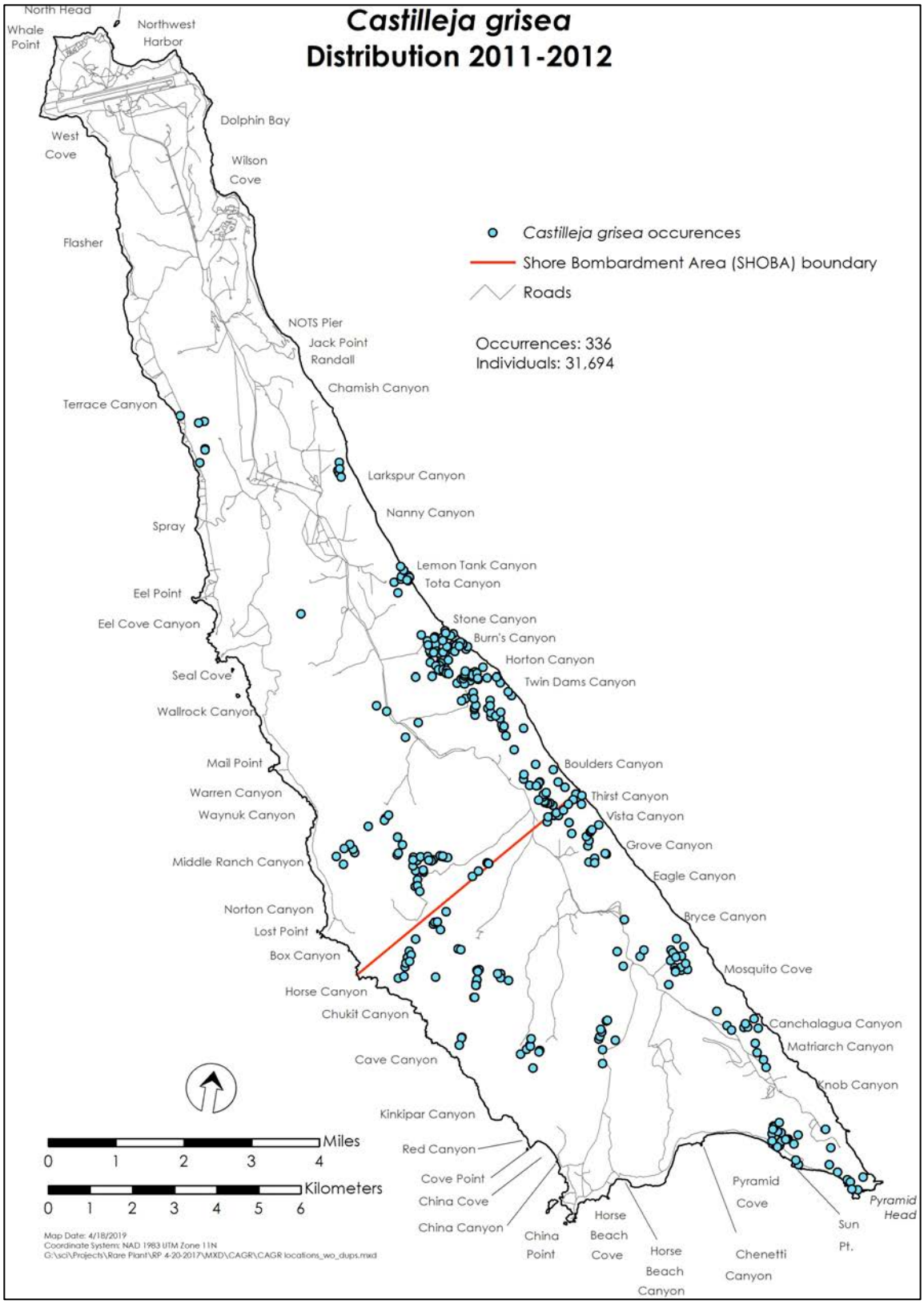
Appendix 2 Continued

Location description	EO #; Point Locations (PLs)	Status at listing; year of first record; current status (reference)	Military value	Current threats
Horse Canyon	No EO; 6 PLs	Unknown; –; Extant (SERG 2010)	Medium	A: Non-native, Fire; E: Climate
Upper Horse Canyon	EO 19, 39; 1 PL	Extant; 1979 CNDDB; Extant (Junak 2004)	Medium	A: Erosion, Non-native, Fire; E: Climate
SHOBA Boundary (north to—and including—Twin Dams Canyon)	EO 31; 55 PLs	Extant; 1965 CNDDB; Extant (Junak 2006, SERG 2011)	Medium	A: Non-native; E: Climate
Horton Canyon (including Stone and Burn's Canyons)	EO 12, 44; 24 PLs	Extant; 1981 CNDDB; Extant (Junak 2006, SERG 2010)	Medium	A: Erosion, Non-native; E: Climate
Lemon Tank Canyon (including Tota Canyon)	No EO; 14 PLs	Unknown; –; Extant (SERG 2010)	Low; area closed	A: Land Use, Erosion, Non-native, Fire; E: Movement, Fire, Climate
Nanny Canyon	EO 13; 3 PLs	Extant; 1979 CNDDB; Extant (Junak 2004)	Low; area partially closed	A: Non-native; E: Movement, Climate
Larkspur Canyon (including Chamish Canyon)	EO 14, 48; 15 PLs	Extant; 1981 CNDDB; Extant (SERG 2006–2011)	Low	A: Land Use, Erosion, Non-native, Fire; E: Movement, Fire, Climate
Box Canyon	EO 20, 41; 22 PLs	Extant; 1979 CNDDB; Extant (SERG 2011)	Low	A: Non-native; E: Climate
Upper Norton Canyon	EO 21; 6 PLs	Extant; 1979 CNDDB; Extant (SERG 2011)	Low	A: Non-native; E: Climate
Middle Ranch Canyon	EO 24; 8 PLs	Extant; 1981 CNDDB; Extant (SERG 2008)	Low	A: Non-native; E: Climate
Waymuck Canyon	EO 22; 1 PL	Unknown; –; Extant (Junak 2004)	High	A: Non-native; E: Climate
Plain northeast of Warren Canyon	No EO; 4 PLs	Unknown; –; Extant (Tierra Data 2007)	Medium	A: Land Use, Erosion, Non-native; E: Movement, Climate
Seal Cove Terraces	EO 43; 2 PLs	Unknown; –; Extant (CNDDB 1985, SERG 2010)	High	A: Erosion, Non-native, Fire; E: Movement, Fire, Climate
Eel Cove Canyon (including terraces)	No EO; 3 PLs	Unknown; –; Extant (Junak 2004)	High	A: Non-native, Fire; E: Movement, Fire, Climate
Terrace Canyon (south to terraces around Spray)	No EO; 6 PLs	Unknown; –; Presumed Extant (SERG 2004)	High	A: Erosion, Non-native; E: Movement, Climate
West Cove	No EO; 3 PLs	Unknown; –; Extant (Tierra Data 2006)	Medium	A: Land Use, Erosion, Non-native; E: Movement, Climate

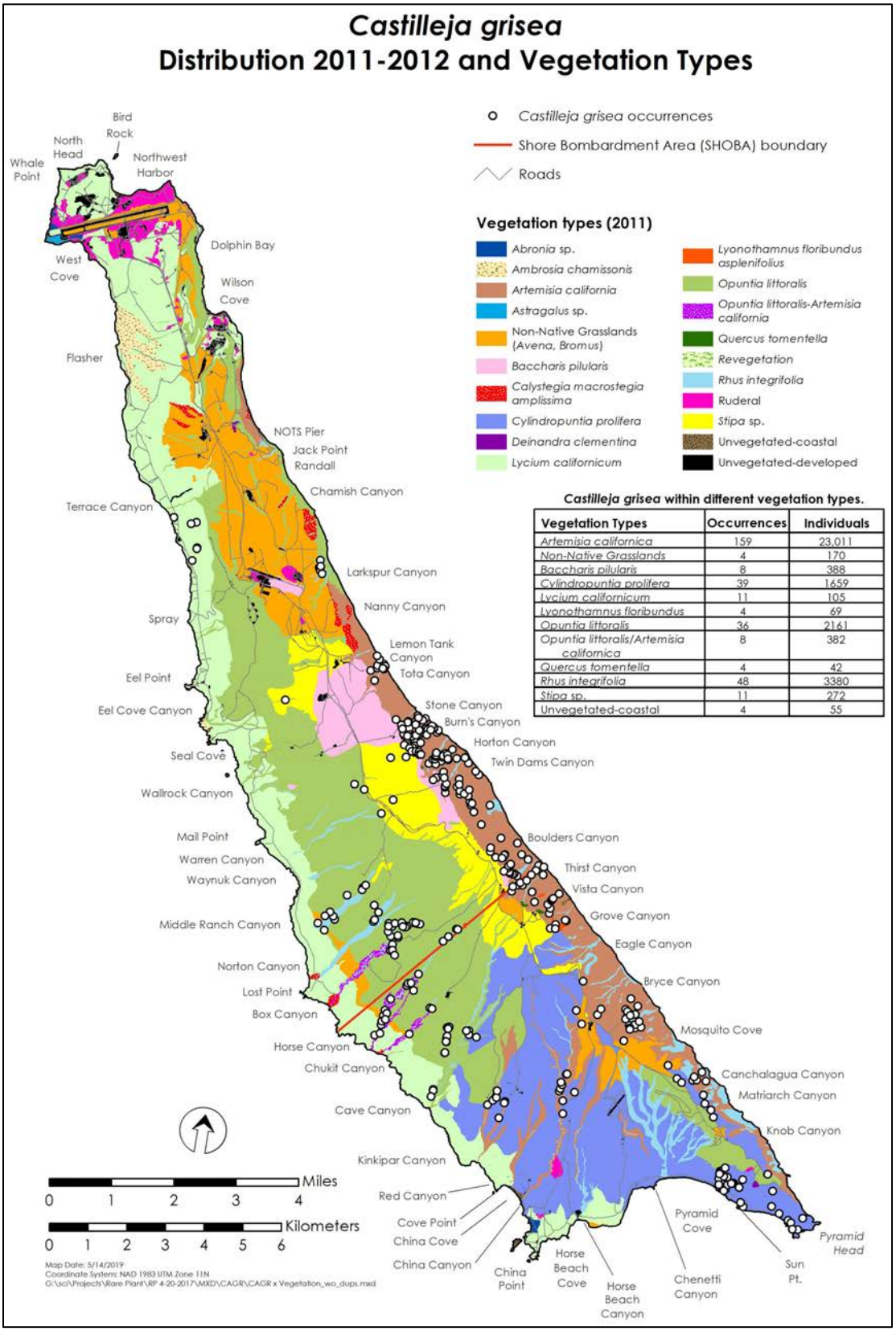
APPENDIX 3

List of Department of the Navy Acronyms:

AFP: Artillery Firing Point; AMP: Artillery Maneuver Point; AVMA: Assault Vehicle Maneuver Area; INRMP: Integrated Natural Resources Management Plan; IOA: Infantry Operations Area; SHOBA: Shore Bombardment Area; TAR: Training Area Range.



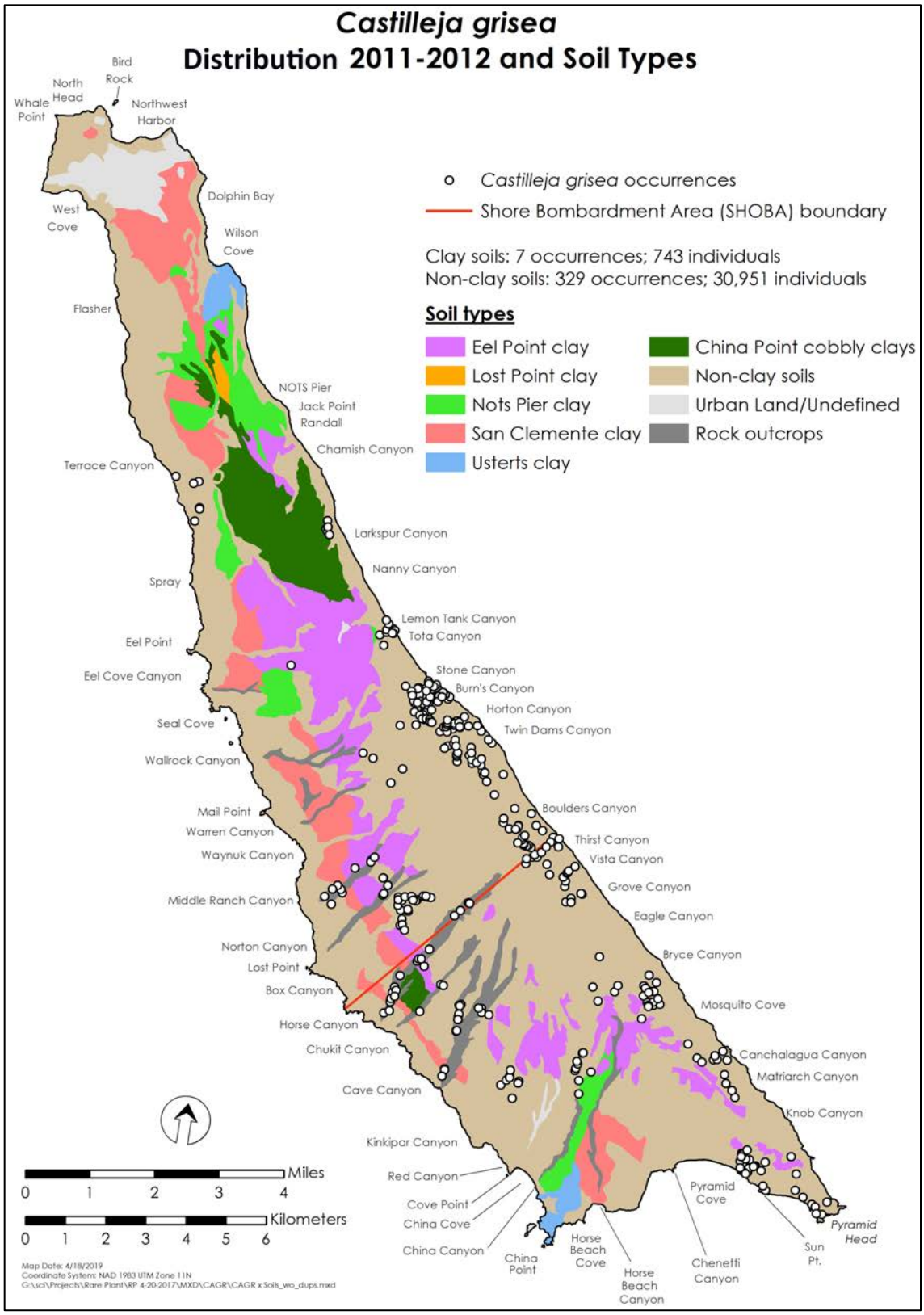
Map 1. Distribution of *Castilleja grisea* on San Clemente Island in 2011–2012.



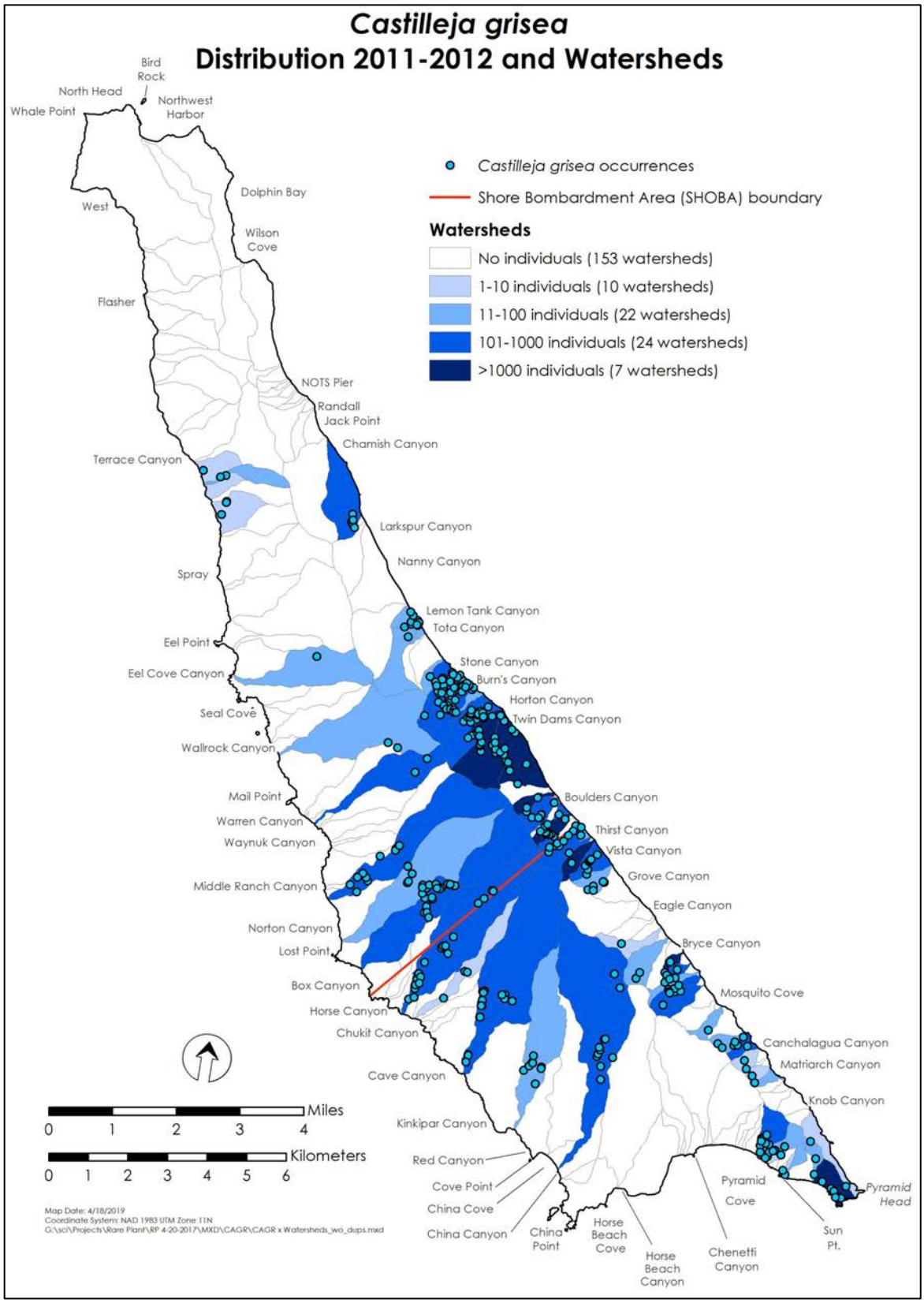
***Castilleja grisea* within different vegetation types.**

Vegetation Types	Occurrences	Individuals
Artemisia californica	159	23,011
Non-Native Grasslands	4	170
Baccharis pilularis	8	388
Cylindropuntia prolifera	39	1659
Lycium californicum	11	105
Lyonothamnus floribundus	4	69
Opuntia littoralis	36	2161
Opuntia littoralis/Artemisia californica	8	382
Quercus tomentella	4	42
Rhus integrifolia	48	3380
Stipa sp.	11	272
Unvegetated-coastal	4	55

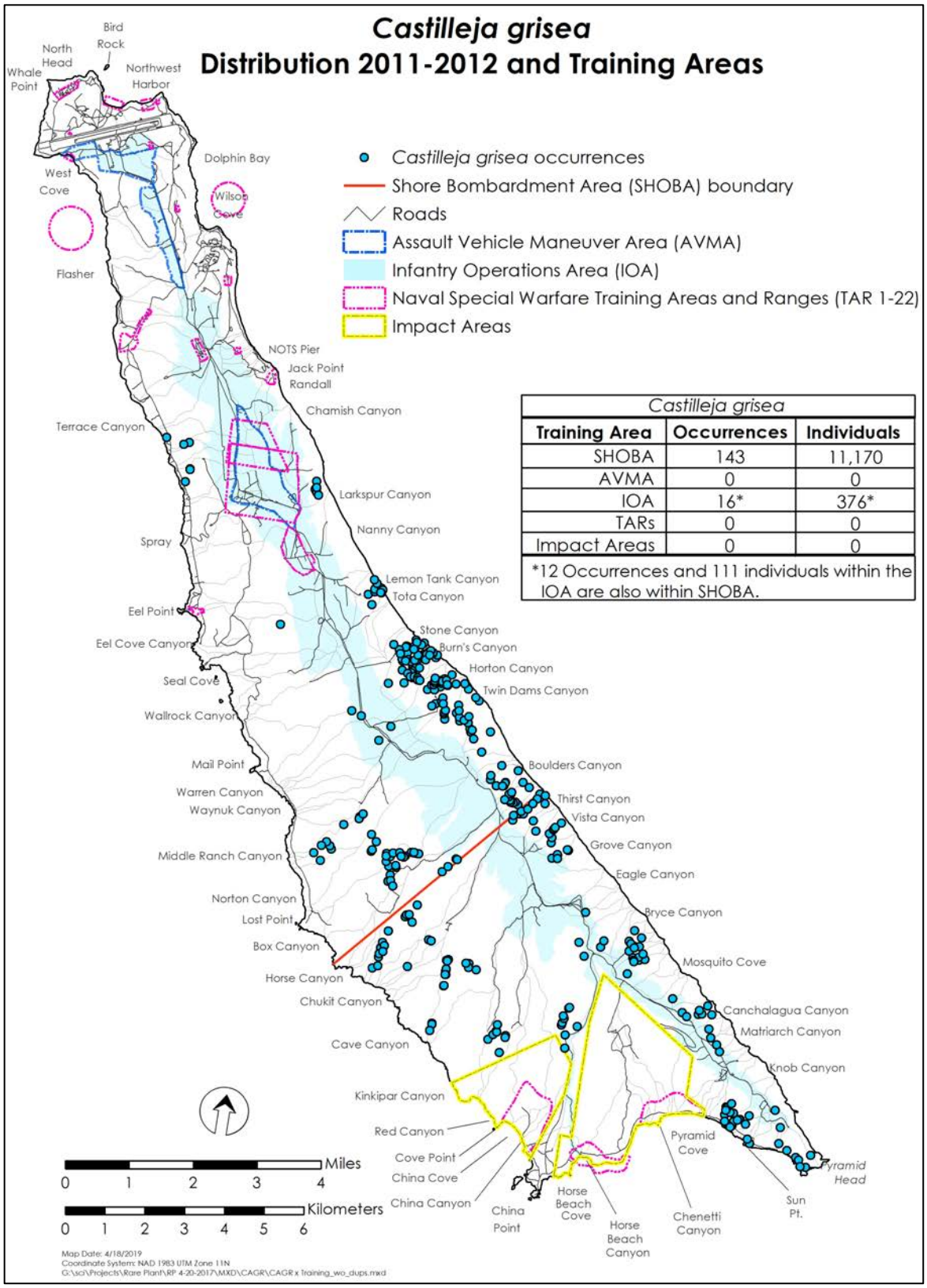
Map 2. Vegetation types and distribution of *Castilleja grisea* on San Clemente Island.



Map 3. Soil types and distribution of *Castilleja grisea* on San Clemente Island, based on the surveys of 2011–2012.



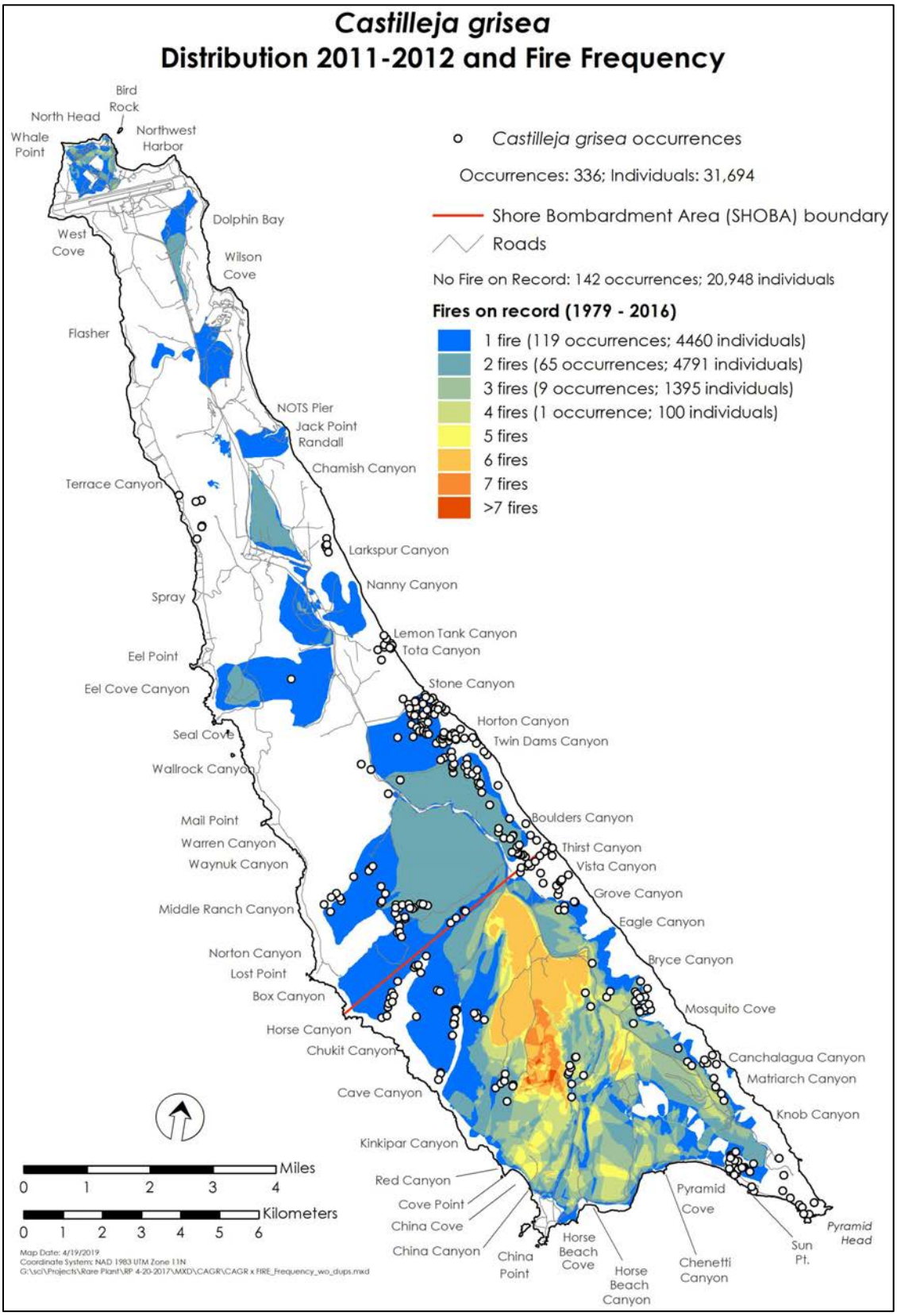
Map 4. Watersheds occupied by *Castilleja grisea* on San Clemente Island.



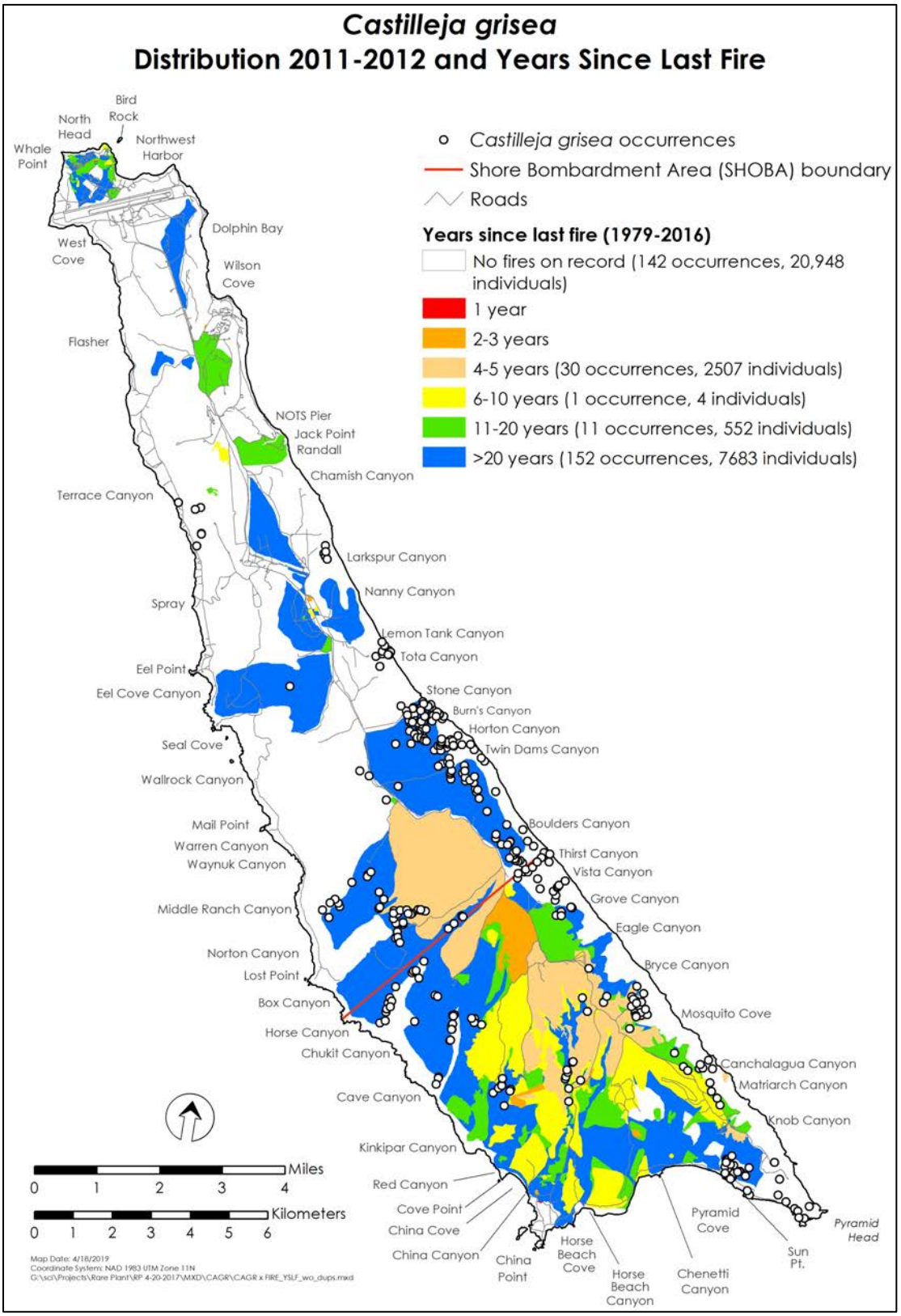
Castilleja grisea		
Training Area	**Occurrences**	**Individuals**
SHOBA	143	11,170
AVMA	0	0
IOA	16*	376*
TARs	0	0
Impact Areas	0	0

*12 Occurrences and 111 individuals within the IOA are also within SHOBA.

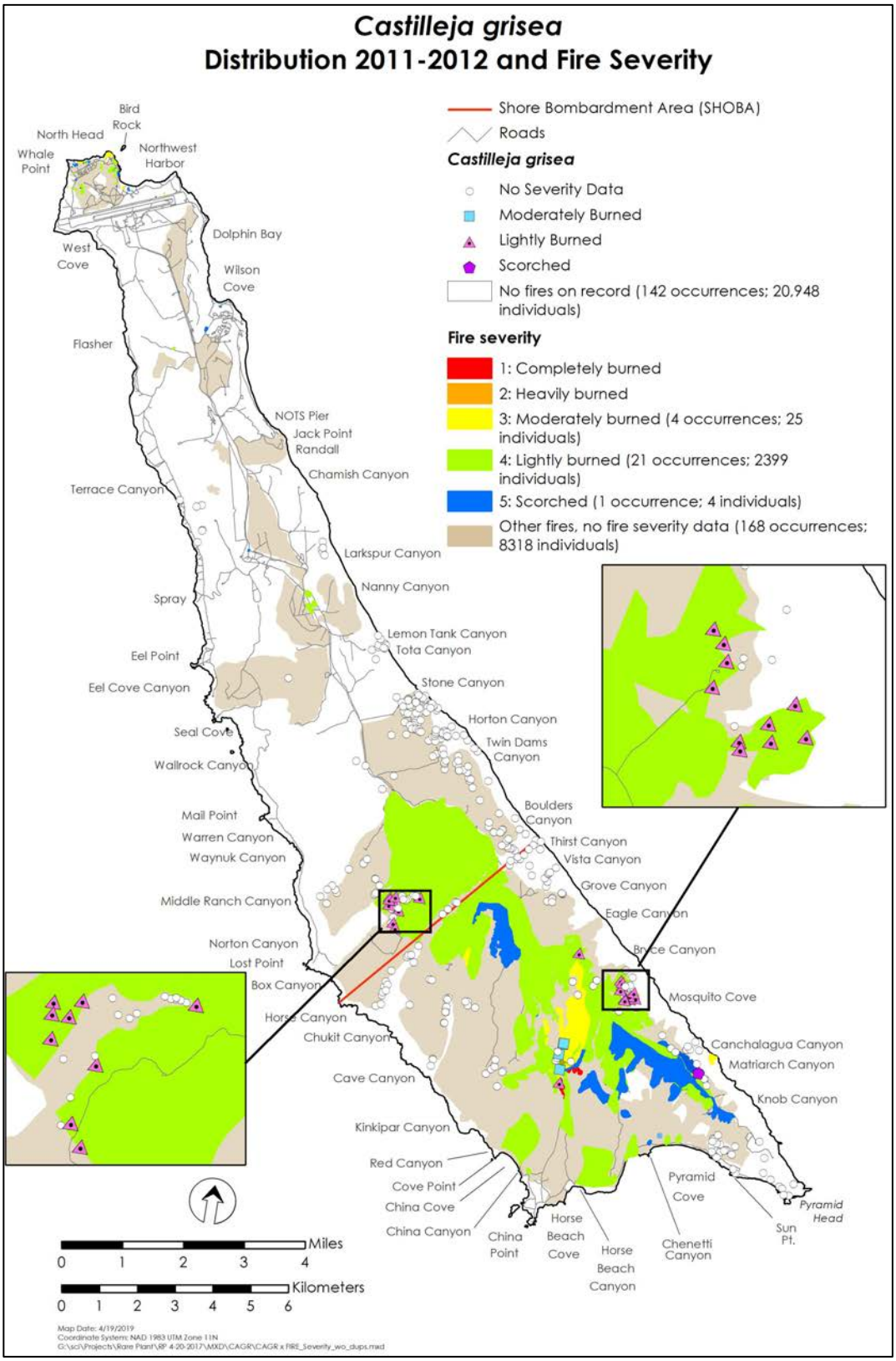
Map 5. Military training areas and distribution of *Castilleja grisea* on San Clemente Island.



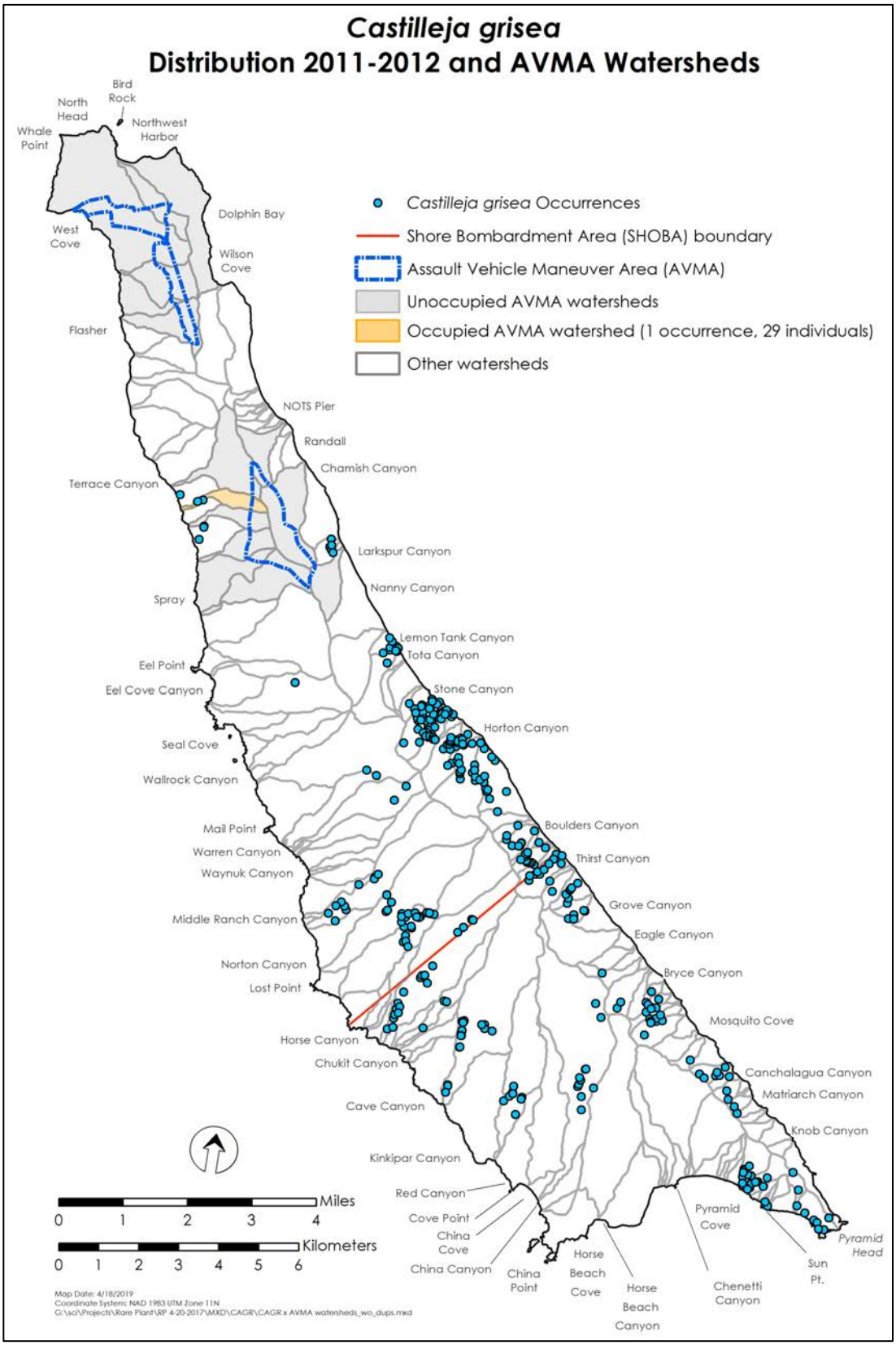
Map 6. Fire frequency and distribution of *Castilleja grisea* on San Clemente Island, based on the surveys of 2011–2012.



Map 7. Years since last fire recorded and distribution of *Castilleja grisea* on San Clemente Island, based on the surveys of 2011–2012.



Map 8. Fire severity and distribution of *Castilleja grisea* on San Clemente Island, based on the surveys of 2011–2012.



Map 9. AVMA watersheds and distribution of *Castilleja grisea* on San Clemente Island, based on the surveys of 2011–2012.