FINAL DRAFT

Species Status Assessment Report for the San Clemente Bell's Sparrow (*Artemisiospiza belli clementeae)*

Version 1.0

Photo by Nicole Desnovers

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U.S. Fish and Wildlife Service
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U.S. Fish and Wildlife Service. 2020. Species status assessment report for the San Clemente Bell's Sparrow (*Artemisiospiza belli clementeae*), Version 1.0. March 2020. Sacramento, CA.

VERSION UPDATES

Version 1.0

EXECUTIVE SUMMARY

This Species Status Assessment (SSA) provides an analysis of the overall species viability for the San Clemente Bell's sparrow (*Artemisiospiza belli clementeae*). To assess the viability of this subspecies, we, the U.S. Fish and Wildlife Service (Service), used the conservation biology principles of resiliency, redundancy, and representation (3 Rs). Specifically, we identified the subspecies' ecological requirements and resources needed for individual survival and reproduction. We described the stressors (threats) influencing these resources and evaluated current levels of population resiliency and species redundancy and representation using available metrics to forecast the ability of this subspecies to sustain populations into the future.

The San Clemente Bell's sparrow is a monogamous passerine, endemic to San Clemente Island (SCI), California. It is a grayish-brown colored sparrow with a small dark breast spot, complete white eye rings, and distinctive white and black malar stripes. Rainfall affects Bell's sparrow reproduction. Bell's sparrows generally respond to low rainfall by reducing reproductive effort but can produce multiple clutches in other years.

The San Clemente Bell's sparrow has been close to extinction, with a low of 38 individual adults reported in 1984. Habitat conversion caused by nonnative ungulates from the mid-1800s to 1991 altered plant communities on SCI, likely impacting the distribution and abundance of California boxthorn (*Lycium californicum*), cactus (*Opuntia littoralis*), and sagebrush (*Artemisia californica, A. nesiotica*) components of San Clemente Bell's sparrow nesting and foraging habitat. Sheep and cattle ranching ceased in 1934 when the island was transferred from the Department of Commerce to the Department of Defense, and the Navy successfully removed feral ungulates by 1992. Habitat on San Clemente Island is now recovering from historical overgrazing impacts.

Maritime desert scrub boxthorn habitat on the west shore of SCI may have escaped the intensive overgrazing impacts observed elsewhere on the island, and was identified as the primary habitat of the San Clemente Bell's sparrow in the 1970s and 1980s; however, Bell's sparrows are now documented in additional plant communities, including habitat dominated by sagebrush, mixed shrubs, cactus, and grasses. Although the ecological mechanisms are not understood, the west shore of SCI remains important to the species, as evidenced by the contraction of Bell's sparrows into this area during a period of population decline, the distance of this area from significant human impacts, and the percentage of the Bell's sparrow population that currently inhabits boxthorn community that dominates this area.

Bell's surveys conducted between 1999 and 2011 occurred along transects on the western shore and terraces of SCI. In 2013, the Navy expanded the area surveyed for Bell's sparrows to include all of SCI, because Bell's sparrows were incidentally observed outside the original survey areas and in many areas of the island. Annual population estimates are derived from 100-125 plots randomly selected each year. Plots are distributed across the island in eight habitat strata, based on the dominant vegetation. Territory density observed on the sampled plots is extrapolated across each stratum to obtain an estimate of the number of Bell's sparrow territories on SCI. The estimated number of adults assumes 2 adults per estimated territory. Observed territory density varies dramatically on sample plots. The high variation in some strata (e.g. see confidence intervals for GrassHerb-N, Table A) reflects the discontinuous distribution of Bell's sparrows in these strata; many grassland plots support no Bell's sparrows. Based on the 2013-2018 survey efforts, San Clemente Bell's sparrows continue to occur at the highest densities in

the northern boxthorn stratum (which includes the west shore of SCI where they were originally identified), followed closely by sagebrush stratum on the eastern escarpment (Table A). The island-wide territory estimate has exceeded 2,000 territories (4,000 adults) since 2013. In 2018, 2,642 (95% CI 1,947–3,336) San Clemente Bell's sparrow territories (5,284 adults) were estimated on SCI, and for this SSA, we consider this the current population.

Table A. Estimated territories on SCI considered current, derived from 2018 data.

Strata	% of Island	Plots (count)	Est. Density	SE (Density)	Total Area (Ha)	Estimated Territories	Lower 95% CI	Upper 95% CI
Boxthorn – N	31.8%	21	0.45	0.06	2,034.51	924.20	667.29	1,181.11
Boxthorn – S	10.6%	7	0.20	0.05	677.10	134.65	69.48	199.82
Cactus	26.3%	16	0.21	0.05	1,678.30	346.89	181.84	511.93
GrassHerb – N	35.7%	12	0.08	0.03	2,279.50	191.23	42.37	340.09
GrassHerb – S	52.5%	12	0.09	0.04	3,356.57	302.09	58.47	545.71
Mixed Shrub	36.9%	21	0.21	0.04	2,359.17	499.34	302.51	696.17
Sagebrush	11.7%	14	0.37	0.07	748.48	277.86	171.55	384.16
Total						2,676.26	1,493.52	3,859.00

Based on the estimated population size, stable density on the west shore, and apparent expansion into recently unoccupied areas on the island, the population of San Clemente Bell's sparrows appears to be resilient to recent variations in weather patterns, current anthropogenic use patterns, predation, and other stressors. The boxthorn habitat on the west shore of SCI appears particularly important to the Bell's sparrow population; however, Bell's sparrow use of other habitat types, particularly the sagebrush stratum, affords the species redundancy to withstand localized catastrophic events. Although no genetic data exists, the ability of the Bell's sparrow to use a wide array of vegetation types indicates its adaptive capacity, despite enduring a population bottleneck.

Threats to San Clemente Bell's sparrow at the time of listing included: 1) habitat modification due to feral livestock, 2) predation by feral cats, and 3) small population size and limited distribution. Since that time, the largest threat, feral livestock has been removed, island vegetation is recovering, and the Bell's sparrow population has grown and expanded in distribution. Threats considered in the 1984 Recovery Plan and the 2009 Five-year review include: 1) reduced food supply, 2) invasive species, 3) land use, 4) fire and other stochastic events, and 5) climate change.

Land use on SCI includes military infrastructure (construction and maintenance), and training activities. SCI is owned by the U.S. Department of the Navy (Navy) and is an important training area for the Pacific Fleet and Sea Air and Land Teams (SEALs). Approximately, 34.8% of the island's area is located in a military training area that is used for explosives use, covert operations, pedestrian traffic, or assault vehicle training. The training areas and associated safety arcs often have significant expanses of potentially suitable habitat which is subject to intermittent impacts ranging from low intensity (e.g. low volume pedestrian traffic) to extremely intensive (e.g. explosives use). An additional unquantified acreage of the island is associated with infrastructure including; a road network, an airfield, maritime operations, power generation and transmission, fuel distribution, housing and office space, a landfill, and quarries and borrow pits. Despite the presence of the above, most of the island is void of any infrastructure. Impacts from military training, construction, fire management, and infrastructure maintenance may impact individual Bell's sparrow and nests and alter or degrade habitat. We estimate baseline impacts from human activities on SCI (focused on impacts in boxthorn habitat on the western shore) to include the permitted take of 65 Bell's sparrow adults or fledglings and 46 nests, well below 1 percent of the population, per 5-year period. Monitoring around several training areas (i.e. TAR 10 and TAR 4) has demonstrated that San Clemente Bell's sparrows can occupy and successfully breed in habitat that is adjacent to military training areas. Training associated with significant impacts (e.g. explosives use, off-road assault vehicle maneuvering) occurs on only a small fraction of the island, and Bell's sparrows may persist at low densities in these areas. Military training and infrastructure needs on San Clemente Island will continue to evolve; thus, the magnitude and location of future impacts from training and infrastructure is unknown. For this assessment, we presume that future habitat alteration and training impacts will be limited to the existing footprint of training and previous fires.

An indirect effect of military training and other human uses is increased frequency of wildfire. The presence of an above-ground electrical distribution system, vehicle traffic, and the use of incendiary devices, live ammunition, and explosives have resulted in an elevated frequency of wildfire on SCI. The Navy implements measures to avoid ignition and contain or suppress fires should they occur. Wildfire poses a threat to the San Clemente Bell's sparrow, because it can kill individuals and reduce habitat suitability. Fire modelling and historically observed fire patterns have been used to predict the most likely fire patterns associated with current ignition sources and fire management practices. While fire patterns associated with current ignition sources and management practices do not appear to threaten viability of the San Clemente Bell's sparrow population, fires do have individual level impacts. Changes in ignition sources or fire management that result in an altered fire footprint or frequency could further impact the species, particularly if fires occur in habitat that supports high densities of Bell's sparrows. Fires have the potential to burn most places on the island, although the habitat with the highest densities of San Clemente Bell's sparrows (boxthorn) is not near the Impact Areas, where live-fire military training ignites most fires. Two TARs that support live fire training are located in the boxthorn habitat; however, to date, they have not resulted in ignitions.

Native and non-native species prey upon Bell's sparrows and their nests. Non-native black rats and feral cats are managed as part of an ongoing predator control program, it is highly unlikely that this threat will ever be removed completely. However, the San Clemente Bell's sparrow population appears stable despite predation, and nest success estimates appear to be relatively high across the island.

Drought conditions are linked to low productivity in San Clemente Bell's sparrows. However, while the population has been shown to decrease following drought years, the subspecies has been able to recover quickly in subsequent years. While California has experienced one of the worst droughts in history over the last decade (2011-2019), rainfall measures indicate that SCI received rainfall not far from average in most of those years. Current population estimates (2013-2018) do not indicate a clear pattern of growth or decline with rainfall totals. However, vegetation fuel moisture data indicates that how vegetation reacts to rainfall amounts is complicated, and that a high rainfall totals do not necessarily correspond to vegetation response. Other factors can lead to the vegetation drying out, affecting the seed and fruit production, and thus Bell's sparrow resources, even in years with average rainfall. While data is inconclusive, due to the subspecies ability to produce multiple clutches in wet years, drought cycles do not appear to significantly impact the San Clemente Bell's sparrow population over time. This subspecies has withstood droughts throughout history and has maintained a both a robust population size over the last decade. Still, extended or more severe drought could impact this taxon; however, the continued viability of the subspecies would be based on its ability to recover in wetter years.

Climate change, also, may have future impacts to the San Clemente Bell's sparrow, but we do not anticipate meaningful negative impacts in the next 20 to 30 years. Beyond this timeframe, the impacts of climate change on SCI, specifically the persistence of the fog belt and the timing and patterns of fog and rainfall, are uncertain, making predictions unreliable. However, we account for possible short-term climate impacts.

We modeled the future condition of San Clemente Bell's sparrow over the next 20- to 30-year time frame (2040–2050) given two different scenarios of future impacts from military training and fire, the two most significant future threats. Using both a low and high density estimate (calculated by manipulating the lowest and highest density estimates for each habitat stratum measured between 2013 and 2018 by one standard error), we calculated the estimated number of territories for each stratum under two potential future scenarios: 1) a "status quo" scenario in which conditions remain similar to those observed 2013–2018 (i.e. no changes in training intensity, fire pattern or frequency) and 2) an "increased impacts" scenario in which increased impacts from training and fire reduce the suitability of habitat within existing training areas and fire footprints to some extent. For this scenario, we report the number of Bell's sparrows that would be supported outside these areas where there may be increased impacts to their habitat. This provided an estimate of the minimum number of territories that could persist outside of projected fires and training area impacts within each stratum. We summed the territories in each stratum for an island-wide estimate, giving a range from low to high densities.

Our future population estimates are presented in Table B and are predicated on our assumptions that no new high intensity training areas or infrastructure will be established outside the existing footprint, and the future fire footprint will be within the boundaries of the existing fire footprint. Results indicate that, even under the "increased impacts" scenario, the minimum population size would be between 2,225 and 6,826 individuals. Under the status quo (no changes in training intensity, training footprint, fire footprint or intensity), the model predicts the population size of San Clemente Bell's sparrows would be between 2,899 and 9,300 individuals. Both of these scenarios yield comparable population sizes to current (2018) estimates.

Therefore, while the population is likely to fluctuate, we expect the population to maintain resiliency into the future. Given that all habitat strata remain occupied in our future scenarios, we expect that the subspecies will maintain adequate redundancy to withstand catastrophic impacts and adequate representation to adapt to changing environmental conditions. Protection of boxthorn habitat on the west shore, sagebrush habitat on the eastern escarpment or other high-density habitat areas would further ensure the subspecies could rebound from localized impacts.

Only an unprecedented, catastrophic impact that affected the high-density habitats, such as an unanticipated wildfire, major development of new facilities or training ranges in key habitat areas, or a prolonged, severe drought is likely to threaten the subspecies' viability. We did not model these into future scenarios because at this time, they are not considered likely. However, a prolonged or severe drought or an impact that reduced or degraded the habitat on the northwest shore could significantly decrease the San Clemente Bell's sparrow resilience, redundancy, and representation. In the event of a population decline due to such an impact, the viability of the Bell's sparrow will hinge on its continued ability to rebound in subsequent years.

Table B. Total island-wide population projections of San Clemente Bell's sparrow territories and individuals within a range of low to high expected densities for two future scenarios. The population estimates under the increased impacts scenario represents the population that would remain in areas with no additional impacts and does not count individuals that we expect would still persist within impacted areas; these estimates represent a minimum population size.

	Increased impacts (minimum habitat)	**"Status Quo" No further impacts (current habitat)**
territories	1,113–3,413	1,449–4,650
(individuals)	(2,225–6,826)	(2,899–9,300)

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SECTION 1 – INTRODUCTION AND ANALYTICAL FRAMEWORK

The San Clemente Bell's sparrow (*Artemisiospiza belli clementeae*; Chesser et al. 2012), formerly called the San Clemente sage sparrow, is a non-migratory subspecies of Bell's sparrow endemic to San Clemente Island (SCI), California. The San Clemente Bell's sparrow was listed as threatened on August 11, 1977 (USFWS 1977, p. 40682), citing habitat loss due to browsing of feral goats and rooting of feral pigs, depredation from feral housecats, and unknown impacts of introduced species. This Species Status Assessment (SSA) (USFWS 2016, entire) provides a review of the available information pertaining to the subspecies' biology and current condition, assesses the resources needed to maintain viability, and evaluates potential for long-term viability under several scenarios of future conditions. The intent is for the SSA to be easily updated as new information becomes available and to support all functions of the Endangered Species Program from candidate assessment to consultations to recovery.

This SSA for the San Clemente Bell's sparrow is intended to provide an update on the subspecies' biological condition and level of viability. For the purpose of this assessment, we generally define viability as the ability of the Bell's sparrow to sustain populations in their natural ecosystem up through a biologically meaningful timeframe, in this case, 20–30 years. We chose 20–30 years because beyond 20 to 30 years, the level of uncertainty associated with the impacts of climate change becomes overwhelming, making predictions unreliable. The available climate model projections for SCI are uncertain, but the impacts are more likely to be minimal within a 20 to 30-year timeframe. Using the SSA framework (Figure 1), we consider what the species needs to maintain viability by characterizing the status of the species in terms of its resiliency, redundancy, and representation (Wolf et al. 2015, entire).

- **Resiliency** describes the ability of populations to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health, such as birth versus death rates and population size. Highly resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities.

- **Representation** describes the ability of a species to adapt to changing environmental conditions. Representation can be measured by the breadth of genetic or environmental diversity within and among populations and gauges the probability that a species is capable of adapting to environmental changes. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of habitat characteristics across the geographical range of the species.

- **Redundancy** describes the ability of a species to withstand catastrophic events. Measured by the number of populations, their resiliency, and their distribution (and connectivity), redundancy gauges the probability that the species has a margin of safety to withstand or can rebound from catastrophic events (such as a rare destructive natural event or episode involving many populations).

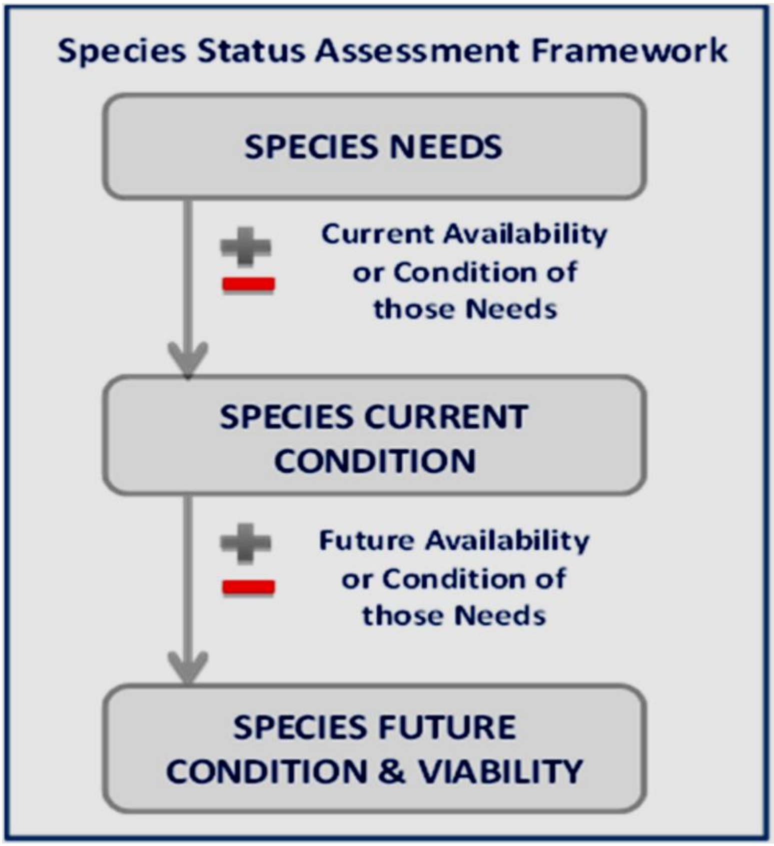

Figure 1. Species Status Assessment Framework.

1.1 Listing Status of the Species

Listed as threatened in 1977 (USFWS 1977, p. 40682), the San Clemente Bell's sparrow is one of the seven taxa addressed in the Channel Islands Recovery Plan (USFWS 1984, p. 79-97). A five-year status review was completed in 2009 (USFWS 2009, entire). Critical habitat for the Bell's sparrow has not been designated.

SECTION 2 – SPECIES BIOLOGY

In this section, we provide biological information about the San Clemente Bell's sparrow, including its taxonomic history, morphological description, historical and current distribution and range, known life history, and current population estimate.

2.1 Taxonomy

The San Clemente Bell's sparrow (*Artemisiospiza belli clementeae,* previously the San Clemente sage sparrow) was first recognized as a subspecies by Grinnell (1897). Formerly assigned to the genus *Amphispiza* (Chesser et al. 2012, p. 583), Ridgeway (1898) noted its smaller size and larger bill when contrasted to nominate subspecies (*A. b. belli*) found on the coastal mainland. The subspecies status for *Amphispiza belli clementeae* was supported by van Rossem (1932) who noted the island birds had longer bills, paler backs as adults, and paler juvenile plumage compared to the mainland nominate subspecies. Grinnell and Miller (1944, p. 503) also supported the island subspecies based on longer bills and paler juvenile plumage but noted that it was "weakly differentiated." Additionally, the American Ornithologists' Union (AOU) Committee on Classification and Nomenclature accepted this subspecies (AOU 1957, pp. 605–606) in their fifth edition of the Check-List of North American Birds.

Johnson and Marten (1992, pp. 1–19) examined genetic variation of *Amphispiza belli belli, A. b. canescens*, and *A. b. nevadensis,* and recommended *A. b. belli* and *A. b. canescens* are a single subspecies. Patten and Unitt 2002 (p. 33) reevaluated the diagnosability of the sage sparrow complex and found no statistically significant difference in bill lengths between the island and mainland birds, but they did find a statistically significant difference in the means of back color of adults They also evaluated other sage sparrow subspecies, and synonomized *Amphispiza belli clementeae* under *A. b. belli*, and *A. b. canescens* under *A. b. nevadensis*.

More recently, studies have reevaluated Patten and Unitt's (2002) data using more rigorous criteria for selecting specimens representing *Amphispiza belli canescens* and *A. b. nevadensis* (Cicero and Johnson 2006, entire) and concluded that *A. b. canescens* and *A. b. nevadensis* are diagnosable phenotypically. Cicero and Johnson (2006) did not reevaluate the data comparing *A. b. clementeae* and *A. b. belli*, but the errors in the specimen selection process used by Patten and Unitt (2002) to evaluate *A. b. canescens* and *A. b. nevadensis* (as identified by Cicero and Johnson (2006)) raises questions over Patten and Unitt's (2002) conclusion regarding *A. b. clementeae* and *A. b. belli*. Until these questions are resolved, we continue to consider the Bell's sparrows on SCI a subspecies, as listed.

Because of geographical isolation and separation from the mainland, this non-migratory subspecies presumably morphologically diverged from mainland Bell's sparrows, as have avian species on other islands (Grant and Grant 1995, pp. 241–251). However, to date there have been no analyses that examine genetic variation of the non-migratory San Clemente Bell's sparrow contrasted with both migratory and non-migratory mainland subspecies of Bell's sparrow.
In 2013, the sage sparrow species was split into Bell's sparrow (*Artemisiospiza belli*) and sagebrush sparrow (*A. nevadensis*), and the SCI endemic was renamed the San Clemente Bell's sparrow and assigned to the genus *Artemisiospiza* (Chesser et al. 2013, p. 9), although a recent genetic study proposes this leaves *A. belli* paraphyletic with respect to *A. nevadensis* (Karin et al 2018, p. 433). This most recent genetic study using mtDNA data place *A. b. clementeae* within a clade with *A. b. belli* and *A. b. canescens* from the San Joaquin Valley. A lack of mitochondrial divergence from *A. b. belli* suggests that *A. b. clementeae* dispersed to San Clemente Island relatively recently and quickly underwent morphological change (bill length and body size) in this novel environment (Karin et al. 2018, p. 433).

2.2 Species Description

The San Clemente Bell's sparrow is a monogamous passerine, endemic on SCI, California. It is a grayish-brown colored sparrow with a small dark breast spot, complete white eye rings, and distinctive white and black malar stripes approximately 5.1–5.9 in (13–15 cm) long, and weighs on average, 0.59 ounces (16.8 grams) (Martin and Carlson 1998, p. 2; Turner et al. 2005, p. 27).

2.3 Range and Distribution

The San Clemente Bell's sparrow occurs exclusively on SCI, located 68 miles (125 km) west of San Diego, California, and the southernmost of the California Channel Islands (Figure 2) (US Navy 2013a, pp. 1–4). The island is approximately 56 square mi (145 square km, 36,073 acres, or 14,598 hectares) (Junak and Wilken 1998, p. 2) and is long and narrow: 21 mi (34 km) long by 1.5 mi (2.4 km) wide at the north end and 4 mi (6.4 km) wide at the south end (USFWS 1984, p. 5). The island consists of a relatively broad open plateau that slopes gently to the west. The western side of the island is characterized by conspicuous marine terraces and the southeastern side of the island is characterized by steep escarpments that drop precipitously to the rocky coastline. Deep narrow canyons extend from the central plateau to both the eastern and western edge of the island. Mount Thirst, the highest point on the island, rises to approximately 1,965 ft (599 m) (US Navy 2013a, pp. 1–4). Average monthly temperatures range from 58°F (14°C) to 66°F (19°C), with a monthly maximum temperature of 72°F (27°C) in August and a monthly minimum of 51°F (10°C) in December (US Navy 2013a, pp. 3–11). Average monthly relative humidity varies from 54% to 86% depending on location and time of year, and the island experiences dramatic fluctuations in annual rainfall, averaging approximately 6.6 in (16.8 cm) (US Navy 2013a, pp. 3.11, 3.13). Precipitation is received mainly from November through April, with little from May through October. In addition to precipitation, fog drip during the typical dry season is a vital source of moisture to the SCI ecosystem (US Navy 2013a, pp. 3.9, 3.13).

Figure 2. San Clemente Island within the Southern California Channel Islands off the coast of California.

SCI supports a unique assemblage of flora and fauna, with numerous species endemic to the island or the Channel Islands. SCI was used for sheep ranching from 1862–1934 (Scott and Morrison 1990, pp. 25–27; Ferguson 1979, pp. 3–8), cattle ranching from 1850–1934 (up to 1,000 head of cattle), and supported a population of over 12,000 feral goats until 1991 (Keegan et al. 1994, p. 58). There is limited information about the ecology of the island prior to the introduction to the nonnative ungulates. However, grazing and browsing by non-native ungulates resulted in observable impacts to the soil, flora, and fauna of SCI. Persistent grazing and browsing defoliated large areas of the island, and the animals caused trampling and trail proliferation which exacerbated erosion. Although limited information is available pertaining to the early ecology of the island, habitat alteration is evident and resulted in the documented extirpation of several species from the island and apparently reduced the distribution of some species, including island endemics. Since the cessation of ranching and the more recent successful removal of non-native goats, the island vegetation is in a state of recovery.

The San Clemente Bell's sparrow has the smallest distribution of any subspecies of Bell's sparrow, as it occurs only on SCI (Turner et al. 2005, p. 1). It was historically common in shrub habitat on the hillsides and lower elevation mesas on SCI (Grinnell 1897, p. 18; Breninger 1904, p. 221; Linton 1908, p. 85). At listing, the Bell's sparrow was primarily distributed within the lower marine terraces along the northwestern portion of SCI, in the maritime desert scrub plant communities, mostly dominated by boxthorn (Figure 3) (Willey 1997, p. 219). Our most recent 5-Year Review reflects this understanding of the subspecies distribution (USFWS 2009, p. 8). However, the Bell's sparrow has more recently been found to occur widely across the island (although at extremely low densities in many areas), bringing recent estimates of potential available habitat from approximately 4,196 ha (10,369 acres) in 2009 (USFWS 2009, p. 8) to approximately 13,132 ha (32,449 acres, almost 90% of the island) (Meiman et al. 2018, p. 5). As the native habitats recovered following the removal of the grazing and browsing animals, the distribution of Bell's sparrow expanded on SCI (Meiman et al. 2019, pp. 2–4).

With the removal of the feral ungulates came shrubland habitat regeneration and re-establishment. Changes to San Clemente Bell's sparrow nesting and foraging habitat are most evident in the upper marine terraces and the maritime desert scrub communities on the southern portions of the island. Maritime desert scrub boxthorn habitat has also regenerated in some previously degraded areas, improving nesting opportunities (USFWS 2008b, p. 173). Recent vegetation mapping efforts show plots classified as boxthorn occurring at higher elevations than in a 1994 vegetation map (Kellogg and Kellogg 1994 in Meiman et al. 2013). Shrub species other than boxthorn have also expanded their range significantly (Tierra Data Inc. 2005, pp. 24–26). Sagebrush (*Artemisia californica*, *A. nesiotica*) is recruiting and moving out of the canyons and into the coastal terraces (Booker 2019, pers. comm.). In 1994, the sagebrush community was estimated to cover 1% of the island (Tierra Data Inc. 2005, p. 26). In 2013, Bell's sparrow monitoring plots classified as sagebrush cover approximately 6%, with plots classified as mixed-shrub or Baccharis-savannah covering another 19% of the island area (See Figure 4) (Meiman et al. 2013, p. 43).

While the San Clemente Bell's sparrow is now distributed widely across the island, its density varies greatly spatially, and the west shore boxthorn habitat, where the species was originally described, remains densely occupied and thus important to the species (see Section 2.6, Density).

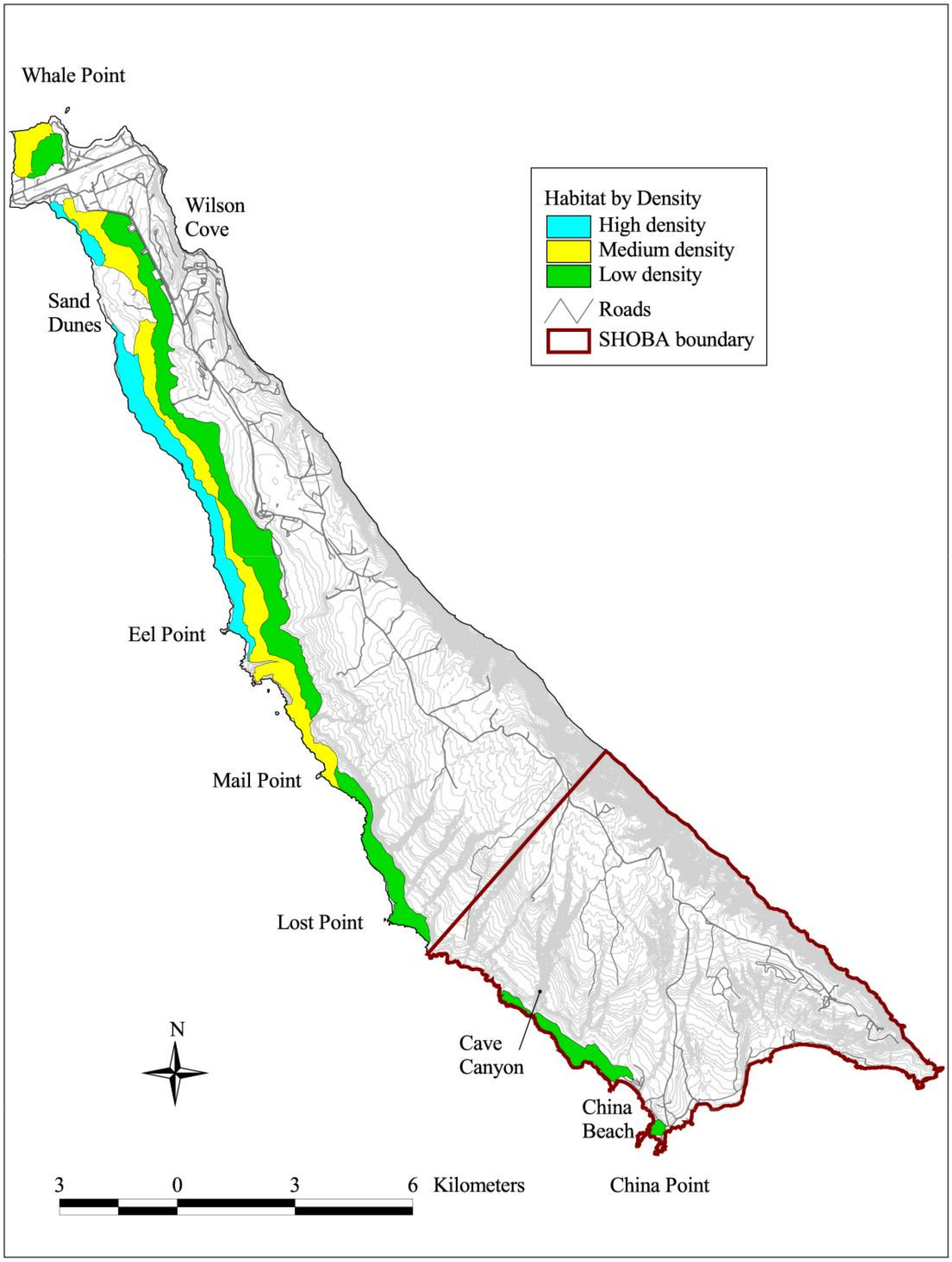

Figure 3. San Clemente Bell's Sparrow habitat mapped in 2002. From Beaudry et al. 2003, p. 6.

2.4 Habitat

San Clemente Bell's sparrows inhabit most plant communities on SCI, including Maritime Desert Scrub in *Lycium* (boxthorn) phase, *Opuntia* (prickly pear) phase, and *Cylindropuntia* (cholla) phase; Maritime sage scrub; canyon shrubland/woodland; and grasslands (Figure 4). Within these plant communities, Bell's sparrows show an affinity for shrub and cactus (*Opuntia* spp.) dominated areas. San Clemente Bell's sparrows demonstrate a positive association with structural shrub cover (Meiman et al. 2015a, p. 33), as they typically use shrubs for nesting substrate and use the gaps between and area underneath shrubs for foraging (see Section 2.5). The abundance of shrubs, including California boxthorn (*Lycium californicum*), has been positively correlated with sparrow density (Turner 2009, pp. 53-54). High grass cover has been correlated with lower sparrow densities and larger territory sizes, which may indicate that grasses are not likely important resources during the nesting season (Turner 2009, pp. 53–54).

Recent survey design has classified the island into eight vegetation strata (Meiman et al. 2015, p. 24) (Figure 4). While the Maritime Desert Scrub, *Lycium* phase translates to the boxthorn strata (broken into north and south for survey purposes and in recognition of the difference in density), the other strata do not directly correspond to particular plant communities (see Appendix A for strata definitions). Canyon Woodland/Bare is the only stratum not considered potential habitat (Figure 4). While boxthorn habitat is still considered high quality habitat, moderate to high population densities are also found in sagebrush and shrub habitat near canyons and along the steep eastern slope. San Clemente Bell's sparrows are present in significantly lower densities in mixed shrub, cactus, and grassland (grass/herb) habitats along the central plateau (Meiman et al. 2018, p. 18).

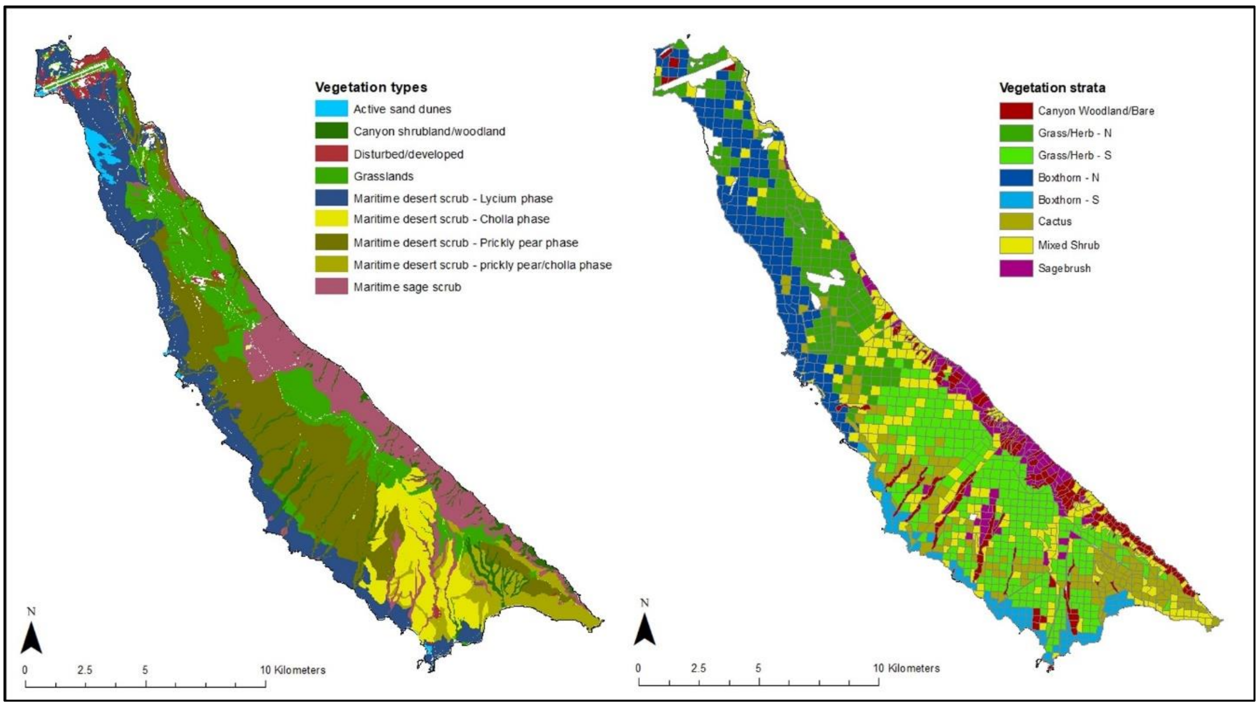

Figure 4. Vegetation types mapped on the island (left) (2011) compared to the vegetation strata delineated for sparrow monitoring starting in 2015 (right). Canyon Woodland/Bare is not considered potential habitat (US Navy 2011 data; Institute for Wildlife Studies data).

Habitat conversion caused by nonnative ungulates from the mid-1800s to 1993 likely reduced the availability of San Clemente Bell's sparrow nesting and foraging habitat. Reduction in California boxthorn, cactus, and sagebrush would have affected availability of cover, food resources, and nesting substrate. In addition, changes to the forb and herb layer would also have affected food and prey species (plant and insect). These changes created reduced protective cover and food resources for the Bell's sparrow (Kaiser et al. 2008, pp. 27–29). As noted above, the island is now in a state of vegetative recovery. Visible expansion of shrublands is evident on the plateau, on the slopes, and in the canyons of SCI. These visible changes in vegetative composition and distribution have likely expanded the distribution of nesting and foraging resources for Bell's sparrows on SCI.

At the time of listing, San Clemente Bell's sparrows were documented only within Maritime Desert Scrub on the west shore of SCI, where the relatively intact shrub community had persisted throughout the ranching and non-native grazing/browsing. Early researchers note that Bell's sparrows preferred habitat that had "abundant quantities" of boxthorn (Byers 1976, p. 6). It is likely that Bell's sparrows had persisted in the boxthorn habitat as grazers and browsers favored other, more palatable shrub communities. Subsequent periodic surveys (1981–1997) and annual surveys (1999–2011) continued to focus effort in Maritime Desert Scrub plant communities until incidental observations of Bell's sparrows outside the surveyed areas prompted assessment of the potential for Bell's sparrow presence in other plant communities on SCI. In 2009, approximately 14% of the island (2,098 ha; 5,184 acres) was thought to be suitable for nesting by Bell's sparrows (USFWS 2009, p. 8). However, current potential habitat includes an estimated 13,132 ha (32,450 acres), or almost 90% of the island, although Bell's sparrows occur in very low densities in some strata, and the boxthorn that supported this subspecies at listing still provides habitat for a large percentage of the island-wide population (see Section 2.6) (Meiman et al. 2018, p. 5; Figure 9). While the boxthorn habitat provided a refugia for this subspecies, as shrublands became re-established, Bell's sparrows likely began utilizing non-boxthorn shrub habitat years before it was being considered habitat (Booker 2019, pers. comm).

2.5 Life History

Much of the life history of the San Clemente Bell's sparrow is known from studies of their distribution in boxthorn habitat, and not much is known about Bell's sparrows specifically in other habitats on the island. For instance, information on diet comes from studies in boxthorn and may not be representative of foraging diet in other habitats.

The San Clemente Bell's sparrow is a ground and stem gleaner. It eats available insects and spiders from the vegetation and seeds taken from the ground and low vegetation, often in openings beneath shrubs, such as boxthorn (*Lycium californicum*) (Hyde 1985, p. 24). During the winter, Bell's sparrows have been observed feeding on prickly pear (*Opuntia littoralis* and *Opuntia oricola*), coastal cholla (*Cylindropuntia prolifera*) fruit, and moths (Hyde 1985, p. 24). While nestlings were found to be primarily fed arthropods, Hyde (1985) found cactus fruit, boxthorn berries, and saltbush (*Atriplex* spp.) fruit to be particularly important food resources at different times of the year. However, the complete winter diet of the San Clemente Bell's sparrow is unknown.

Generally, boxthorn flowers and fruits from March through June (Beaudry et al. 2003, p. 29), providing foraging opportunities on insects attracted to the leaves, flowers, and berries and on the berries and seeds themselves during the peak of the breeding season. In years with severe drought, such as 2002 and 2007, boxthorn may not produce new growth or flower (Beaudry et al. 2003, p. 29; Kaiser et al. 2007, p. 41), and Bell's sparrows may rely on other species that continued to produce flowers and berries during drought (Beaudry et al. 2003, p. 44-45).
San Clemente Bell's sparrow breeding activity typically begins in late January or February but has been detected as early as December (Stahl et al 2010, p. 27). The initiation of breeding activity and the length of the nesting season appear to be tied to precipitation patterns (Kaiser et

al. 2007, pp. 48–49; Meiman et al. 2018, p. 36). Breeding activity usually peaks in March and April and lasts through late June or July. Breeding season length averaged 112 days between 2006–2016 (Meiman et al 2018, p. 34). The longest recorded breeding season lasted 177 days (2019) and the shortest lasted 61 days (2002), with the earliest known nesting attempt on January 4 in 2008, and the latest known nesting attempt on July 24 (presumed), in 2019 (Meiman et al. 2018, p. 55; Meiman 2019, pers. comm). While it had long been thought that San Clemente Bell's sparrows primarily nest in dense boxthorn, sagebrush (*Artemisia californica* and *Artemisia nesiotica*) was used for 30% of the nests found in 2017, and 36 species have been recorded as the primary nest substrate, although boxthorn is still the most common, supporting 54% of the nests detected in 2017 and 70% in 2018 (Meiman et al. 2018, pp. 39, 51; Meiman et al. 2019, p. 27). Known nest sites range in elevation from 5 m to 553 m (Meiman et al. 2018, p. 55). Open nest cups are constructed of grass, lichen, twigs, and forb stems and lined with feathers, flower heads, hair, and grasses (Hyde 1985, p. 3; Petersen and Best 1985, pp. 217–221). Mean nest height from 2013–2017 was 27.9 cm with at least an additional 20 cm (8 in) of canopy above the nest (US Navy, unpublished data). Dense shrubs provide cover from prevailing winds and from predators (Willey 1997, p. 218). San Clemente Bell's sparrows are able to successfully reproduce in their first year (USFWS 2008, p. 169).

Eggs are bluish-white, approximately 20 mm long and 15 mm wide, with dark brown and black markings occasionally in a wreath at the blunt end (Ehrlich et al. 1988, p. 578; Martin and Carlson 1998, p. 9). Clutch size ranges from 1–5 eggs (from 2004–2017, clutch size averages range from a high of 3.7 eggs in 2008 to a low of 2.74 in 2014), with asynchronous hatching after an average of 12 days of incubation conducted mostly by the female (Martin and Carlson 1998, p. 9; Meiman et al. 2018, pp. 10, 55), although males will guard the nest when the female leaves the eggs unattended to forage (Martin and Carlson 1998, p. 9). A single pair has been documented to attempt nesting up to 5 times in a season (Meiman et al. 2018, p. 55). Incubation typically lasts 11–14 days, and fledging occurs 10–14 days after hatching (11 days is used for Mayfield nest success estimator) (Martin and Carlson 1998, p. 9; Meiman et al. 2019, p. 10). Both parents feed the chicks (Martin and Carlson 1998, p. 9), who depend on their parents for several weeks post fledgling (Kaiser et al. 2008, p. 24).

Amounts and distribution of rainfall affects the timing and extent of vegetation growth and flowering. During drought years, Bell's sparrows may not reproduce at all or a subset of the population may suppress breeding (Kaiser et al. 2007, p. iv; Stahl et al. 2010, p. 48; Meiman et al. 2019, p. 35), which can, bud does not always, result in depressed populations following drought years. Bell's sparrows appear to respond to favorable precipitation patterns and resulting conditions by producing multiple clutches, which typically drive population numbers up in years that follow "good" precipitation years (Kaiser et al. 2007, p. iv; Stahl et al. 2010, p. 50). In some years, the reproductive rate (percent of monitored pairs for which at least one nesting attempt was detected) has been notably high (e.g., 90% in 1986, 97% in 1999), while in others, virtually no reproduction has occurred. For instance, during extremely low rainfall years of 2002 and 2007, Bell's sparrows on SCI delayed nest initiation or failed to nest (Beaudry et al. 2003, p. 24; Kaiser et al. 2007, p. iv). While the 2018 drought year produced low nesting overall, the probability of fledging at least 1 chick was high. Despite below-average rainfall in 2014, 2015, 2016, and 2018 (SERG, unpublished data), recent population estimates throughout this time have been relatively consistent (see Section 2.6).

San Clemente Bell's sparrows do not migrate, but juveniles move from natal/breeding territories during the winter months (USFWS 2009, p. 5). Hyde (1980 in USFWS 2008, p. 169) found that adult Bell's sparrows exhibited little movement, and he observed that adult pairs remain on territory as late as October, when his study concluded. Although Bell's sparrows remain in the vicinity of their nesting territories year-round, they rarely exhibit behavior indicative of territorial defense during the non-nesting season (Munoz et al. 2016, p. 1). Willey (1990, p. 30) measured an average breeding territory size of 3.1 ± 0.42 ha (7.75 ± 1.03 ac). Data on territory sizes is limited to monitoring conducted in boxthorn habitat through 2012. In 2012 (the last year that territories were mapped), estimated mean territory size was 0.97 ± 0.05 ha (2.40 ± 0.12 ac) (n = 106). In some years, data analyses found a statistically significant difference in mean territory size among sampled plots. For instance, territory size was lower in areas that have higher density of boxthorn shrubs (Beaudry et al. 2004, pp. 23, 28; Kaiser et al. 2007, p. 57), but this pattern did not hold true for each year. Male Bell's sparrows aggressively defend territory boundaries during the breeding season with little overlap between adjacent pairs (Willey 1990, p. 30).

The longest recorded dispersal recorded (juvenile to adult) is 9.1 mi (14.6 km). The longest movement by an adult (based on incidental band resights; no dispersal study has been conducted) is 3.4 mi (5.4 km) (Meiman et al. 2018, p. 55).

Native nest predators include common raven (*Corvus corax*), island fox (*Urocyon littoralis*), and island night lizard (*Xantusia riversiana*), as documented with nest cameras. Non-native predators include black rats (*Rattus rattus*), which have been documented predating nests, incubating adults, and juveniles (Meiman et al. 2017, pp. 35–36; Meiman et al. 2018, p. 26). House mice (*Mus musculus*) and feral cats (*Felis catus*) are also likely predators, although mice are rarely documented and cats have not been documented (Meiman et al. 2017, pp. 35–36, Bridges 2019, pers. comm).

To date, the oldest-known banded sparrows were recorded at the time of recapture/resighting as at least 10 years old (Meiman et al. 2018, p. 55).

2.6 Population Demographics and trends

Population size

The San Clemente Bell's sparrow has been close to extinction, with a low of 38 individual adults reported in 1984 (Hyde 1985, p. 30). Byers (1976, p. 7) noted that some habitat that seemed "appropriate" was not occupied despite its similarity to occupied habitat, indicating that not all available habitat was being occupied at listing. Several studies of Bell's sparrow distribution were conducted between 1976–1997 (Byers 1976, Hyde 1985, KEA 1997). The population was estimated to be 316 in 1981, 38 in 1984, and 294 in 1997 (Beaudry et al. 2003, pp. 1–2). Some of this population fluctuation may be related to differences in survey methods and areas surveyed (Kaiser et al. 2008, pp. 31–33). Early studies may have underestimated the Bell's sparrow population in the 1970s and 1980s, as they did not include *Lycium californicum* habitat at higher elevations and thus may have underestimated the total suitable habitat on SCI (Kaiser et al. 2008, pp. 31–33; Table 1).

Starting in 1999, the Institute for Wildlife Studies (IWS) was contracted to estimate San Clemente Bell's sparrow population size on the western terraces from repeated surveys of transects located within known and historic Bell's sparrow habitat (Meiman et al. 2018, p. 2). Population size estimates for the Bell's sparrow ranged from 452 to 1,546 adults between 2009 and 2012. Observations of Bell's sparrows outside the west shore historic habitat prompted an annual 1-weekend early-breeding-season survey, which began in 2010. These weekend surveys sampled areas outside and within boxthorn habitat but were not intended to provide an island-wide population estimate. These surveys detected a significant number of Bell's sparrows outside the Maritime Desert Scrub habitat on the west side of the island, suggesting that the population range and size were likely being underestimated (Docherty et al. 2011, p. 1; Ehlers et al. 2012, p. 1). For instance, the population estimate for 2010 within the northwest boxthorn was 1,253 total individuals, based on methods of sighting male birds singing on transects and assuming a 1:1 sex ratio, and the 2010 weekend survey detected an additional 798 birds outside the west shore area. In order to more accurately estimate distribution and population size, Bell's sparrow breeding season surveys were redesigned in 2012, implementing double-sampling surveys at randomly selected plots distributed across the island (Meiman et al. 2019, pp. 3–4). These surveys used both rapid (one-visit) and intensive (multi-visit) survey types (see Bart and Kern 2014 for full methodology). This new survey methodology was implemented island-wide in 2013 (after a 2012 pilot survey), resulting in an island-wide estimate of 4,534 adult sparrows (2,267 pairs). The population estimates have consistently been over 4,000 adults since 2013 (4,194–7,656) (Figure 5, Table 1).

Table 1. Population estimates of adult San Clemente Bell's sparrow. From Kaiser et al. 2008, p. 102; USFWS 2008, p. 170, Stahl et al. 2010, p. 1; Docherty et al. 2011, p. 1; Ehlers et al. 2012, p. 1; Meiman et al. 2015, p. 1; Meiman et al. 2016a, p. 1; Meiman et al. 2016b, p. 1; Meiman et al. 2018, p. 1; and Meiman et al. 2019, p. 1. For years where territories were reported, individuals are calculated by multiplying by 2.

Year	Estimated Adult Population Size	Sampling Area
1976	93	Boxthorn
1980	176	Boxthorn
1981	360	Boxthorn
1982	205	Boxthorn
1983	198	Boxthorn
1984	38	Boxthorn
1985	91	Boxthorn
1997	294	Boxthorn
1999	578	Boxthorn
2000	452	Boxthorn
2001	578	Boxthorn
2002	1,519	Boxthorn
2003	544	Boxthorn
2004	980	Boxthorn
2005	729	Boxthorn
2006	1,216	Boxthorn
2007	716	Boxthorn
2008	511	Boxthorn
2009	727	Boxthorn
2010	1,253	Boxthorn
2011	1,544	Boxthorn

2012		Pilot Survey
2013	4,533	Island Wide
2014	6,364	Island Wide
2015	4,381	Island Wide
2016	4,354	Island Wide
2017	7,656	Island Wide
2018	5,284	Island Wide

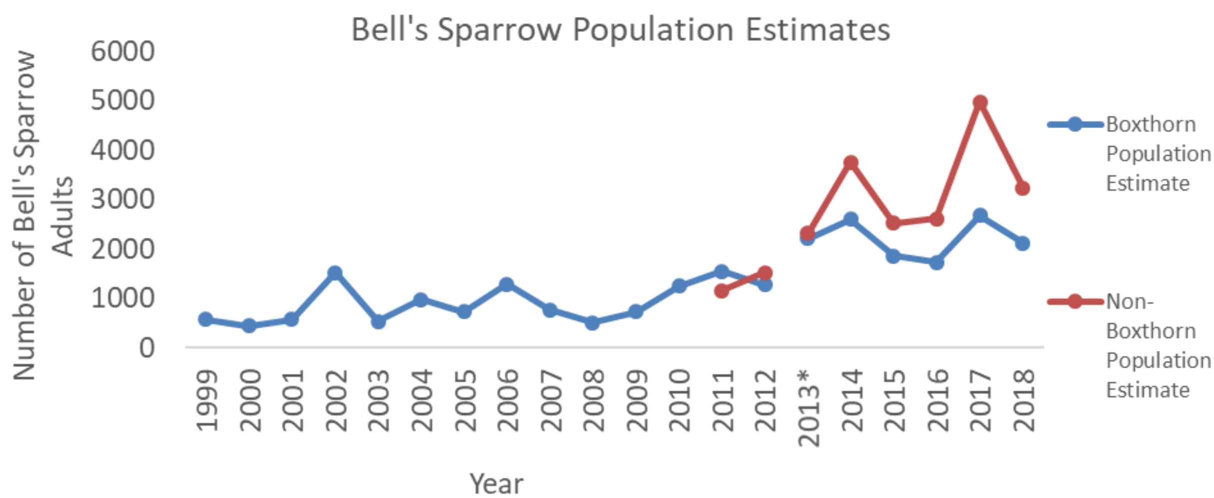

Figure 5. Bell's sparrow population estimates from 1999 through 2018, in boxthorn and outside boxthorn habitat on SCI, California. *Sampling changed in 2013 and estimates after 2013 are only roughly comparable to the pre-2013 data. (From Meiman et al. 2019, p. 37)

A population viability analysis (PVA) modeling by IWS (Beaudry et al. 2003, pp. 46–47; Kaiser et al. 2008, p. 47), using demographic information from 2000–2007, suggested that the primary variable contributing to extinction risk is juvenile mortality, followed by the effects of drought (USFWS 2008, pp. 167–185).). However, the mortality estimates used in the PVA may have been biased by unrecognized dispersal of banded juveniles and adults from the study area. Dispersal would result in low band return rates, which could be interpreted as mortality. The expanded surveys conducted following the new protocol and show that San Clemente Bell's sparrows occupy more areas of the island now than was known when the PVA was run. It is unknown if and how many juveniles were dispersing out of the boxthorn habitat during the 2000–2007 study or whether the occupation of these new habitat types has been more recent; Beaudry (2019, pers. comm.) notes that biologists working on the San Clemente Loggerhead Shrike (*Lanius ludovicianus mearnsi*) were instructed to report on "extra-territorial" sparrow observations. Until 2003, reports were confined to winter, implying that Bell's sparrows expanded primarily after 2003. No PVA has been run using the most recent data.

Density

The island-wide, random stratified sampling approach to monitoring that began in 2013 subdivided the island into sample plots, varying from 2 to 22 ha, with ~100 plots surveyed each year. A subset of these plots (12–14) were sampled multiple times and territory mapped to determine the proportion of the "true" number of territories that were documented on the plots that were visited just once, employing a double sampling method. Plots were originally classified as one of six vegetation strata (later expanded to eight) using a combination of ground truthing and aerial images (Appendix A). Strata include boxthorn, sagebrush, mixed shrub, cactus, grassland/herbaceous, and canyon/woodland or bare. "Canyon/woodland or Bare" is a lumped category of vegetation types that are not potential habitat for San Clemente Bell's sparrow (Appendix A).

Although Bell's sparrows may be found in most plant communities or strata on San Clemente Island, density, measured by territories, varies significantly throughout the island. (Figure 9) (Meiman et al. 2018, p. 16; Meiman et al. 2019, p. 15). Broken down by vegetation strata, estimated density is consistently highest in plots categorized as boxthorn-N (North of Mail Point/Stone Station line) (0.45 territories/ha in 2018), which corresponds to the northern areas of the habitat monitored during previous survey techniques. Sagebrush has also had high estimated densities (0.37 territories/ha in 2018), and the mixed shrub strata has also had years where density exceeded 0.3 (Table 2, Figure 7, Figure 8). In 2017, the estimated density in plots categorized as sagebrush surpassed that of boxthorn-N (Figure 7). From 2013 to 2018, density estimates for non-boxthorn plots have generally increased, although there is significant variation among plots within some strata as well as fluctuation among years (Figure 6, Figure 8).

San Clemente Bell's sparrows are most dense in the northern boxthorn habitat on the west shore, the habitat that likely provided refugia from the goats, and the only area they were known to occupy at listing. Bell's sparrow density is very low in the Grass/Herb habitat strata with high standard error. Presence of sparrows in these habitats are presumably linked to the presence of shrubs within the grasslands. Thus, many individual plots within the Grassland/Herb strata do not support Bell's sparrows (Figure 6).

Table 2. San Clemente Bell's sparrow population estimates by strata for 2018 on SCI, California. From Meiman et al. 2019, p. 17. Descriptions of each stratum can be found in Appendix A.

Stratum	**Estimated Density (territories/ha)**	**SE (density)**	**Estimated Territories**	**Lower 95% CI**	**Upper 95% CI**
Boxthorn – N	0.45	0.06	924.20	667.29	1,181.11
Boxthorn – S	0.20	0.05	134.65	69.48	199.82
Cactus	0.21	0.05	346.89	181.84	511.93
Grass/Herb – S	0.09	0.04	302.09	58.47	545.71
Grass/Herb – N	0.08	0.03	191.23	42.37	340.09
Mixed Shrub	0.21	0.04	499.34	302.51	696.17
Sagebrush	0.37	0.07	277.86	171.55	384.16
Total			2,676.26	1,493.52	3,859.00

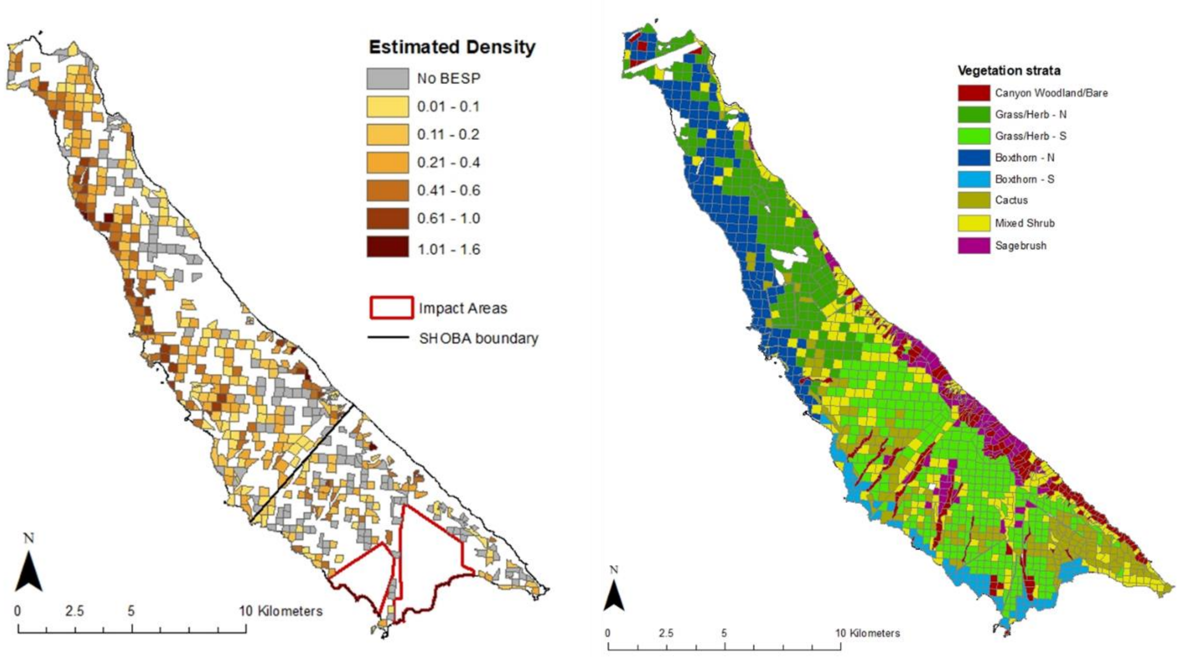

Figure 6. Average individual plot densities as measured between 2013 and 2018 in relation to defined vegetation strata. As plot boundaries changed when the vegetation strata changed, 2016-2018 values are averaged (if the same plot was surveyed multiple years), and 2013-2015 values are averaged. While density estimates are averaged over all plots within a stratum, there are hot spots and unoccupied areas within some strata.

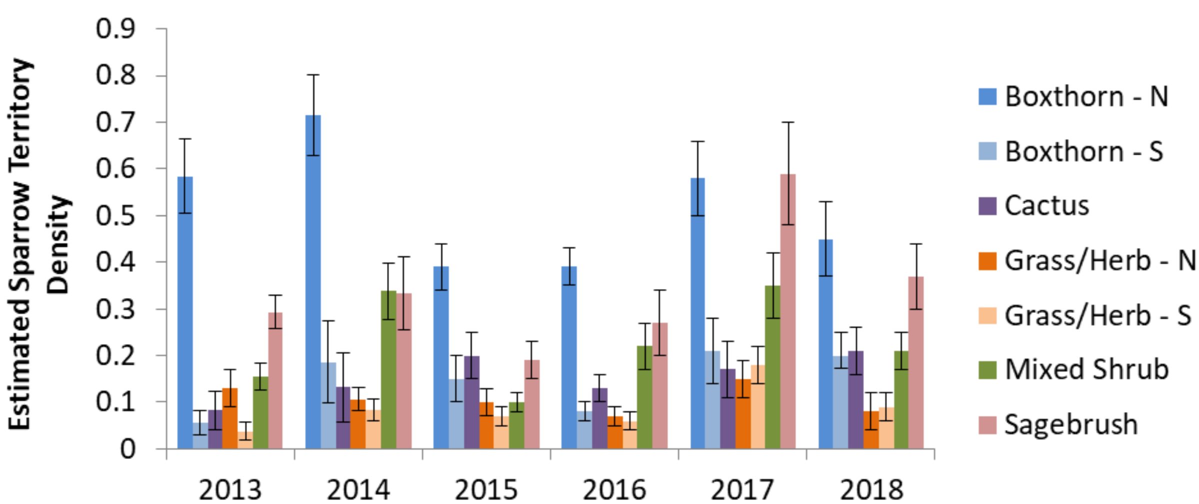

Figure 7. Density of San Clemente Bell's sparrow territories (± 1 SE) by strata from 2013–2018 on SCI, California. From Meiman et al. 2019, p. 20. Descriptions of each stratum can be found in Appendix A.

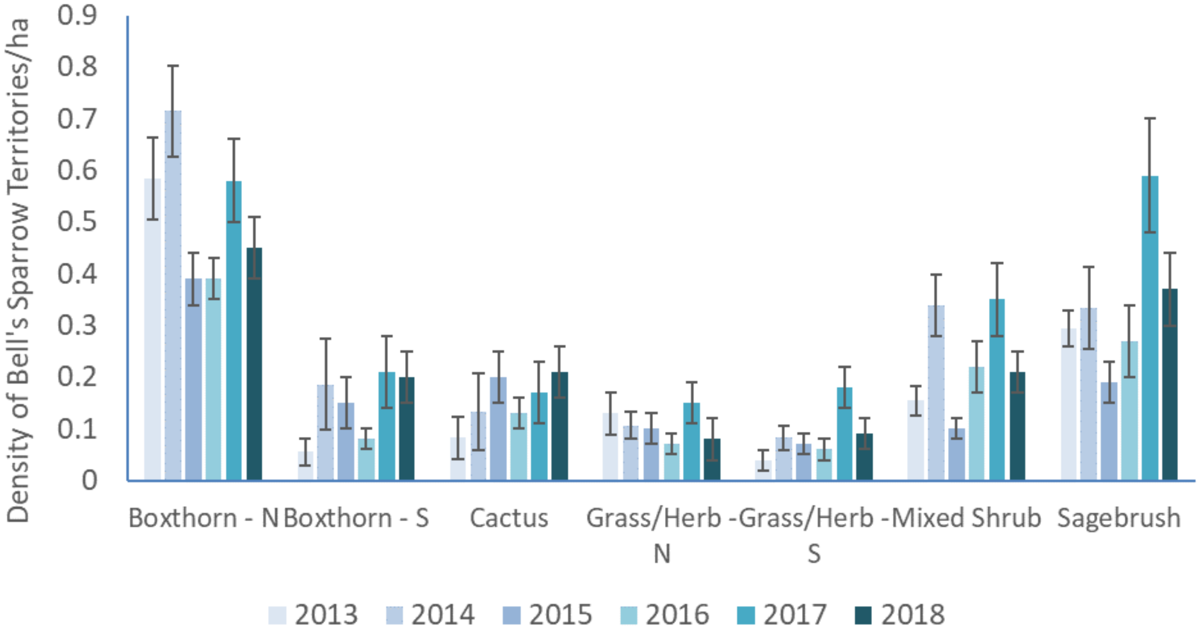

Figure 8. Annual San Clemente Bell's sparrow mean density estimates (± 1 SE) collected from 2013–2018 and sorted by habitat stratum on SCI, California. From Meiman et al. 2019, p. 38. Descriptions of each stratum can be found in Appendix A.

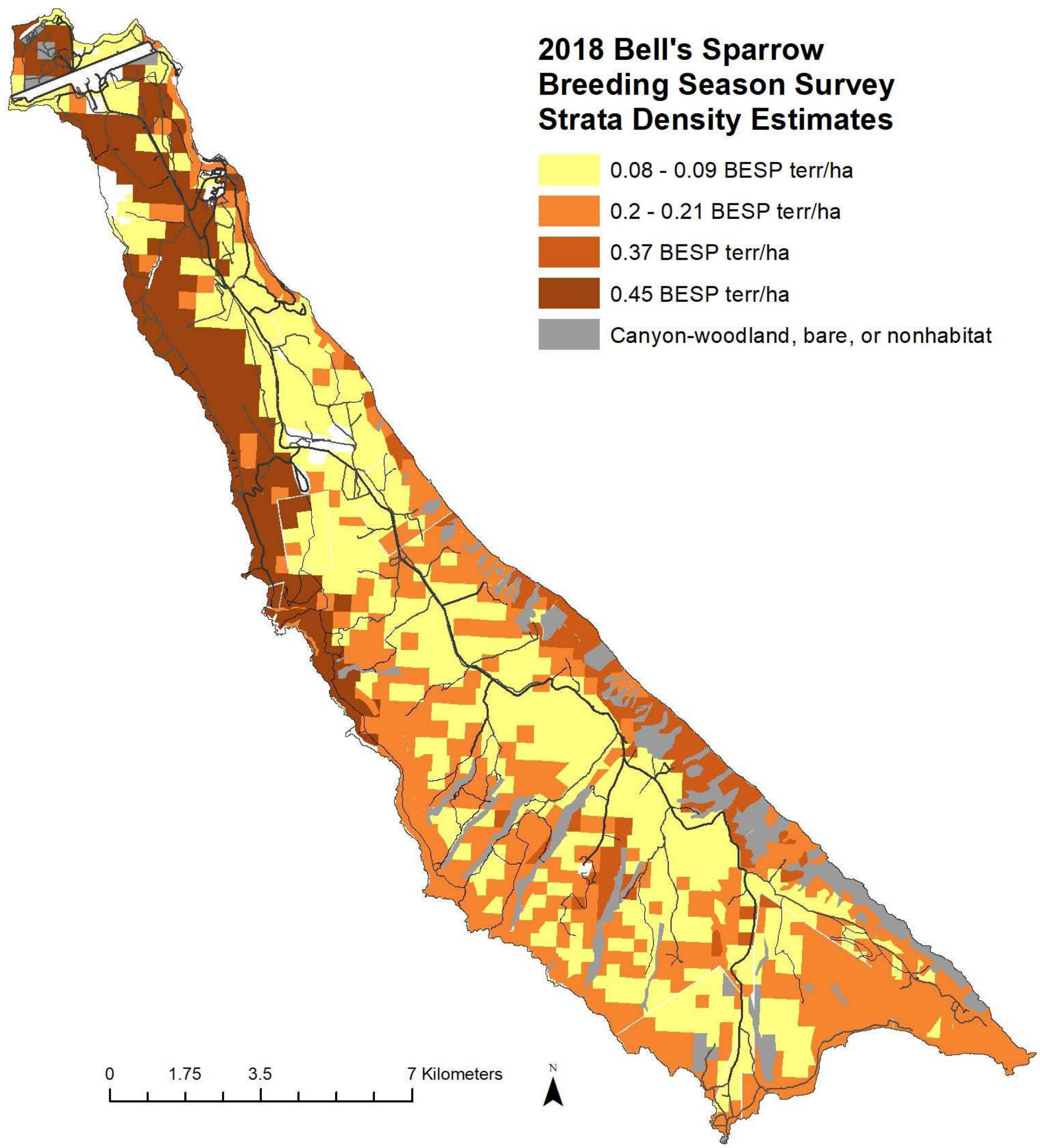

Figure 9. Estimated densities of San Clemente Bell's sparrow territories on SCI, California using double-sampling surveys for 2018. From Meiman et al. 2019, p. 18.

Survival

Prior to the 2013 sampling methodology, monitoring had indicated that juvenile San Clemente Bell's sparrows experience high first year mortality rates, with apparent juvenile survivorship declining between 2001 and 2008 (Kaiser et al. 2008, p. 126; Table 2). These survivorship estimates were based on complete band re-sight data (i.e., partial band re-sights were excluded from the analysis), and neither adult survival nor juvenile survival were correlated to rainfall or adult density (Kaiser et al. 2008, p. 37). Juvenile survival was considered a major concern, and the biggest factor in the risk of extinction (USFWS 2008b, pp. 167–185). The

Service suggested adult and juvenile survivorship may be underestimated due to variability in population monitoring, and that there may have been more juvenile survivors than was being estimated (USFWS 2008b, p. 171). The Navy proposed to investigate juvenile survivorship using telemetry to improve understanding of this variable. Since then, monitoring has discovered that juvenile dispersal to unsampled areas likely contributed to the low numbers of banded birds that were re-sighted, resulting in low survivorship estimates. Dispersing juveniles have been observed in habitats outside the boxthorn dominated areas where they had been more traditionally seen (Meiman et al. 2015, pp. 35–36), and data indicates that juvenile survivorship is higher than previously thought (Ehlers et al. 2013, p. 84). Island-wide double sampling, beginning in 2013, has found that Bell's sparrows are using many habitat types on SCI.

Nest success

Nesting success is relatively high island-wide (Figure 10, Table 3) (Meiman et al. 2018, p. 25). Nesting success does not appear to differ between the historic boxthorn habitat and other habitats on the island, indicating that these other habitats are likely not population sinks (Meiman et al. 2018, p. 24; Meiman et al. 2019, p. 25). In a currently unpublished study from 2014-2016, nests in boxthorn habitat and nests placed in boxthorn substrates produced smaller clutch sizes and fewer fledglings per successful nest compared to those located in other habitats and placed in other substrates (Meiman et al. in prep). Nesting success and clutch size (Figure 11 and Figure 12) as well as productivity and breeding season length, all appear to be influenced by average total rainfall (Meiman et al. 2018, pp. 34–36).

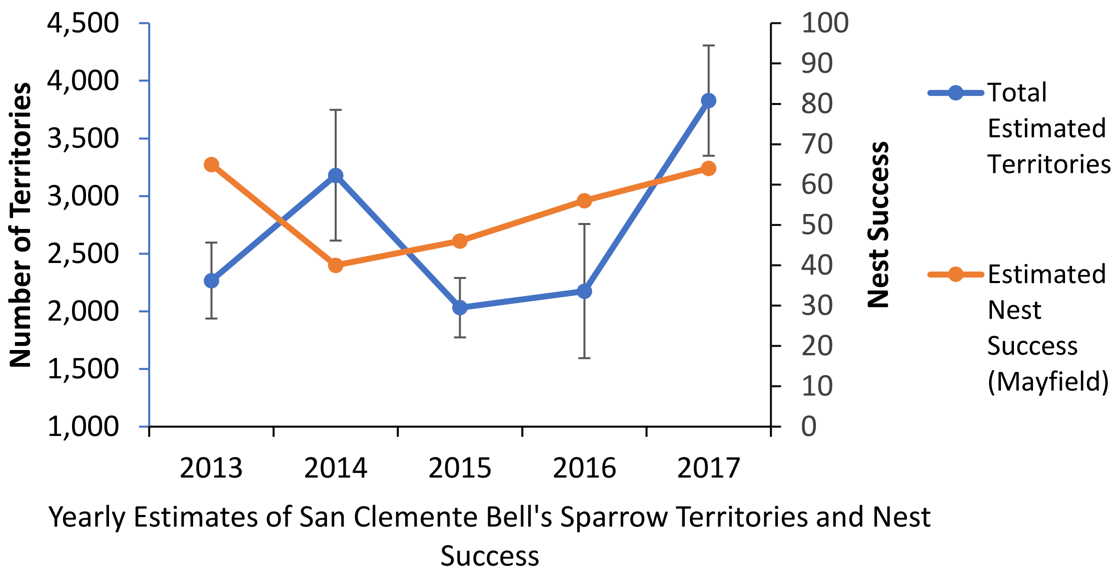

Figure 10. Bell's sparrow population estimates compared to nest success from 2013-2017, SCI, California. From Meiman et al. 2018, p. 38.

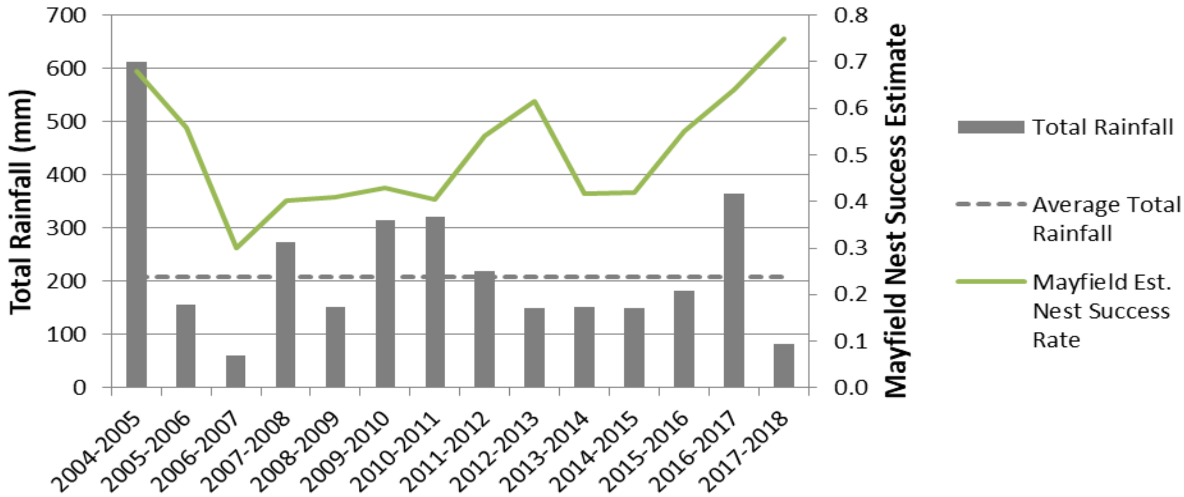

Figure 11. Yearly variation in Bell's sparrow estimated nest success and rainfall (averaged over the study years), SCI, California, 2004–2018. From Meiman et al. 2019, p. 27.

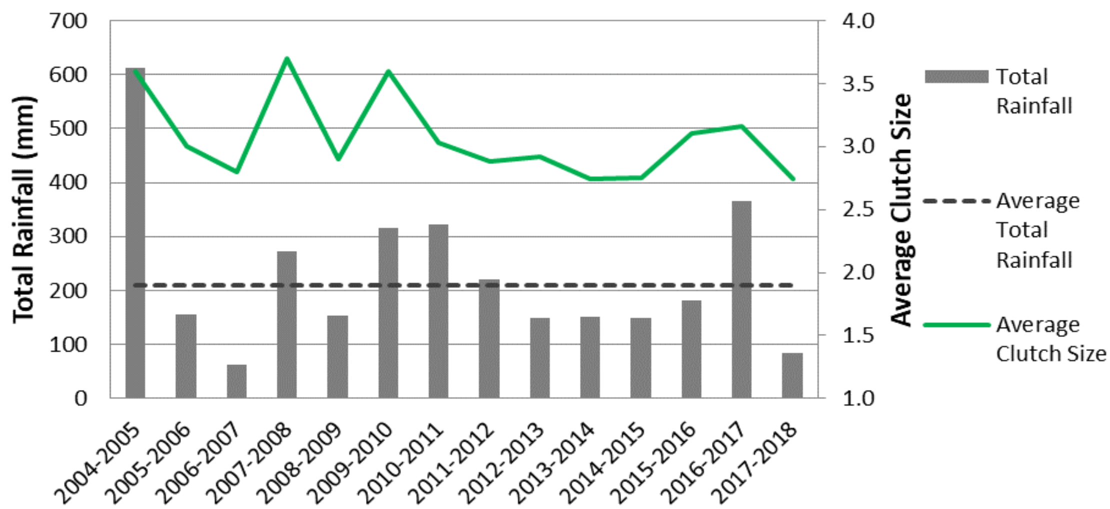

Figure 12. Bell's sparrow average clutch size and yearly rainfall (averaged over the study years), SCI, California, 2004–2018. From Meiman et al. 2019, p. 27.

Table 3. Daily nest survival rates (DSR) and associated standard errors (SE), Mayfield's stage survival rates (SSR) during the incubation (12 days) and nestling stages (11 days), and Mayfield's nest survival rates for the entire nesting cycle (NSR) of San Clemente Bell's sparrow nests on SCI, California, from 2006–2018. Taken from Meiman et al. 2019, p. 25.

	Incubation		Nestlings		Incubation and Nestling			
YEAR	DSR ± SE	SSR	DSR ± SE	SSR	Nests with Eggs or Nestlings	Nest Failed	Apparent Nest Success (%)	NSR (%)
2006	0.983 ± 0.004	0.811	0.967 ± 0.005	0.691	148	61	58.8	55.9
2007	0.968 ± 0.022	0.675	0.931 ± 0.033	0.456	12	6	50.0	30.7
2008	0.958 ± 0.002	0.594	0.965 ± 0.001	0.679	78	24	69.2	40.3
2009	0.949 ± 0.009	0.536	0.976 ± 0.006	0.762	92	38	58.7	40.9
2010	0.953 ± 0.009	0.564	0.976 ± 0.005	0.763	149	31	79.2	43.0
2011	0.960 ± 0.007	0.612	0.970 ± 0.006	0.713	122	41	66.4	40.4
2012	0.981 ± 0.005	0.799	0.977 ± 0.005	0.687	113	36	68.1	54.9
2013*	0.980 ± 0.008	0.782	0.979 ± 0.007	0.788	66	15	77.3	61.6
2014*	0.973 ± 0.008	0.723	0.951 ± 0.011	0.578	76	27	64.5	41.8
2015*	0.955 ± 0.012	0.574	0.971 ± 0.010	0.724	61	23	62.3	42.0
2016*	0.967 ± 0.008	0.666	0.983 ± 0.006	0.826	87	23	73.6	55.6
2017*	0.975 ±0.005	0.734	0.986 ±0.004	0.859	139	34	74.1	64.1
2018*	0.986 ±0.007	0.843	0.989 ±0.005	0.885	47	8	85.4	75.1
2006–2018 average	0.968 ± 0.008	0.658	0.970 ± 0.008	0.724	91.5	28.2	68.3	49.7

* Plot sampling expanded to include more areas of SCI.

SECTION 3 – SPECIES NEEDS

In this section, we synthesize the information about the species range, habitat, and life history to highlight the overall needs of the species. We start with the individual level, then move to the population level, and then finally to the species level. We consider that the effects are cumulative: survival of individuals contributes to survival of the cohort of individuals within a defined area which, in turn, contributes to the survival and persistence of the population and ultimately, the species.

If the needs of some number of individuals in a population are being met, allowing for an adequate population size and a sufficient rate of growth, then that population will likely have sufficient resiliency. The number of resilient populations, their size, distribution, and their level of connectivity can be used as a measure of the species' level of redundancy relative to potential catastrophes. Similarly, the breadth of genetic or environmental diversity within and among populations can be used as a measure of the species' level of representation. Thus, for the species to sustain populations in the wild over time and be viable, the populations need to be able to withstand stochastic events (to have resiliency), and the species as a whole needs to be able to withstand catastrophic events (to have redundancy) and to adapt to changing environmental conditions (to have representation).

For the purpose of this report, we define viability as the ability of the species to sustain itself in the wild over time. We describe the species' needs at the individual, population, and species' levels in terms of resiliency, redundancy, and representation.

3.1 Resiliency

For the San Clemente Bell's sparrow to maintain viability, its population or some portion thereof must be resilient to stochastic factors. Some stochastic factors that have the potential to affect Bell's sparrows include drought, fire, and disease. Other factors that influence the resiliency of Bell's sparrow populations include ecological integrity of its habitat to provide the dietary resources and cover necessary to support population size, and dispersal ability. Influencing those factors are elements of Bell's sparrow ecology that determine whether the population can grow to maximize habitat occupancy, thereby increasing resiliency (Figure 5). These factors and habitat elements are discussed below. Assuming that these factors influence the number of individuals that can or will occupy available habitat on the island, we will use population size (estimated number of territories and individuals) as our measure to estimate resiliency.

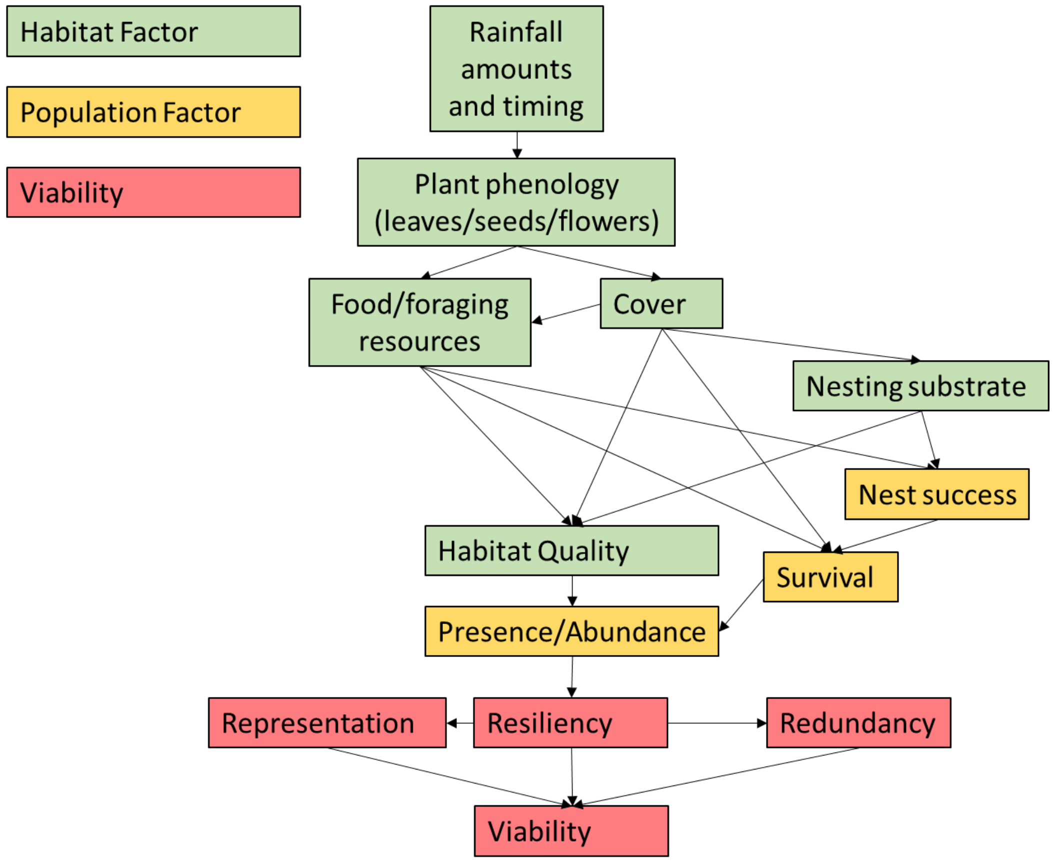

Figure 13. Habitat and population factors that influence the viability of Bell's sparrow throughout its range.

Individual Level

Like all animals, individual San Clemente Bell's sparrows have basic needs for survival: food, water, and cover from predators. During the breeding season, successful individuals require a nesting substrate, typically (and seemingly preferably) a shrub or sub-shrub, that provides suitable cover from the elements and predators. Preferred nest substrates may be boxthorn or sagebrush. Successful individuals also require access to mates, and adequate food resources (fruit, seeds, insects, etc.) to sustain both themselves and their nestlings. Bell's sparrows forage in and under shrubs, on insects drawn to flowers and on seeds, although they also may forage in open areas; thus, some shrub component seems to be required within its habitat, although the threshold at which shrub cover becomes so low that it is no longer habitat is unknown. Fires within Bell's sparrow habitat could kill individuals or reduce productivity, and fires that burn at a frequency or severity that affects shrubs could preclude individuals from utilizing these areas, possibly both for breeding and foraging. Bell's sparrows require adequate food resources to sustain themselves through the winter, although the complete winter diet is unknown. Individual survival and fitness are heavily dependent on the vegetation to provide food (fruit, seeds, insects attracted to flowers) and cover (for foraging and nesting). The phenology of the vegetation in a given year (the timing of leafing out, flowering, and seed set) is heavily influenced by the timing and amount of rainfall. Rainfall patterns also influence the life cycles/abundance and therefore availability of arthropods.

Population Level

For a population to persist, enough individuals in that population must be able to successfully reproduce such that over time, the number of new individuals is equal to or higher than the number of individuals lost to mortality. As the San Clemente Bell's sparrow seems to represent a single population, emigration and immigration will not factor into population resiliency. Successful reproduction requires enough individuals to find a mate, nesting site, and adequate resources to provide for the costly work of reproduction (defending a territory, nest building, incubation, mate and nestling feeding, etc.). There do not appear to be limitations to the ability of Bell's sparrows to locate mates on SCI; we do not see any fragmentation of the population that would preclude Bell's sparrows from accessing mates. For the other requirements, as discussed, having the adequate resources to successfully fledge offspring appears highly dependent on rainfall.

Also, for a population to persist, enough habitat with access to sufficient resources must be maintained to support a large number of individuals. Populations must be suitably large and connected to provide a reservoir of individuals to interbreed and to maintain levels of genetic diversity high enough to prevent harmful consequences from inbreeding depression and genetic drift (Ellstrand and Elam 1993, entire). The influence of stochastic variation in demographic (reproductive and mortality) rates is much higher for small populations than large ones. In general, the smaller the population, the greater the probability that stochastic fluctuations in demographic rates will lead to extinction. There are also genetic concerns with small populations, including reduced availability of compatible mates, genetic drift, and inbreeding depression. Small populations are generally more vulnerable to stochastic events. The number of individual Bell's sparrows necessary to meet these requirements is unknown; however, the population has rebounded from an apparent genetic bottleneck, declining to as few as 38 individuals in the 1980s. While we cannot be certain of the full extent of the genetic repercussions of this decline, there is no obvious impact. Given the dispersal distances of Bell's sparrows and their distribution across the island, habitat connectivity is likely not an issue (Taylor et al. 1993, p. 572).

3.2 Redundancy and Representation

Species Level

For the species to be viable, there must be a suitable population number, distribution, and connectivity to allow the species to withstand catastrophic events (redundancy). Redundancy improves with increasing numbers of viable populations and large population sizes, and connectivity among populations and individuals (either natural or human-facilitated) allows the species to "rescue" itself after catastrophes. For the San Clemente Bell's sparrow, which represents a single population, we would expect that a large population, distributed across SCI, with suitably high rates of productivity within several regions of the distribution, would have sufficient redundancy to withstand most imaginable catastrophic impacts (severe or large fires, extreme drought). For adequate redundancy, the population requires quality habitat that allows for successful reproduction in different geographic regions of the island, such that one impact would not deplete a huge percentage of the population, such that the population couldn't recover given other existing threats. While fires would have localized effects, drought would impact the entire island; many individuals occupying various habitats would increase the probability that enough Bell's sparrows would persist, perhaps by securing resources from the more drought tolerant plants or occupying areas that collect the most fog moisture.

Also for species viability, the population must have adequate genetic and environmental diversity to allow the species to adapt to changing environmental conditions (representation). Representation improves with increased genetic diversity and/or environmental conditions within and among populations. For this species, in absence of genetic information that would indicate genetic diversity, adequate representation would be indicated by the population being distributed throughout multiple habitat types and across multiple elevations, indication that the species is adapted to these different environmental and habitat conditions.

SECTION 4 – CURRENT CONDITION

In this section, we consider the San Clemente Bell's sparrow's current distribution and abundance as a measure of the availability of resources and other species' needs as described in the previous sections. We characterize the current condition of San Clemente Bell's sparrows in terms of their current resiliency, representation, and redundancy on SCI.

4.1 Populations

Resiliency is typically measured at the population level. In trying to delineate populations of San Clemente Bell's sparrows, we found no evidence to suggest that this subspecies is comprised of more than one population. As San Clemente Bell's sparrow numbers have increased and the subspecies has spread into new habitat types across the island, there do not appear to be barriers to dispersal or breeding. Of eight strata delineated for annual San Clemente Bell's sparrow surveys, only one type, canyon woodland/bare ground (7% of the island), is unoccupied. Although San Clemente Bell's sparrows occur in low densities in some areas, such as within the grasslands, this habitat contributes to current productivity and does not appear to present a barrier to dispersal. In addition, although Bell's sparrows typically exhibit little movement from their established territories (Hyde 1980 in USFWS 2008, p. 169), adults of this subspecies have been recorded moving up to 5.4 km (3.4 mi), and juveniles have been shown to disperse 14.6 km (9.1 mi) (Meiman et al. 2019, p. 52). Thus, even if habitat is fragmented, it is likely that Bell's sparrows could disperse to, or recolonize underutilized habitat areas.

4.2 Current Condition

Annual surveys of San Clemente Bell's sparrow density have broken the island down into eight vegetation strata (Figure 4). Because densities vary greatly among these strata each year (Figure 7), and because these strata are used for annual monitoring, we will assess the resiliency of the subspecies within each of these strata in terms of the estimated population size, but will then scale up from these strata to the resiliency of the subspecies. Therefore, we will be assessing how the subspecies is able to withstand stochastic events in each of these vegetation strata, and how the resiliency of each stratum contributes to the viability of the entire island population (the subspecies). We acknowledge that actual density patterns may not fit perfectly with the vegetation strata and that density may vary spatially within strata; however, monitoring has been done this way, and the habitat/density relationship is biologically significant.

Using the 2018 annual survey data of the current distribution of the subspecies (Meiman et al. 2019, pp. 15–18), we evaluated the estimated number of territories and the trends in density estimates by habitat strata, which indicate the ability of the San Clemente Bell's sparrow to withstand and recover from stochastic events.

The 2018 survey data estimated that the boxthorn-dominated habitat on the northwest side of the island (Boxthorn – N) supported approximately one third (34%) of the estimated territories on the island (Table 4). Together, the boxthorn strata (Boxthorn-N and Boxthorn-S) supported 40% of the island-wide population (Table 4). Mixed Shrub accounted for 19%. The Sagebrush stratum supported 10% of the estimated territories despite occurring on only 5% of the island area, due to the high density in this stratum (Table 4). Conversely, plots dominated by grasses (GrassHerb-N and GrassHerb-S) extend across 40% of the island but supported only 15% of the population and the data display high confidence intervals due to the sparse and patchy occupation of grasslands by Bell's sparrow.

Table 4. Results of the 2018 survey season by habitat strata, including the estimated density and estimated territories in each.

Strata	% of Island	Plots (count)	Est. Density	SE (Density)	Total Area (Ha)	Estimated Territories	Lower 95% CI	Upper 95% CI
Boxthorn – N	14.4%	21	0.45	0.06	2,034.51	924.20	667.29	1,181.11
Boxthorn – S	4.8%	7	0.20	0.05	677.10	134.65	69.48	199.82
Cactus	11.8%	16	0.21	0.05	1,678.30	346.89	181.84	511.93
GrassHerb – N	16.1%	12	0.08	0.03	2,279.50	191.23	42.37	340.09
GrassHerb – S	23.7%	12	0.09	0.04	3,356.57	302.09	58.47	545.71
Mixed Shrub	16.6%	21	0.21	0.04	2,359.17	499.34	302.51	696.17
Sagebrush	5.3%	14	0.37	0.07	748.48	277.86	171.55	384.16
Total						2,676.26	1,493.52	3,859.00

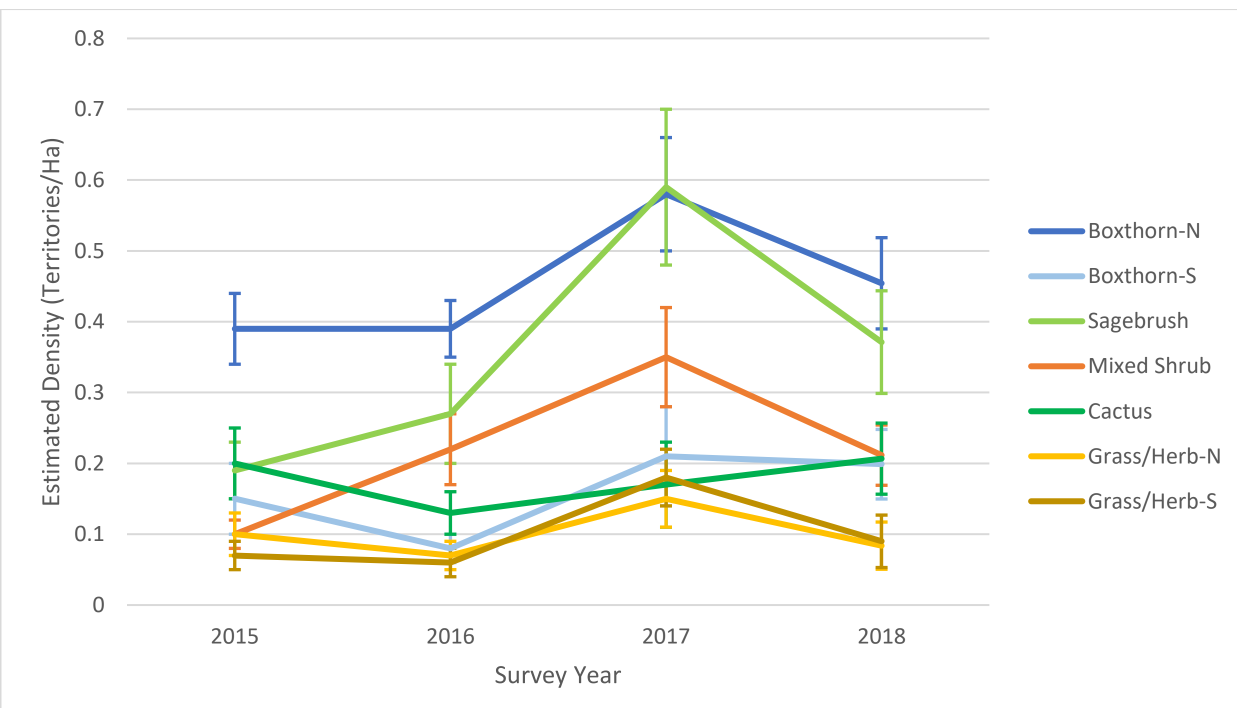

Figure 14. Plots of density estimates by habitat strata from 2015-2018. Error bars represent standard error.

Because the current habitat strata were not incorporated into the survey design until 2015, we can evaluate density estimate trends within each stratum for only the past four years (Figure 14). While all strata except Cactus were the highest in 2017, Sagebrush densities increased the most from 2016 values. While data are limited, we have no indication that San Clemente Bell's sparrows are declining in any stratum during this timeframe (2015–2018). Given that reproductive effort can vary annually and other stochastic factors, fluctuations in density are expected.

Using the overall estimated island-wide density, Meiman et al. (2019, p. 15) reported that, in total, there were an estimated 2,642 (95% CI 1,947–3,336) San Clemente Bell's sparrow territories on SCI in 2018 (Table 4), or approximately 5,284 individuals, while only 93 individual birds were known at listing. Using the individual densities from each stratum and summing the territories, the estimate is similar, at 2,676 territories (95% CI 1,494–3,859). Due to the survey focus on the northwest boxthorn habitat through 2011, and island wide surveys only commencing in 2013, we cannot determine how fast the population grew or at what point this subspecies began colonizing other parts of the island as the vegetation recovered and habitat became available. We do know, however, that the population has increased since listing; whether or not it has plateaued in recent years or has begun to decrease is unknown. Looking at the past 5 years, when island-wide estimates of total territories were reported, we see that the 95% confidence intervals overlap among survey years (Figure 15). While we do not have a long enough time scale to show a long-term trend, a trendline set to these years shows an increase of 56 territories per year. Given the ability of this population to fluctuate over time and no known increase in threats, evidence does not suggest that the population is decreasing.

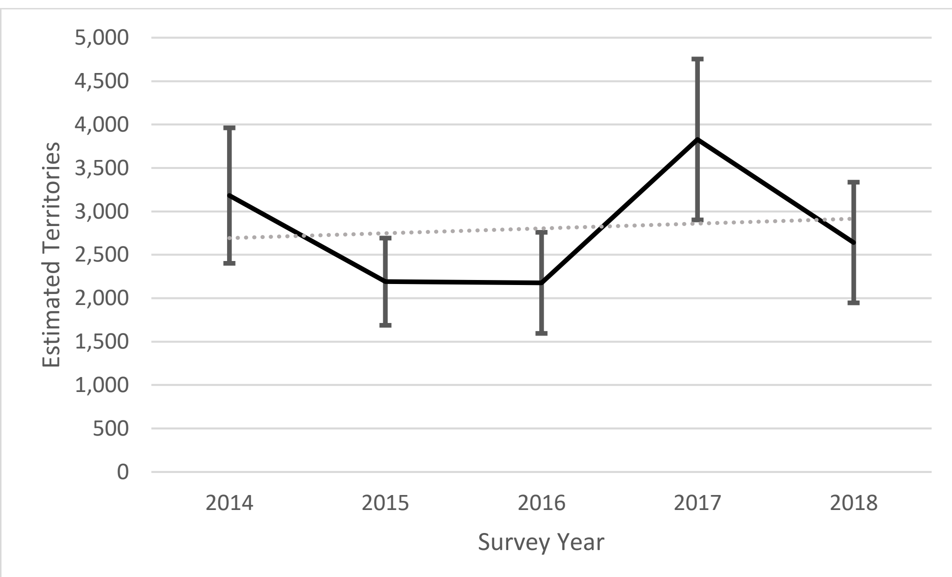

Figure 15. Estimated total San Clemente Bell's sparrow territories on SCI (and 95% CIs) by year from 2014–2018 and resulting trendline.

4.3 Current Population Resiliency

We define the species' current resiliency based on the estimated numbers of territories and individuals island-wide from the estimates within each habitat stratum, accounting both for trends in estimated territory densities within stratum and trends in the island-wide territory estimates. We assume that this population has persisted given the existing factors that can affect viability (threats to individuals and habitat) and is a product of life history, demographics, and habitat factors, such as shrub availability, arthropod abundance, seed and fruit abundance, habitat quality, dispersal ability, nest success, and survival. We assume that current resiliency of the island-wide population is a product of their numbers and population trend over time.

The current population (2018) is estimated at 2,676 territories and 5,284 individuals island wide. Almost 35% of the population occurs within the northern boxthorn habitat stratum (Table 4). Trends do not indicate that the territory density in any habitat strata are decreasing, although individual stratum fluctuate annually. Overall, the population of San Clemente Bell's sparrows on SCI has increased since listing and, for at least the past five years, has withstood current stochastic effects. Given these trends and the relatively large population size, we consider this population to currently be highly resilient to stochastic factors.

4.4 Current Species Representation

We have no evidence of genetic units within the population of San Clemente Bell's sparrows. However, the species is ecologically well represented in plant communities that support shrub vegetation. The ability to successfully breed at a wide range of elevations and utilize a wide range of habitats indicates that this subspecies exhibits environmental plasticity and is very adaptive, which they appear to have maintained through the population bottleneck. Thus, we expect this subspecies has likely retained the necessary representation that has allowed it to historically withstand changes in environmental conditions. Coupled with redundancy, this representation has likely facilitated the subspecies' ability to deal with changes in environmental conditions throughout history such as drought cycles, including the most recent drought in California, and the slowly changing climate. However, extreme or extended drought could still have major impacts to the subspecies, as the full effects of prolonged or severe drought are unknown.

4.5 Current Species Redundancy

San Clemente Bell's sparrows are well distributed across the island and occur in moderate to high densities along the northern west shore, along the eastern escarpment, and in some central areas of the island (Figure 9). They occur in lower densities along the southern western terraces and in the southeastern-most part of the island. Given their numbers and distribution, and considering the likely potential catastrophic events, we envision that only an unusually severe event that would impact the entire island could foreseeably extirpate the taxon entirely. A catastrophic fire or a severe drought are the most plausible potential impacts. We expect that even a large, severe fire would be unlikely to affect a significant portion of the island; however, 35% of the population is currently estimated to exist in the northern boxthorn habitat stratum alone, and 40% of the population is supported by the boxthorn habitat if we group the north and south together. A fire or other impact that removed a substantial portion of the boxthorn habitat or other high-density habitat could have significant effects to the population size. While only an extreme, prolonged drought could wipe out the subspecies entirely, the effects of multiple, severe drought years, coupled with other stressors, could have substantial impacts to subspecies viability. A severe drought, for instance, has the ability to impact the vegetation island-wide, as drought could affect the vegetation's phenology, which would impact the food and cover resources of Bell's sparrows across broad areas of the island. Bell's sparrows have been shown to suppress breeding in drought years. We expect that drought would affect different species of shrubs in different ways depending on their drought tolerance and that drought impacts would have both an elevational gradient and an east/west difference due to prevailing wind direction. Given their wide distribution, we expect at least some of the population would be able withstand even relatively severe drought, perhaps by securing resources from the more drought tolerant plants or occupying areas that collect the most fog moisture. However, depending on the length and severity of drought, impacts to the subspecies could be substantial. These threats will be discussed further in Section 5. Because San Clemente Bell's sparrows are limited to San Clemente Island, they would be unable or unlikely to disperse elsewhere in the event of an impact that affected the entire island.

SECTION 5 – FACTORS INFLUENCING VIABILITY

The following discussion provides a summary of the factors that are affecting or could be affecting the current and future condition of the San Clemente Bell's sparrow throughout some or all of its range.
Threats to San Clemente Bell's sparrow at the time of listing included: 1) feral livestock; 2) predation by feral cats; and 3) small population size and limited distribution. Since that time, the largest threat, feral livestock, has been removed, and the island has steadily recovered. Threats considered in the 1984 Recovery Plan (USFWS 1984, entire) and the Five-year review (USFWS 2009, entire) have varied (Table 5) and have included: reduced food supply, invasive species, land use, fire and other stochastic events, and climate change. Based on our assessment of current influences on the San Clemente Bell's sparrow (

Figure 16), we will address similar threats as presented in the 2009 5-year review.

Table 5. Review of past and current threats assessed for the San Clemente Bell's Sparrow.

Threat	Listing 1977	Recovery Plan 1984	5-year Review 2009
Feral Livestock	X	X	-
Reduced/Unavailable Food Supply	-	X	-
Predation from Invasive Species	X	X	X
Land Use (military activities)	-	-	X
Small Population Size	X	-	X
Stochastic Events/Fire	-	-	X
Climate Change/Drought	-	-	X

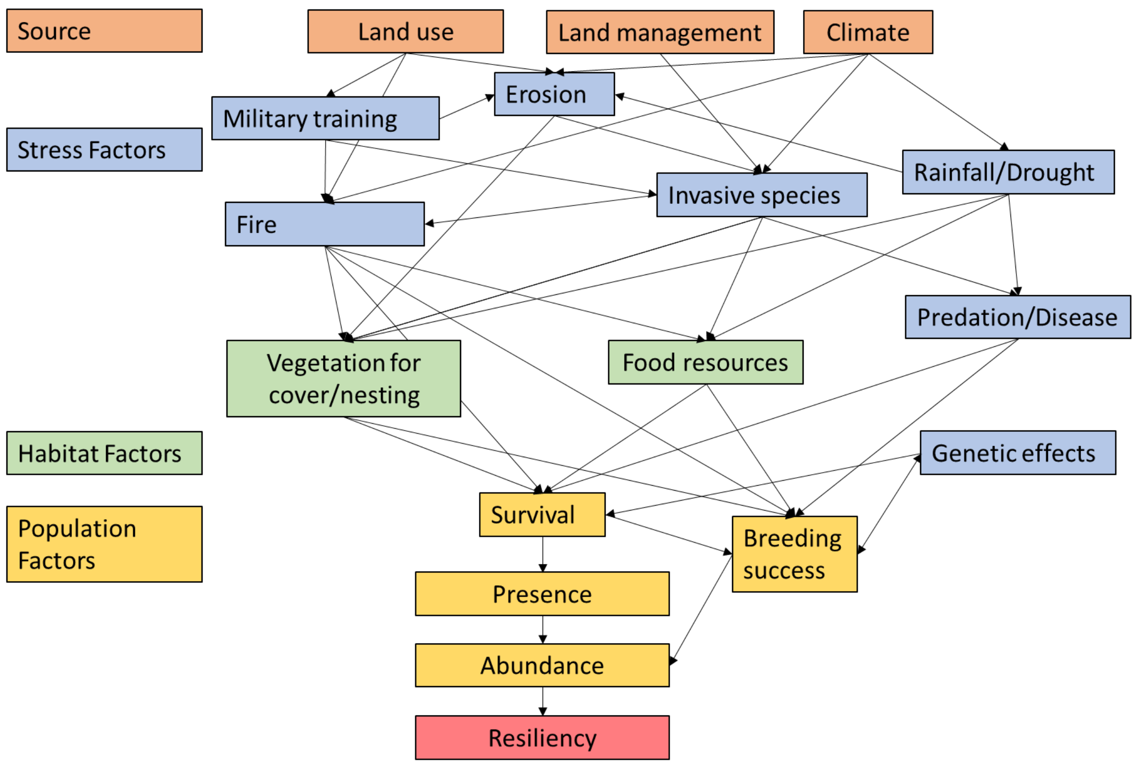

Figure 16. The main factors that may affect population resiliency of the Bell's Sparrow population. This is not an exhaustive list of all potential stressors, and interactions are meant to be simplified.

5.1 Military training and other human activities

SCI is owned by the U.S. Department of the Navy (Navy) and, with its associated offshore range complex, the island is the primary maritime training area for the Pacific Fleet and Sea Air and Land Teams (SEALs). The island also supports training by the U.S. Marine Corps, the U.S. Air Force, U.S. Army, and other military organizations. As the western most training range in the eastern Pacific Basin, where training operations are performed prior to troop deployments, portions of the island receive intensive use by the military (US Navy 2008a, p. 2–2). Various training activities occur within particular land use designations and training areas on the island. Military training activities within some of these training areas can involve the movement of vehicles and troops over the landscape and can include live munitions fire, incendiary devices, demolitions, and bombardment (Table 6).

Table 6. Land-based training areas on SCI (2008-current/2019), including their size, the percent of the island they encompass, and their use. (AVMA: Assault Vehicle Maneuver Area; IOA: Infantry Operations Area; TAR: Training Area and Ranges).

Training area	Size (Acres)	% of island	Use
AVMAs (3)	1,060.5	3%	Tracked and wheeled vehicular maneuvering
IOA	8,827.6	24%	dispersed foot traffic

TARs (20) (terrestrial only)	1,968.2	5%	Explosives/demolition, ingress/egress, live or blank fire, RDT&E
Impact Areas (2)	3,399.7	9%	Explosives/demolition, live munitions fire (small arms, artillery, naval gun), incendiaries, bombardment (ship to shore, air to ground)

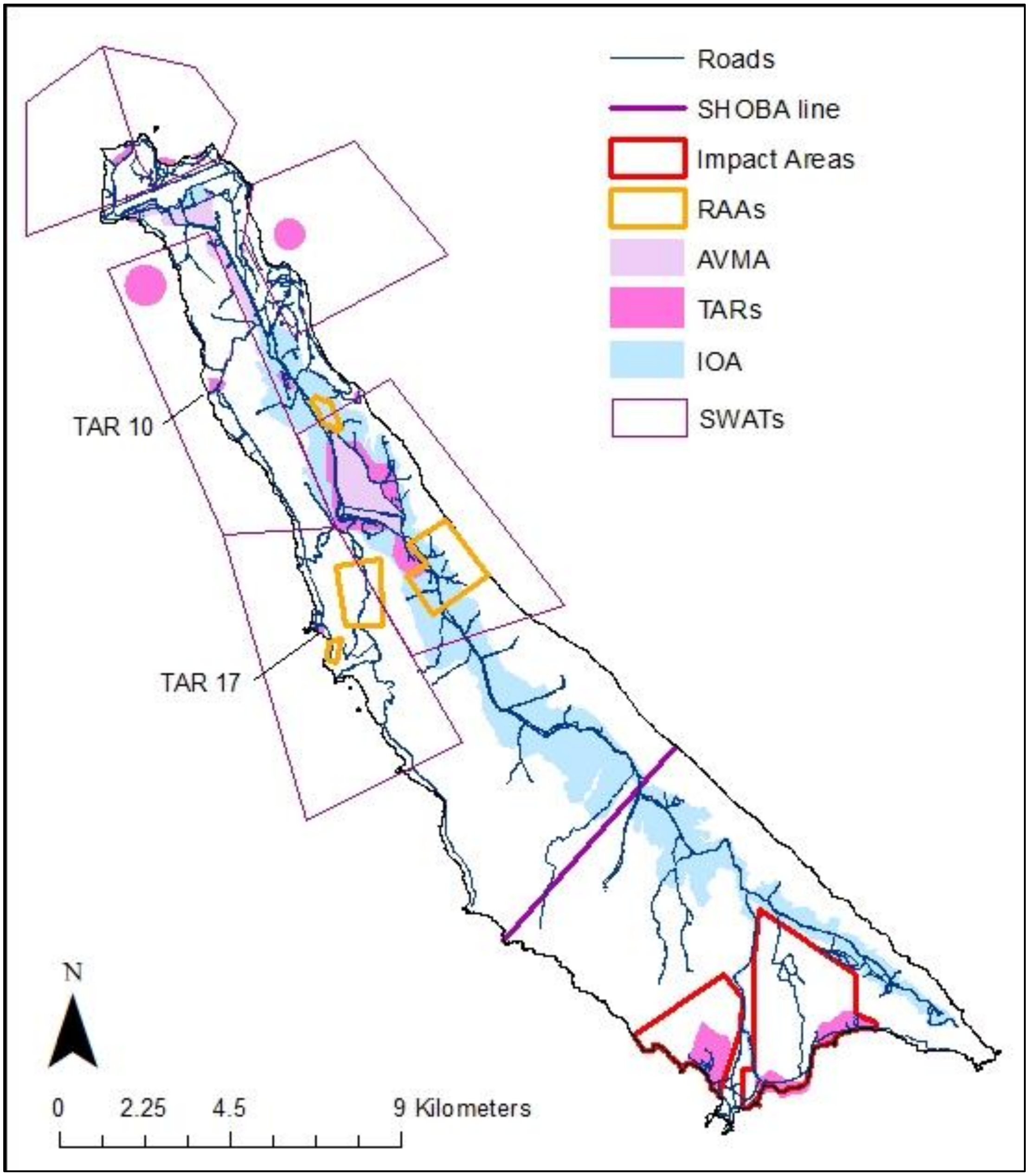

Figure 17. Locations of training areas on SCI, including the Impact Areas, the Training Areas and Ranges (TARs), the Assault Vehicle Maneuver Areas (AVMAs), the Infantry Operations Area (IOA), and the Shore Bombardment Area (SHOBA), which occupies the southern third of the island. The Restricted Access Areas (RAAs) are also shown.

SCI supports 20 terrestrial Training Areas and Ranges (TARs), three Assault Vehicle Maneuver Areas (AVMAs), and the Infantry Operations Area (IOA). TARs are operating areas that support demolition, over-the-beach, and tactical ingress and egress training for Naval Special Warfare personnel (US Navy 2008a, p. 2–7). AVMAs are designated for off-road vehicle use, including tracked vehicles, and the IOA is designated for dispersed foot traffic by military units in support of a battalion-sized landing (US Navy 2008a, p. 2–37) (Figure 17). While the IOA is a broad designated area for foot traffic, use has been, and is anticipated to continue to be, concentrated around the AVMR (Artillery Vehicle Maneuver Road). Soldiers fan out from but move in concert with artillery vehicles, which are restricted to the AVMAs and AVMR; accordingly, foot traffic has occurred predominantly within 50 feet of the AVMR, within the IOA (Booker 2019, pers. comm.). Other potential impacts (artillery firing points [AFPs] and bivouacking) within the IOA also occur near the road (USFWS 2008, pp. 42, 164). This buffer around the AVMR makes up less than 1% of the IOA (Table 6).

Additionally, six near-shore Special Warfare Training Areas (SWATs) have been designated on and around SCI (Figure 17). These large areas encompass land, water, and associated airspace. They are used as ingress and egress of small troops to specific TARs. Basic and advanced special operations training is conducted within these areas by Navy and Marine Corps units (US Navy 2013a, p. 2.10; US Navy 2008a, p. 2.7). Thus, impacts from training in these areas is infrequent and dispersed (Booker 2019, pers. comm.).

The Shore Bombardment Area (SHOBA) is the largest terrestrial training area on SCI and supports a diversity of military training (including Anti-Surface Warfare, Amphibious Warfare, Naval Special Warfare, Bombing Exercises, and Combat Search and Rescue) (Figure 17). SHOBA occupies roughly the southern third of the island and is approximately 13,824 ac (5,594 ha) (US Navy 2008a: Tables 2–7; US Navy 2009, p. 2–4). Areas of intensive use within SHOBA include the two Impact Areas and three TARs, which lie within the Impact Areas. Impact Areas support naval gun firing, artillery firing, and air-to-ground bombing (US Navy 2008a, p. 2–7; US Navy 2013a, p. 2–8). Collectively, the Impact Areas and TARs within SHOBA encompass 3,400 acres [1,376 ha], which amounts to 24.6% of the area within SHOBA. Much of the remainder of SHOBA serves as a surface danger zone (buffer) around Impact Areas I and II, and 59% of SHOBA is not within the IOA, Impact Areas, or a TAR and therefore not subject to any direct training activities. Some areas, particularly the escarpment along the eastern coast, have limited training value because precipitous terrain hinders ground access.

The Impact Areas sustain live fire, which is a recurrent source of fires. Most fires are of low severity, which does not have a strong negative impact to shrubs (see Table 9). While canyons and slopes within the Impact Areas may support shrubs (Figure 18), little shrub vegetation persists in many parts of the Impact Areas, which is likely the result of the altered fire frequency. Fuel breaks are applied each year prior to fire season to help prevent spread of fire to areas outside of the Impact Areas for protection of natural resources. Fire will be discussed in greater detail in Section 5.2. Because parts of SHOBA are used for bombardment, access to this area is restricted for nonmilitary personnel on days when bombing is occurring. Individuals conducting surveys or working on invasive species control projects are granted access to areas outside of the Impact Areas within SHOBA when military activities requiring exclusive use are not occurring. Because of the frequency of training, access to SHOBA can be restricted for periods of time.


Figure 18. Shrub vegetation, including boxthorn and endangered San Clemente Island bushmallow (*Malacothamnus clementinus*), within TAR 21, which is also part of Impact Area I.

The IOA encompasses approximately 25% of the island, the Impact Areas encompass about 9.4% of the island, TARs, which in places overlap the IOA, Impact Areas, and AVMAs, cover 5.5 % of the island, and the AVMAs, which fall entirely within the IOA, encompass about 3% of the island (US Navy 2008a, p. 2–17, 2–45; US Navy 2008b, p. 3.11–52) (Table 6, Figure 17). Altogether, 34.8% of the island's area is located in one of these training areas; much of the island is devoid of any infrastructure. In comparison to many other military installations, there is a very low visual presence of the military on SCI (McFarland 2019, pers. comm.).

In 2008, the Southern California Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) (US Navy 2008a) and the accompanying Biological Opinion: San Clemente Island Military Operations and Fire Management Plan (BO) (USFWS 2008) were finalized, and together, these documents allowed for increased training at SCI and addressed obligations for fire management and listed species management (US Navy 2008a, pp. 2.1–2.52). To avoid underestimating impacts and to ensure adequate coverage under all applicable federal laws and regulations, including but not limited to the National Environmental Policy Act (NEPA), the ESA, and the Clean Water Act, the analyses considered a training tempo that was at the highest reasonably anticipated level. It is unlikely that the maximum operational tempo will be reached for all activities simultaneously because overseas deployments, availability of personnel and assets, planning and construction timelines, development of platforms and systems, and other factors can lower the tempo and/or delay implementation; however, it was necessary to analyze the potential impacts of such a tempo (O'Connor pers. comm., 2019).

Training began to increase soon after issuance of the 2008 BO and Record of Decision (ROD) for the EIS, but increases in some types of training, particularly those that required acquisition of assets, development of platforms and systems, and/or planning and construction, have increased more gradually, and some have not reached the operational tempo in the documents (see Section 5.7), although the tempo of training is not reported. The TARs (all except TAR 19) were fully developed and utilized shortly after issuance of the ROD and have been in use since. TARs 10 and 17 were of particular concern due their location on the west side of the island within high-density San Clemente Bell's sparrow habitat and the introduction of new ignition sources to the west shore (Figure 17). These two TARs together encompass approximately 169 ha (418 ac) of habitat and were estimated to support between 27 and 93 Bell's sparrows in 2008 (USFWS 2008, p. 174). Both TARs include the use of live fire and demolition (USFWS 2008, pp. 24, 29). After approximately 11 years of use, no fires have occurred in either of these TARs, and focused monitoring of plots both within the TARs and TAR-adjacent has not detected impacts to Bell's sparrow from military training in either location (Meiman et al. 2018, p. 39).

Range schedulers are aware of the natural resources obligations within SHOBA, and at least 1 day a week is usually allowed for natural resource programs to conduct their activities. Weeks with reduced natural resource access, including infrequent events that exclude natural resources personnel from SHOBA for 10 to 20 days, are announced in advance and provide natural resources managers the opportunity to plan accordingly. Impact Areas I and II have been indefinitely closed for any activities except for range maintenance, range clearance, and military activities. For safety reasons, restrictions include any activity associated with biological monitoring and surveys ''for any purpose, including monitoring and management of endangered and sensitive species and their habitat'' (US Navy 2008a, p. 2–45).

Access to additional areas on the island where unexploded ordnance has been found is often restricted for natural resources personnel, but these areas are removed once they are assessed by unexploded ordnance specialists and are deemed safe for entry (Figure 17). When closed, these restricted access areas (RAAs) can be accessed if accompanied by a trained unexploded ordinance technician (Munson 2019, pers. comm.).

San Clemente Bell's sparrows may be adversely affected in habitat within and surrounding operational areas by ordnance use, accidental fire, fire containment and suppression, air traffic, foot traffic and vehicle traffic. These adverse effects include modification and degradation of habitat; disturbance, death or injury of individual sage sparrows (more likely nestlings and fledglings), and loss of active sage sparrow nests (USFWS 2008, p. 174). The Service estimates that 65 Bell's sparrow adults or fledglings and 46 nests may be taken during each 5-year period as a result of training activities, including fires resulting from training (USFWS 2018, p. 15). Impacts to San Clemente Bell's sparrows from military training activities have been limited because most of the intensive impacts occur outside of high-density Bell's sparrow habitat (Figure 17, Figure 9). However, Bell's sparrows have continued to inhabit and successfully reproduce in habitat adjacent to and within the TARs, IOA and AVMAs (Figure 19) (Meiman et al. 2018, p. 39). Because training activities in each TAR vary widely and Bell's sparrow density also varies, potential threats vary by TAR. Two TARs (10 and 17) are located within high-density Bell's sparrow habitat within the boxthorn on the west shore, and both TARs include the use of live fire and demolition (Figure 17) (USFWS 2008, pp. 24, 29), which can directly impact sparrows within the TARs or could ignite a fire that could burn outside the TARs, although no fires have burned outside the TARs here since training began. San Clemente Bell's sparrows that occur within and nearby these two TARs were monitored from 2015 to 2018 to assess population density change within plots both within the TAR and TAR-adjacent plots (Meiman et al. 2019, p. 9). Random, non-TAR plots provided an index of the range of change expected. The mean density in the plots for both TARs decreased between 2015 and 2016, despite the random plots increasing. Between 2016 and 2017, TAR 17 plots increased on average, although some individual plots decreased. The mean density increased in TAR 10 more between 2016 and 2017 than observed elsewhere or in the random plots in previous years (Figure 20) (Meiman et al. 2019, pp. 20–23). Densities on the TAR and TAR-adjacent plots are comparable to the densities within the rest of the boxthorn habitat, although densities varied annually (Meiman et al. 2019, pp. 22-23, 38). Thus, the results of the TAR monitoring do not indicate major impacts to Bell's sparrow densities due to training in these TARs on Bell's sparrows, and Bell's sparrows continue to inhabit these areas. However, specific demographic parameters, such as nesting success or survival, have not been monitored or compared specifically in relation to the TARs.

San Clemente Bell's sparrow habitat also occurs within the boundaries of the IOA and SWATs; disturbances and threats within the IOA are limited to dispersed foot traffic, mostly within 100 ft of the AVMR, AVMAs and Ridge Road (the primary road down the spine of the island) (Booker 2019, pers. com.). Impacts could include trampling of Bell's sparrows nests or nestlings near the roads or temporary disturbance. Dispersed foot traffic can also occur within the SWATs, typically between the TARs and the coastline. However, due to the nature of the foot traffic in these areas, impacts to nests or nestlings and disturbances are assumed to be infrequent and will remain so given training does not change. Habitat also occurs within the boundaries of the AVMAs and along the Artillery Vehicle Maneuver Road (AVMR), which runs through the Assault Vehicle Maneuver Corridor (AVMC; which consists of the AVMR and AVMAs collectively). As analyzed in the EIS/OEIS and BO (US Navy 2008a, USFWS 2008), off-road vehicle use in these areas is expected to result in erosion and the spread of nonnative exotic plant species. However, the major vehicular movement through this area will be confined to a limited number of unpaved roads and small areas with low erosion potential as a precaution against severe erosion, and as of yet, most of this area has not been used (US Navy 2013b, p. 37-50, 111). San Clemente Bell's Sparrows continue to be present in these areas (Meiman et al. 2018, p. 17).

Although the Impact Areas are inaccessible to monitoring by biologists, Bell's sparrows are present in immediately adjacent habitat (Figure 19). Additionally, observations outside the Impact Area boundaries and a single visit by a team of Navy biologists into Impact Area I, which was conducted under a one-time waiver of access restrictions in support of environmental planning for USMC amphibious landings at Pyramid Cove, verified that suitable habitat persists within the Impact Areas. As there is no boundary to avian movement in or out of the Impact Areas, suitable habitat within Impact Areas is expected to be occupied at a rate comparable to that adjacent to the Impact Area boundary.

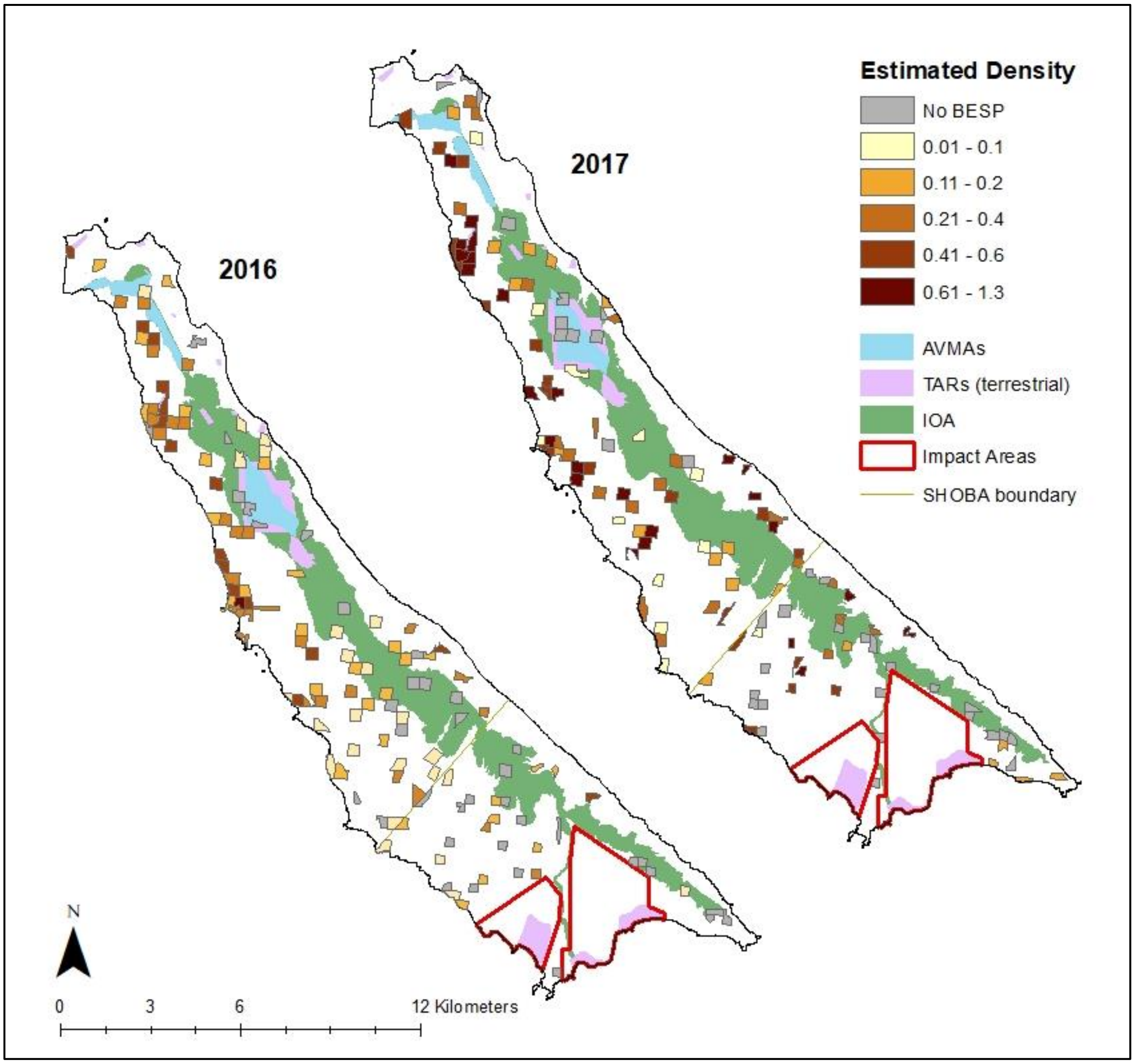

Figure 19. Locations of monitored plots in 2016 (left) and 2017 (right) and the estimated density on those plots in relation to the training areas (Assault Vehicle Maneuver Areas (AVMAs), Training Areas and Ranges (TARs), Infantry Operations Area (IOA), and Impact Areas) on SCI (Meiman et al. 2017, Meiman et al. 2018, data). Several plots within or adjacent to training areas had detected San Clemente Bell's sparrows within them in both years. 2018 data was not available.

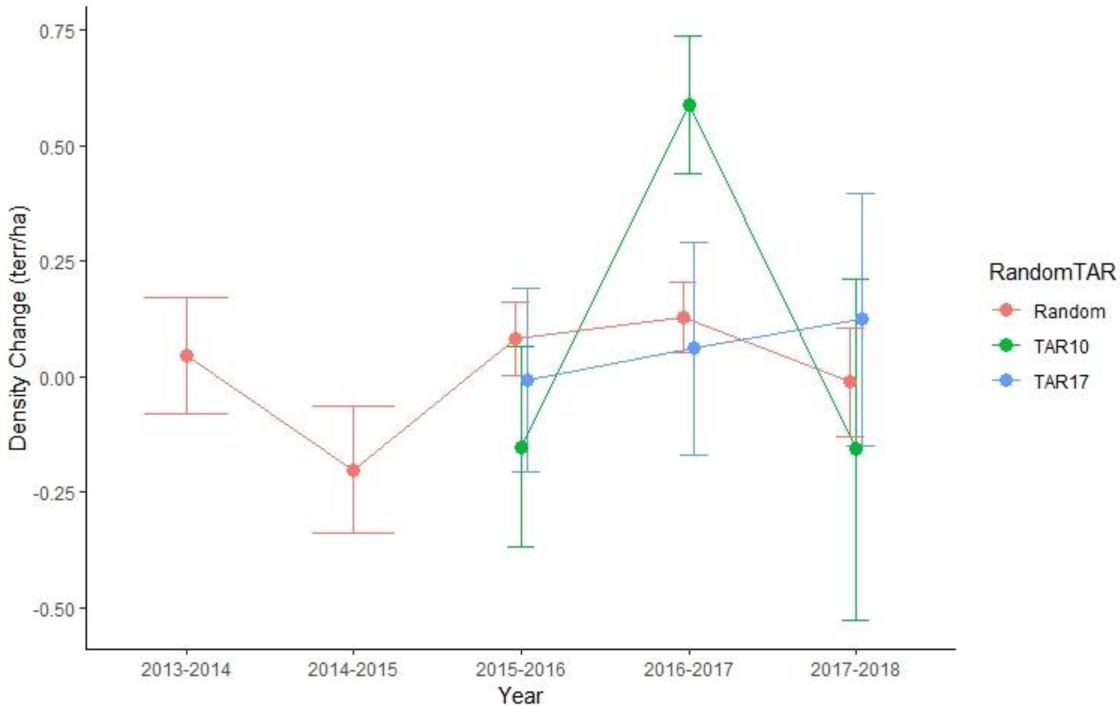

Figure 20. Mean changes in Bell's sparrow densities on random plots surveyed as rapids and in Training Area and Ranges (TAR)-adjacent plots (±SD), 2013–2018. From Meiman et al. 2019, p. 21.

Thus, specific human activities that have and/or still represent potential adverse effects to Bell's sparrows and/or their habitat are limited to current training, with associated foot and vehicular traffic, ordnance disturbances, infrastructure maintenance, and elevated fire frequency. However, these effects are likely to impact a small percentage of the population.

Currently, 4,788 ha (11,831 ac) of potential San Clemente Bell's sparrow habitat falls within a training area. Based on the 2018 territory density estimates, this represents 25% of the total island population (Table 7). These training areas overlap; again, based on the 2018 territory density estimates, individually, the IOA provides habitat for approximately 17% of the population, while the Impact Areas provide habitat for approximately 7%, and the TARs and AVMAs combined support only about 5% of the population (Table 8). Although the TARs are fairly small areas, TAR 10 and TAR 17 are located within some of the densest Bell's sparrow habitat; although there is no evidence of impacts to Bell's sparrows outside the TAR boundaries, and although no fires have burned outside the TAR boundaries as a result of training in those TARs to date, large numbers of the subspecies could be impacted were training to cause disturbances in habitat surrounding these TARs.

Table 7. Hectares and approximate number of territories occurring within training areas based on the 2018 estimated territory densities and the percent of the total island population represented.

Estimated Density 2018	Hectares	Approx. Territories	Percent of total population
0.08-0.09	3,097.9	247.8	9%
0.2-0.21	1,346.8	269.4	10%
0.37	78.0	28.8	1%

0.45	265.3	119.4	4%
Total	4,788.0	665.4	25%

Table 8. Percent of the estimated island-wide San Clemente Bell's sparrow population that occurs within each of the training area types, broken down by estimated territory density from the 2018 surveys (Meiman et al. 2019, dataset).

Estimated Density 2018	**IOA**	**TARs**	**AVMA**	**IA**
0.08-0.09	7.77%	1.37%	0.91%	1.43%
0.2-0.21	4.39%	1.25%	0.15%	5.73%
0.37	0.98%	0.00%	0.00%	0.13%
0.45	3.92%	0.54%	1.06%	0.00%
Total	17.06%	3.16%	2.12%	7.29%

IOA = Infantry Operations Area; TARs = Training Areas and Ranges; AVMA= Assault Vehicle Maneuver Area; IA = Impact Area

SCI also supports infrastructure including: linear utilities (i.e., electrical, water, wastewater and fuel); roads and associated drainage structures; fences and gates; and buildings, quarries and other facilities (Figure 21), which require maintenance and repair and could impact San Clemente Bell's sparrows. However, most impacts will be infrequent and minor. Further, these maintenance and repair corridors support less than 6% of the potential habitat on SCI (USFWS 2017, p. 24).

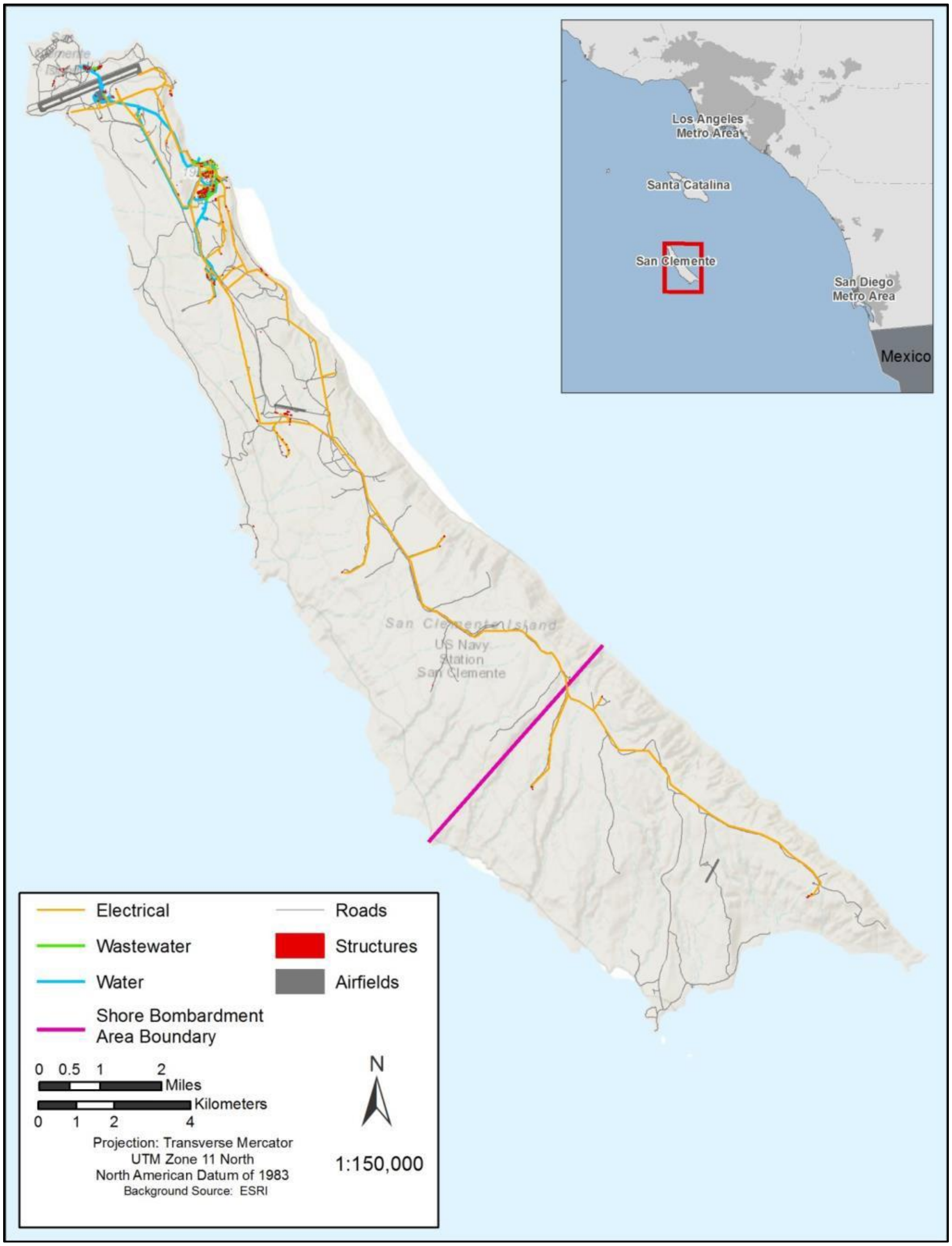

Figure 21. SCI infrastructure maintenance and repair corridors. Taken from USFWS 2017, p. 3.

5.2 Fire

Fire was not considered a threat to the San Clemente Bell's sparrow in the listing rule; however, our understanding of fire in maritime island scrub habitat and grasslands has changed since the listing of the subspecies in 1977 (Dyer 2002, pp.101–111). Fire is a natural component for regeneration and maintenance of many habitats; however, maritime desert scrub communities on SCI are not believed to have been fire-dependent due to maritime related humidity, limited natural ignition sources, and adaptations of specific indigenous plants. Sources of fire prior to the mid-1800s have been natural lightning (rare) and pre-historic humans (US Navy 2002, p. 3).

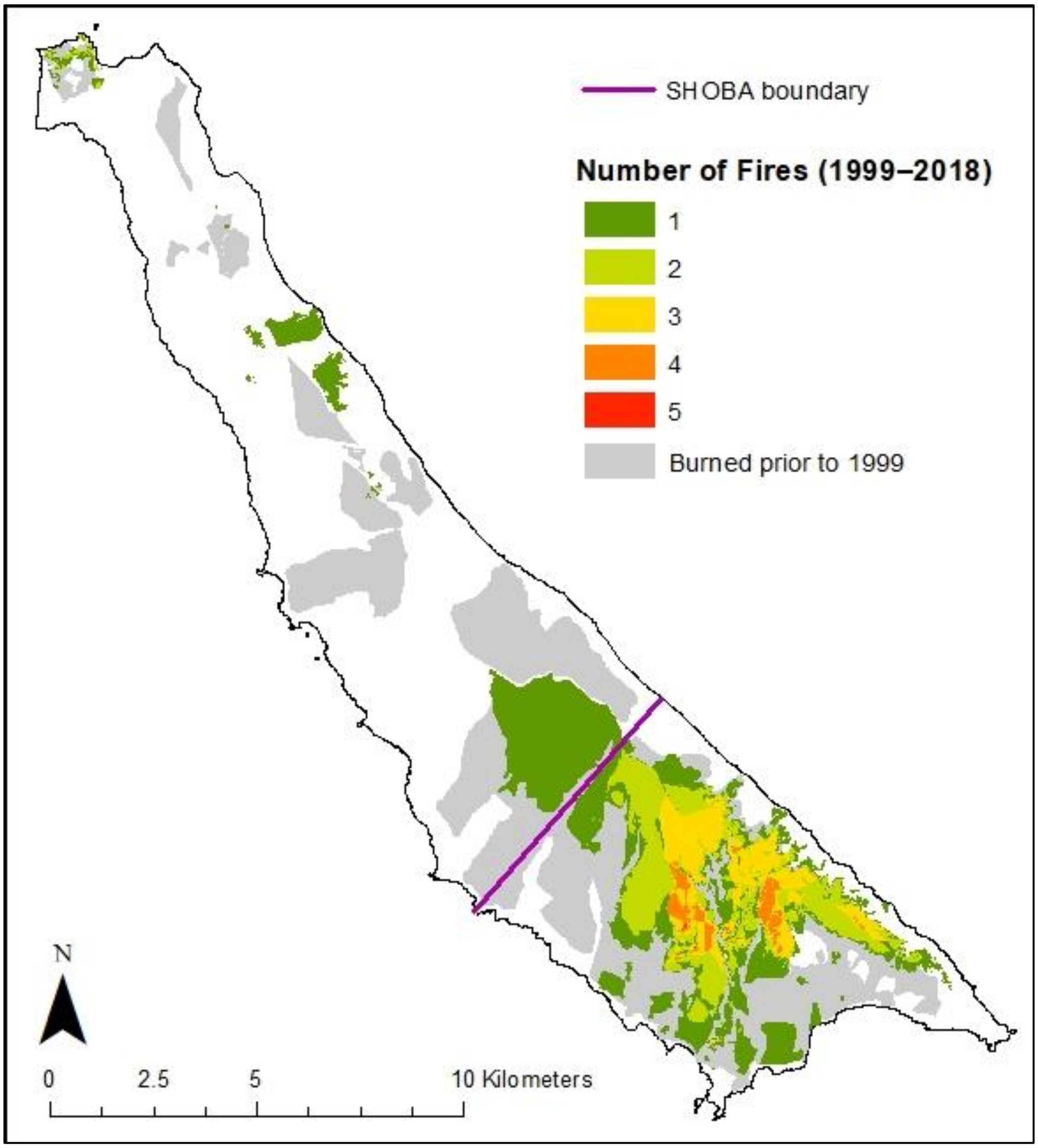

Figure 22. Fire footprints of all fires that have been recorded on SCI since 1979 and the number of fires that burned in the past 20 years (1999–2018), since fire management was initiated (US Navy, internal data).

Since the San Clemente Bell's sparrow was listed, over 50 percent of the island has experienced at least one wildfire (US Navy 2013a, pp. 3–47), with the majority of acreage burned concentrated in SHOBA (US Navy 2013a, pp. 3–45) (Figure 22). Most of these fires are classified as a severity of 4 or 5, considered lightly burned or scorched. At these severity levels, fires have little effect on shrubs, which resprout and recover easily (Table 9) (US Navy 2009, pp. 4–52). For fires with associated severity data (2007 to present), 15.6% of the acreage burned has been of a severity class that has detrimental effects on shrubs, class 1 through 3, considered completely burned to moderately severe; most of that acreage burned in 2017 (Figure 23, Figure

24). Typically, due to the patchy nature of fires, not all areas within a fire footprint are burned uniformly; therefore, not all plants in a burn polygon are necessarily burned or burned at the same severity (SERG 2012, p. 39).

Fire can result in habitat loss and the direct mortality of adult Bell's sparrows and nestlings (US Navy 2018, p. 20). While any fire severity can destroy nests and nestlings, low severity fires (severity classes 4, 5) are unlikely to eliminate habitat altogether, as shrubs are typically not impacted or are set back only slightly; shrubs often resprout even in moderate to more severe fires (severity classes 2 and 3) (Table 9). Therefore, a burned area, unless experiencing a particularly severe fire, would still provide nesting substrate once the shrubs have recovered. A fire return-interval of three years or fewer has been shown to negatively impact woody shrubs on San Clemente Island (Keeley and Brennan 2015, p. 3).

Table 9. Fire severity classes and definitions, reproduced from the US Navy 2009 Fire Management Plan for SCI, 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.

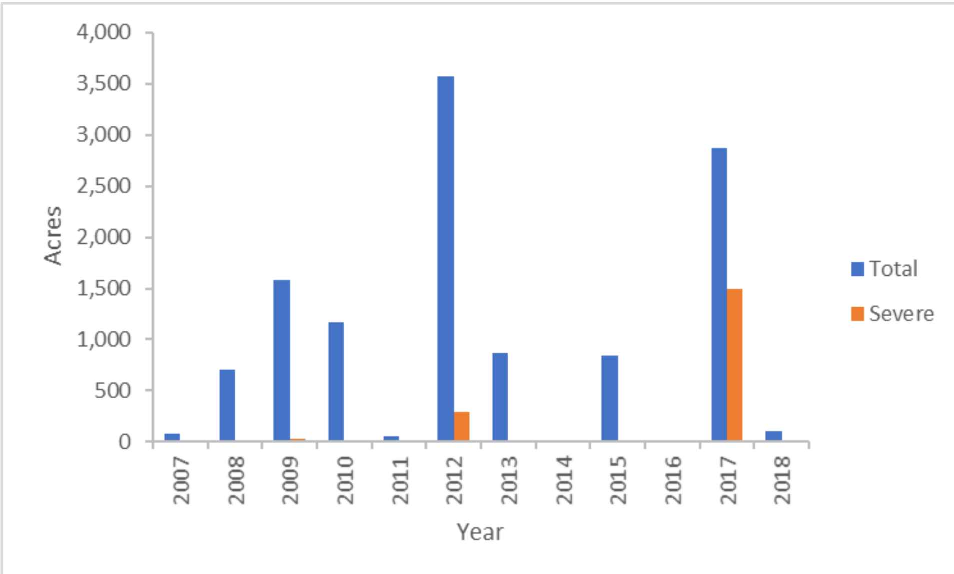

Figure 23.Total acres on SCI that have burned annually in wildfires and acres that were recorded to have burned at a moderate to high severity (severity classes 1, 2, or 3). Fire severity data was not available prior to 2007.

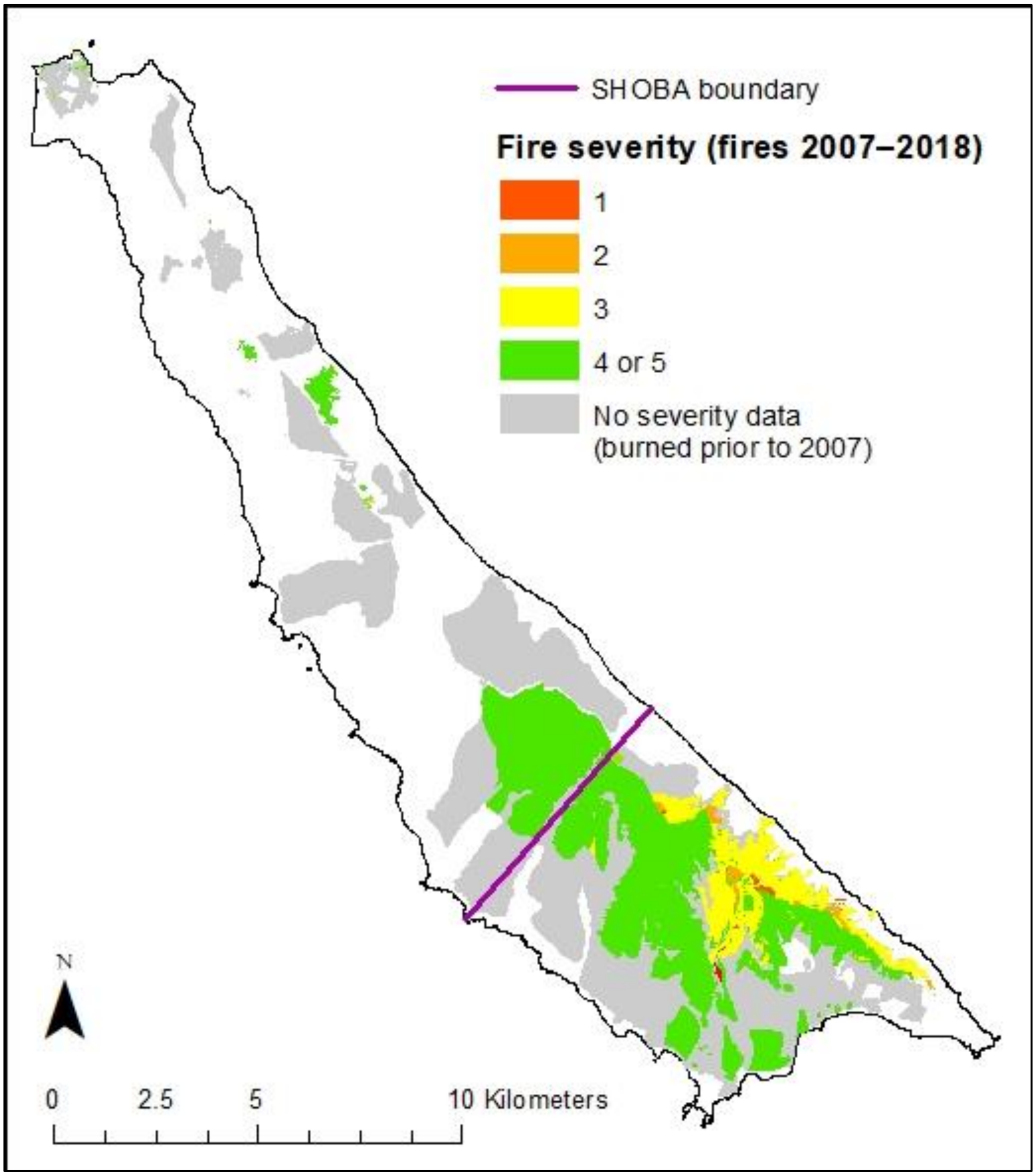

Figure 24. Fire footprints of all fires that have been recorded on SCI since 1979 and those with documented fire severity data (recorded between 2007-2018). Severity categories 1, 2, and 3 have the potential to burn shrubs (which provide nesting substrate) to a degree to which resprouting is very limited; severity categories 4 and 5 have little to no effect on shrubs. Fire severity data was not available prior to 2007.

While the risk of outbreak of frequent fire is higher in Impact Areas I and II and within SHOBA (USFWS 2008, p. 50), fires may also be ignited by electrical system malfunction, vehicle use, military training, or unknown causes north of SHOBA (US Navy 2013a, pp. 3.45–3.47; USFWS 2018, GIS data). In 2017, a large fire burned part of the eastern escarpment within SHOBA, where no other recorded fire has burned. After having seemingly gone out, the fire restarted the next day and response was therefore delayed; this fire has prompted a change to fire monitoring once they are thought to be out (O'Connor 2019, pers. comm.). The fire burned 1,522 acres, almost all (98%) of which were of moderate to high severity (3, 2, or 1 severity class). Surveys later that year indicated that while shrub cover was reduced, some shrub structure remained after the burn (Meiman et al. 2018, p. 41), however post-fire assessment of plots previously surveyed for Bell's sparrows has not been conducted. Vegetation plot monitoring in 2019 has indicated that the vegetation is recovering (SERG 2019, unpublished data).

Fires between 2011 and 2013 burned an estimated 3,608 acres and affected an estimated 241 San Clemente Bell's sparrow territories (USFWS 2017, p. 26), and an estimated 223 Bell's sparrow territories were burned in 2017 fires (Meiman et al. 2018, p. 30).

Future increased fire frequency from intensified military use could lead to localized changes in vegetation. The Navy significantly expanded the number of locations where live fire and demolition training can take place in 2008 (USFWS 2008, p. 21– 37). In addition to demolitions, certain munitions exercises involve the use of incendiary devices, such as illumination rounds, white phosphorous, and tracer rounds, which pose a high risk of fire ignition. However, the number of acres that burn annually varies greatly, and the biggest fire years in the last 15 years (2012 and 2017) have burned less than half the acreage of the biggest fire years between the time of listing and now, all of which preceded implementation of the SCI Wildland Fire Management Plan (US Navy 2009) (Figure 25).

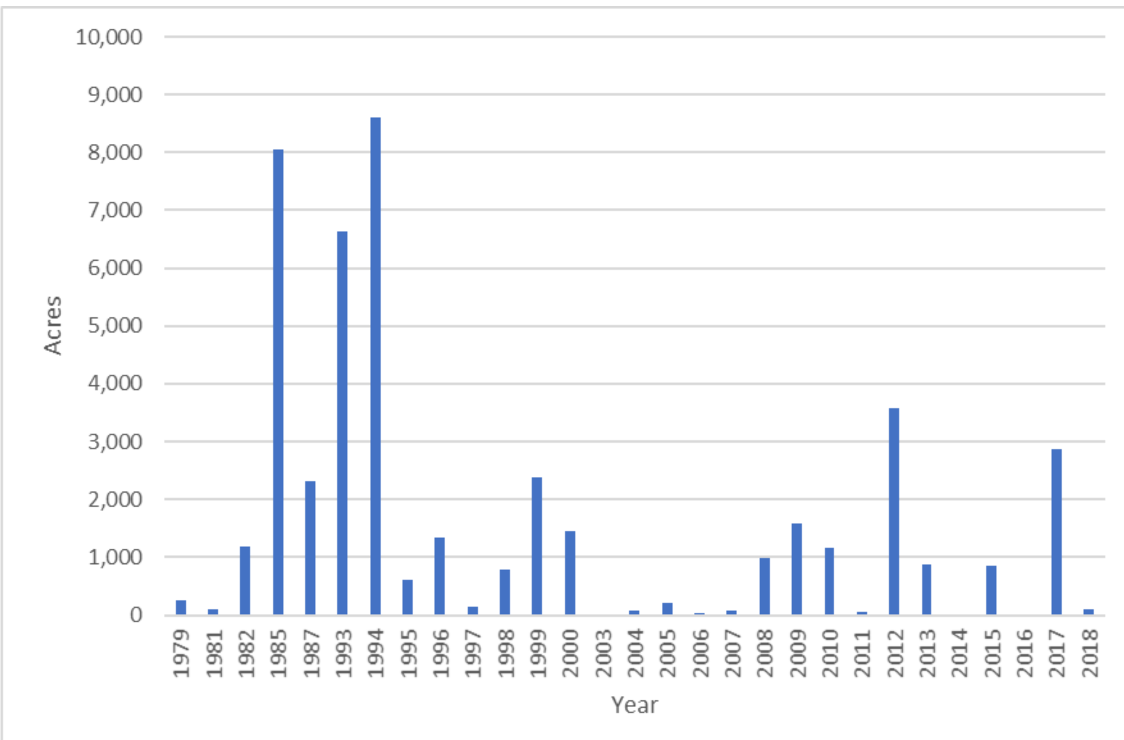

Figure 25. Acres burned annually on SCI for years where fires were estimated since listing.

Although fire ignition points are concentrated in the military training areas, fires that escape these areas could potentially spread to other areas of the island; however, due to vegetation and topography, these fires have generally been confined to the same small areas (Figure 10) (Munson 2019, pers. comm.).

In 2008, based on the presumed distribution in the boxthorn-dominated habitat, the USFWS concluded that the threat of wildfire associated with increases in training activities that were proposed for the island would not jeopardize the continued existence of the San Clemente Bell's sparrow (USFWS 2008b, p. 210) but recognized that fires were likely to adversely affect the species (USFWS 2008b, p. 177). At the time, there existed a high degree of uncertainty regarding the extent, severity, and impact of future fires due to the increase in training on the island (USFWS 2008b, p. 177). However, the fire patterns and severity have mostly stayed the same following the training increase (Figure 24, Figure 25). Fires typically start in the Impact Areas, are of low severity, and burn limited areas due to the application of firebreaks and fire suppression (Figure 22). To date, no fires have broken out and burned the high-density boxthorn habitat around TARs 10 and 17, despite this concern (Figure 24). In 2008, the Bell's sparrow population estimates were much smaller, raising concerns about the effects of any fire on a small population, but the sparrow's perceived range was much smaller. Based on current knowledge of habitat use, with the expansion of San Clemente Bell's sparrows into a broader range of habitats, the more of the subspecies' distribution of is within areas we expect could be impacted by fire.

Boxthorn does not carry fire as readily as other vegetation; however, an invasion of annual grasses or other nonnative species into the boxthorn could increase its ability to carry fire. The Navy works to control specific nonnative species (see Section 5.7), and at this point, annual grasses have not invaded the boxthorn habitats.

Any fire can have a short-term negative impact on San Clemente Bell's sparrows locally. Frequent, widespread, or high-severity fires could have a longer-term negative impact depending on where and how they burn. For instance, a fire that burns a substantial portion of the boxthorn habitat or sage brush habitat could impact a substantial portion of the San Clemente Bell's sparrow population; for instance, the northern boxthorn strata supports almost 35% of the population (see Table 4).. Fire threats in regard to climate change will be discussed in Section 5.6.

5.3 Disease and predation

At the time of listing, disease was not identified as a threat, but predation by feral cats was noted as a probable factor affecting the San Clemente Bell's sparrow in the listing rule (USFWS 1977, p. 40684), and the recovery plan also mentioned predation as a threat to the subspecies (USFWS 1984, p. 87).

Since listing, predation by introduced black rats and feral cats, and by native predators, including the SCI fox (*Urocyon littoralis*), the common raven (*Corvus corax*), the island night lizard (*Xantusia riversiana*), and the San Clemente loggerhead shrike (*Lanius ludovicianus mearnsi*), has been documented. Rodents can affect habitat components by consuming plant material and preying on eggs, chicks, and adult birds. While total population sizes of feral cats and black rats on the island are unknown and have not been estimated, both are managed on the island (see Section 5.7), which may reduce the frequency of observed depredation. Since 2000, 61 to 356 cats have been removed annually; however, the success rate of rodenticide is unclear, and rat trapping has been largely unsuccessful (Burligame et al. 2018, pp. 29, 59). Despite ongoing predation, the Bell's sparrow population has increased in abundance and distribution. Predation rates for the Bell's sparrows on SCI may be lower than on the mainland due to a smaller suite of predators; nest success is higher than on the mainland (snakes appear to be the main culprit on the mainland; Misenhelter and Rotenberry 2000, p. 2892).

West Nile Virus has been known to be extant in southern California since 2004 (Reisen et al. 2004, p. 1374), but no records suggest that this disease has affected adult or juvenile Bell's sparrows (or any avian species) on SCI. The closest record of West Nile Virus is on mainland California, and migratory birds use SCI during fall and winter months. On SCI, mosquitoes are present during the months when migrants are on island, but typically in low numbers (Booker 2019, pers. comm.).

Avian pox also has been noted as a potential source of mortality; in 2007 and 2008, there were observations of lesions resembling avian pox on Bell's sparrows that were captured during banding (Kaiser et al. 2007, p. 81; Kaiser et al. 2008, p. 38). Avian pox is highly contagious and has been considered a factor contributing to the decline and demise of Hawaiian avifauna (Atkinson et al. 2005, p. 538). To date, no diagnostic work has been conducted on the lesions to determine if they were a form of avian pox. If confirmed to be present on San Clemente, avian pox could cause or contribute to a rapid population reduction of juvenile and adult Bell's sparrows. At this time, ecto and endo parasites are not known to be a threat for San Clemente Bell's sparrows.

5.4 Small population size

Few nests and only 93 individual Bell's sparrows were known at listing (1977), and the population further declined to 38 individuals in 1984. In 2008, analysis of the effective population (sex ratio, breeding propensity per individual and pair, mate choice, mortality during breeding, etc.) suggested that fewer than 511 adults were breeding (Kaiser et al. 2010, p. 1; USFWS 2009, p. 5). In 2009, it was thought that low-density habitat may be a population sink, and genetic effects of small populations, such as inbreeding depression and genetic drift, were a concern (USFWS 2009, p. 17). Allee (1931, p. 17-50) suggested small, single populations are vulnerable to extirpation when opportunities for reproduction diminish because of reduced opportunity of individuals to find each other (Allee effect or depensation) (Courchamp et al. 2008, pp. vi - 216). Stephens et al. (1999, p. 185 -190), Dennis (2002, p. 389 - 401) and Courchamp et al. (2008, p. vi - 216) suggest that the Allee effect is a density-dependent event that is inversely related to population size.

However, the survey design implemented in 2013 has consistently estimated the population size of the San Clemente Bell's sparrow at over 4,000 individuals (Table 1). While the population has grown substantially since goats were removed on the island, the full genetic effects of the population bottleneck are unknown.

5.5 Rainfall patterns and drought

San Clemente Bell's sparrow breeding success is influenced by rainfall (Hudgens et al. 2011, p. 1357) (see Section 2.5). Bell's sparrows can forego breeding in drought years but can produce up to 5 clutches in wet years, allowing the population to recover fairly quickly. However, the actual rainfall requirements for successful breeding (rainfall amounts and timing) are not understood. Long periods of sustained drought, with no breaks to provide an opportunity for the population to rebound, could impact this taxon significantly. Further, periods of heavy rainfall can also cause wash-outs and erosion, although we expect these impacts would be highly localized.

A 2011 study found that population size in the boxthorn habitats decreased by average of 40% a year (mean lambda = 0.6 ± 0.2 SD) during three years of drought in 2002, 2004, and 2007 (Figure 26) (Hudgens et al. 2011, p. 1355-1356). Drought years were defined as years with <45 mm of rainfall, and normal years had >110 mm of rainfall (Hudgens et al. 2011, p. 1352). It is unclear where these rainfall measurements came from. However, the population rebounded in subsequent years (Figure 26) (Hudgens et al. 2011, p. 1356). This study focused on the boxthorn habitats, before the population had expanded or was known to expand into different habitat strata on the island.

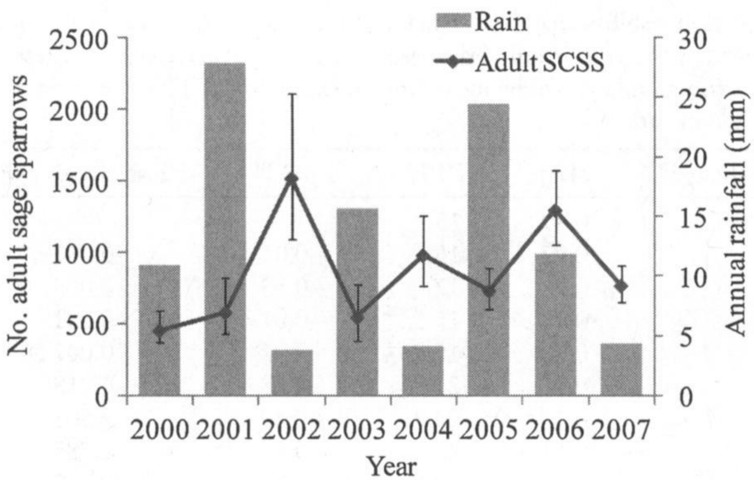

Figure 26. Rainfall versus San Clemente Bell's sparrow adult population estimates from 2000 to 2007 within habitat on the west shore (boxthorn dominated habitat). Annual rainfall is shown in cm, not mm (this is an error in the original figure). From Hudgens et al. 2011, p. 1356.

California has experienced one of the worst droughts in history between 2011 and 2019 (NIDIS 2019), although rainfall amounts on SCI have fluctuated in those years (Table 10). Based on our current understanding of the available habitat, we looked at population change (lambda, λ) in relationship to rainfall amounts using data from 2013–2018, years in which the new island-wide monitoring protocol was used and San Clemente Bell's sparrows were known to be occupying a range of habitat types. Using the rainfall totals from the fall through spring prior to each breeding season (e.g., 2012–2013 rainfall year), we compared the population estimate measured during/prior to breeding that year (e.g. 2013 population) to the population estimate measured the following breeding season (e.g., 2014 population), which would include the prior breeding season's offspring (Table 10).

We found that the San Clemente Bell's sparrow population has an average lambda (λ) of 1.06 for these years. Using only the years where rainfall was below the average (168 mm) for this time period (fall through spring of 2012-2013, 2013-2014, 2014-2015, 2015-2016, and 2017-2018), the lambda average was 0.97 (Table 10). However, our rainfall measures during this period, obtained from local rain gauges, were never as low as during the Hudgens et al. (2011) study, when drought was defined as less than 45 mm of rainfall a year. It is unclear whether rainfall measurements came from the same source between studies.

There is no clear relationship between lambda and rainfall deviation (Figure 27). Thus, minor deviations from the average rainfall do not appear to have a major impact on the current San Clemente Bell's sparrow population.

Table 10. Annual population change (lambda, λ) estimates from population estimates as they relate to the annual precipitation and classification of drought years.

Rainfall year (fall-spring)	Rainfall mm (fall - spring)	Rainfall deviation from average (Rainfall mm/ 168 mm)	% deviation from average (168 mm)	Population estimate t_1 e.g., 2012-13 rainfall year = 2013 population estimate	Population estimate t_{t+1} (e.g., 2012-13 rainfall year = 2014 population estimate)	λ (Population estimate time t / Population estimate time t+1)
2012-2013	148.9	-19.1	-11%	4,534	6,362	1.4
2013-2014	151.8	-16.2	-10%	6,362	4,194	0.66
2014-2015	149.2	-18.8	-11%	4,194	4,352	1.04
2015-2016	182.4	14.4	+8%	4,352	7,656	1.76
2016-2017	365.2	197.2	+117%	7,656	5,284	0.69
2017-2018	83.2	-84.8	-50%	5,284	4,198	0.79
Overall Average						1.06
Dry Average						0.97

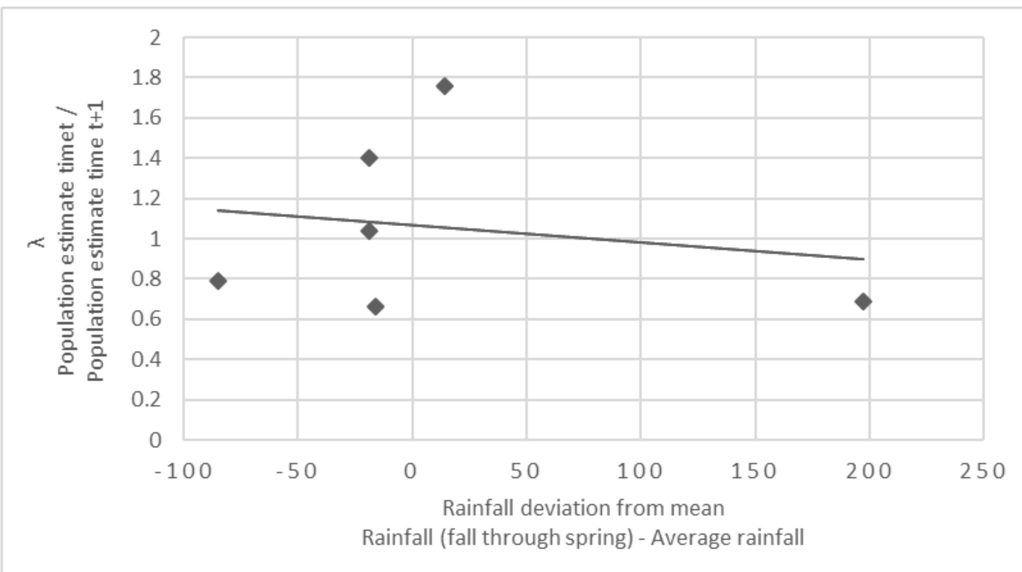

Figure 27. Population change (lambda) plotted against the rainfall deviation from the mean (166 mm) for winter 2012 through spring 2018 data (values from Table 10).

Looking at drought from a statewide level, the drought in California between 2011 and 2019 was worse than the drought during the Hudgens et al. (2011) study (NIDIS 2019). However, some rainfall measures reported in Hudgens et al. (2011) were lower than those measured from 2012 to 2018. As rainfall amount alone is not a perfect indicator of drought, we further analyzed percent live fuel moisture (measured as the wet vegetation weight over dry vegetation weight) for the available years (2003-2018). While the timing and amount of rainfall influences the vegetation, there are other factors that influence the amount of time that the vegetation can retain that moisture, which influences the ability to produce seeds and fruits, which provides cover and food resources for San Clemente Bell's sparrows. Therefore, we looked at fuel moisture both leading up to and during the Bell's sparrow breeding season. We used measures from both the average of all vegetation types (2003-2018), as well as boxthorn, only (available data from 2007-2018).

Looking at all vegetation types together, the fuel moisture data do not reflect the same dry years as the Hudgens et al. (2011) study and the recent rainfall measures (Table 10, Figure 26, Figure 28). Fuel moisture in 2004 and 2007 are not drastically lower than 2005 and 2006 (Figure 28). Both 2014 and 2018 appear to have very low fuel moisture in general. While 2013, 2015, and 2017 began with low fuel moisture in January, it increased in March in all these years (Figure 28).

While we do not have fuel moisture data for just boxthorn to compare to the years of the Hudgens et al. (2011) study, fuel moisture patterns from 2007 through 2018 are different than the analysis of all the vegetation types together. Boxthorn appears to have been particularly dry (and dry early) in 2012, 2013, 2014, 2015, and 2018 (Figure 29).

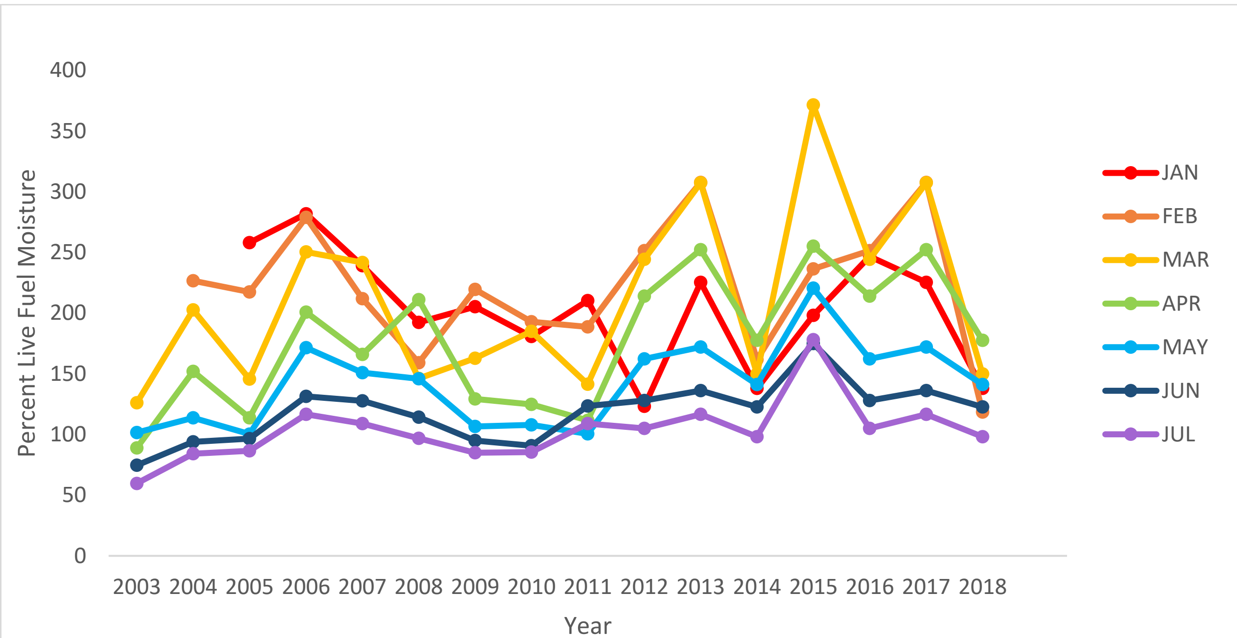

Figure 28. Percent live fuel moisture averaged across all strata measured during January through July of 2007 through 2018. These months were picked to correspond to the lead-up and duration of San Clemente Bell's sparrow breeding season, which typically begins in March and can last through July.

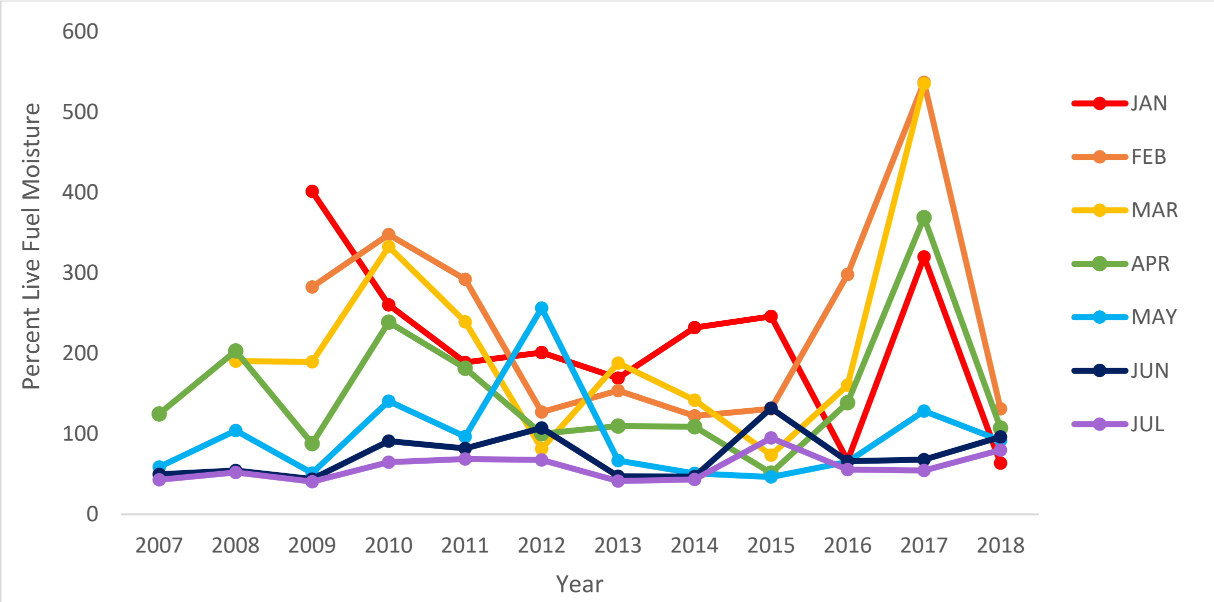

Figure 29. Percent live fuel moisture of boxthorn measured during January through July of 2007 through 2018. These months were picked to correspond to the lead-up and duration of San Clemente Bell's sparrow breeding season, which typically begins in March and can last through July.

The fuel moisture data indicate that drought is a complex issue, and that rainfall alone may not be the best indicator of drought. Further, the data indicate that the response of San Clemente Bell's sparrows to varying conditions are more complicated than simply a correlation between winter rainfall and productivity that spring. The timing of rainfall, the vegetation response, and the timing of that vegetation response are all likely important factors.

While the literature indicates that a relationship exists between reproductive effort, reproductive output, and rainfall in the previous year, the current available data show an inconsistent relationship between annual rainfall and the effect on the overall population size. Recent data show that the population has remained robust through California's recent drought cycle (2011–2019), and fuel moisture data indicates that the vegetation response to rainfall on SCI requires a more complex analysis than just looking at rainfall totals. Since 2013, the island-wide population of Bell's sparrows appears to have increased in some years and decreased in others, with no clear relationship to rainfall. Therefore, the full impacts of droughts of varying duration and severity on the population are unclear, and the mechanisms driving these relationships are unknown.

Rainfall between 2012 and 2018 may have been high enough or had the right timing to not cause any drought effects on the Bell's sparrow, and more extreme drought years may reduce the population as Hudgens et al. (2011, p. 1355) found. However, given the expanded habitat since this study and the assumed dispersal of juveniles into these novel habitats, it is possible that survival and reproduction may be high enough in drought years to make up for low productivity. Survival in drought years may also be increased due to less predation, if predator numbers are affected by drought or through suppression of breeding. It is also possible that, given the error associated with annual population estimates, our estimates may not represent reality and thus, our lambda estimates may be inaccurate. Additional years of data may clarify this relationship.

The San Clemente Bell's sparrow has withstood previous drought cycles, presumably enduring drought when the population was smaller and before the vegetation began recovering on SCI, and presumably being able to bounce back from population declines in dry years by producing multiple clutches in wet years. While the population is now much larger and can seemingly withstand recent decreases in annual rainfall and years of low fuel moisture, the effects of more extended and/or intense drought specifically on SCI and the threat that such a drought may pose are unclear. Periodic drought conditions are anticipated over the next 20 to 30 years, but the number of consecutive drought years or the intensity of droughts is unknown. If dry periods more closely resemble those observed in recent years (2011-2017), the species may show little response. Conversely, if dry periods on SCI are more extended or extreme, the population may exhibit more marked declines.

Were a major drought to threaten the island during this time and decrease the population size by some percent (perhaps 40%, as in Hudgens et al. 2011), the viability of the San Clemente Bell's sparrow will be dependent on the subspecies' continued ability to rebound in the years following the drought. Thus, maintaining quality habitat in high density habitat, such as the west shore boxthorn habitats that have historically provided refugia for the subspecies and the sagebrush habitats, will be important.

5.6 Climate and climate change

Since the listing of the San Clemente Bell's sparrow (USFWS 1977, p. 40684), the potential impacts of ongoing, accelerated climate change have become a recognized threat to the flora and fauna of the United States (IPCC 2007, pp. 1–52; PRBO 2011, pp. 1–68). Climate change is likely to result in warmer and drier conditions with high overall declines in mean seasonal precipitation but with high variability from year to year (IPCC 2007, pp. 1–18; Cayan et al. 2012, p. ii; Kalansky et al. 2018, p. 10).

The effects of climate change on the San Clemente Bell's sparrow could be minimal or extreme, depending on the exact timing and frequency of rainfall events and the resulting effects on vegetation. Drought frequency resulting from climate change has been identified as a threat to the continued existence of the San Clemente Bell's sparrow (USFWS 2008, p. 171). Because rainfall patterns appear to contribute significantly to Bell's sparrow reproduction, climate change could threaten the Bell's sparrow population if significant drought conditions become more frequent on SCI (see Section 5.5).

SCI is located in a Mediterranean climatic regime with a significant maritime influence. Current models suggest that southern California will likely be adversely affected by global climate change through prolonged seasonal droughts and rainfall coming at unusual periods and different amounts (Pierce 2004, p. 1-33, Cayan et al. 2005, p. 3-7, CEPA 2006, p. 33; Jennings et al. 2018, p. iii; Kalansky et al. 2018, p. 10). Climate change models indicate a 4 to 9 degrees Fahrenheit (2 to 4 degrees Celsius) increase in average temperature for the San Diego Area of southern California by the end of the century (Jennings et al. 2018, p. 9), with inland changes higher than the coast (Cayan et al. 2012, p. 7). By 2070, a 10 to 37 percent decrease in annual precipitation is predicted (PRBO 2011, p. 40; Jennings et al. 2018, p. iii), though other models predict little to no change in annual precipitation (Field et al. 1999, pp. 8–9; Cayan et al. 2008, p. S26). SCI typically receives less rainfall than neighboring mainland areas (Tierra Data Inc. 2005, p. 4). However, predictions of short and long-term climatic conditions for the Channel Islands remain uncertain, and it is unknown at this time if the same climate predictions for coastal California (a warmer trend with localized drying, higher precipitation events, and/or more frequent El Niño or La Niña events) equally apply to the Channel Islands (Pierce 2004, p. 31).

Low-level temperature inversions are common along the California coast and Channel Islands, and these inversions form low cloud cover (fog), otherwise known as the marine layer, which has a strong influence on coastal ecosystems and SCI (US Navy 2013a, pp. 3.13, 3.26). Although the island has a short rainy season, the presence of fog during the summer months helps to reduce drought stress for many plant species through shading and fog drip, and many species are restricted to this fog belt (Halvorson et al. 1988, p. 111; Fischer et al. 2009, p. 783). Thus, fog could help buffer 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 2014, p. 5). Climate on the Channel Islands continues to support paleoendemic plants, such as *Lyonothamnus*, which once was widespread in the southwest of North America and is thought to have been extirpated on the mainland as conditions became warmer and drier (Bushakra et al. 1999, pp. 473–475). However, coastal fog has been decreasing in southern California in recent decades, possibly due to urbanization (which would not affect SCI) or climate change (Williams et al. 2015, p. 1527; Johnstone and Dawson 2010, p. 4537; LaDochy and Witiw 2012, p. 1157). Coastal cloud cover and fog are poorly addressed in climate change models (Qu et al. 2014, pp. 2603–2605).

Warming projections in California, particularly the possibility that the interior will experience greater warming than the coast (Cayan et al. 2012, p. 7), suggest that the fate of coastal fog is uncertain (Field et al. 1999, pp. 21–22; Lebassi-Habtezion et al. 2011, pp. 8–11). Iacobellis et al. (2010, p. 129), however, showed an increasing trend in the strength of low-level temperature inversions, which suggests that the marine layer is likely to persist and may even increase. Recent work examining projected changes in solar radiation and cloud albedo show projected increases in cloud albedo during the dry season (July–Sept) and decreases during the wet season (Nov–Dec, Mar–Apr) (Clemesha 2020, entire). The summer projections mean an increase in fog and low clouds the decreases in the winter likely reflect a decrease in a combination of precipitation and fog (Clemesha 2020, pers. comm.; Clemesha 2020, entire). Such a scenario could moderate the effects of climate change on the Channel Islands and would be expected to reduce its potential threat to island plants, including nesting and cover substrates for Bell’s sparrows, especially on the western shore’s lower terraces (including the boxthorn habitat strata), where the marine layer is common. Dry season low clouds and fog are particularly important to plant growth, survival and population dynamics in arid systems through both a reduction in evapotranspiration demand and potentially water deposition (Corbin et al. 2005, p. 511; Johnstone and Dawson 2010, p. 4533; Oladi et al. 2017, p. 94).

Less rainfall and warmer air temperatures could limit the range of some plants on which the San Clemente Bell’s sparrow depends, although there is no direct research on the effects of climate change on these species. Sea levels are predicted to rise between 0.9 m and 1.4 m by 2100 (Cayan et al. 2012, p. 24), which, due to the topography on SCI and the elevations at which San Clemente Bell’s sparrow habitat occurs, would not directly affect Bell’s sparrow populations.

Predicting impacts due to climate change are further complicated by the timing of increased or decreased rainfall; dry conditions in the winter and early spring can lead to less growth early in the season which can provide less fuel for fire later. However, drier conditions in only the summers and falls may increase fire likelihood (Lawson 2019, pers. comm.). Therefore, making predictions about future fire patterns as affected by climate change is difficult.

While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make meaningful oceanographic and atmospheric predictions regarding its effects to the San Clemente Bell's sparrow, its food/prey, and its habitat. Current trends based on meteorological information suggest climate change is already affecting southern California through sea level rise, warming, and extreme events like large storms associated with El Niño events (Sievanen et al. 2018, p. 7). In the future, climate change is likely to cause more severe droughts or extended dry periods on coastal California via lessened low stratus cloud regime and hydrologic effects of reduced fog delivery (Fischer et al. 2009, pp. 783–799; NOAA 2009; Sievanen et al. 2018, p. 7). Although climate change is affecting coastal and inland habitat in the United States (Karl et al. 2009, pp. 13–152), the site-specific effects of climate change on SCI are uncertain. We focus on a 20 to 30-year window, in which we do not expect major impacts to San Clemente Bell's sparrows from these long-term effects of climate change, which are typically projected to have major effects in the latter half of this century (Cayan et al. 2012, p. 24; Clemesha 2020, entire; Kalansky et al. 2018, pp. 19-21). However, in this short-term 20 to 30-year window, climate change may result in more frequent or severe fires, heavy periods of rainfall that could lead to major erosion events (see Section 5.5) or periods of drought (Kalansky et al. 2018, p. 10).

5.7 Management and conservation efforts

The Navy has implemented and continues to implement significant conservation measures to minimize impacts to San Clemente Bell's sparrows and their habitat and has been an effective steward of this species. Likely the most significant contribution to Bell's sparrow conservation was the successful removal of feral ungulates from the island. The Navy now coordinates with the Service under Section 7 of the ESA and incorporates avoidance and minimization measures into training activities and projects. For example, the Navy implements fire prevention, containment, and suppression measures as part of their fire management plan (US Navy 2009, entire); monitors sites proposed for new facilities and infrastructure; sites projects outside of Bell's sparrow habitat, when possible; prioritizes construction projects to occur outside the nesting season; monitors for and avoids active nests during the breeding season; enforces a 35 mph speed limit on Ridge Road, which is reduced to 15 mph in project/construction areas (USFWS 2008, pp. 63–64; USFWS 2018, p. 10); and includes erosion control measures in new projects (US Navy 2013b).

Pursuant to the Sikes Act (as amended, 2012), SCI is managed under the SCI Integrated Natural Resources Management Plan (INRMP) (US Navy 2013a). The SCI INRMP outlines appropriate management actions necessary to conserve and enhance land and water resources on SCI, which encompasses the entire range of the Bell's sparrow. Bell's sparrow conservation identified in the INRMP includes a commitment to monitor Bell's sparrows and manage for population stability and resilience. The INRMP also contains a NEPA review process that assures avoidance and minimization measures are applied to future projects proposed on SCI. Finally, the INRMP outlines steps to ensure compliance with EO 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds, 66 FR 3853, Jan 2001) and the Memorandum of Understanding (MOU) between DoD and USFWS to promote the conservation of migratory birds (2014), which stipulates responsibilities for DoD. The MOU outlines a collaborative approach to promote the conservation of bird populations and the INRMP is required to address migratory bird conservation regardless of ESA status. As part of the program outlined under the INRMP, the Navy supports the Bell's sparrow population monitoring program. Population monitoring provides a robust population estimate and facilitates planning to avoid and minimize impacts of Navy training and infrastructure projects.

The SCI INRMP is currently being updated to include prioritization of conservation and management within 4 core San Clemente Bell's sparrow habitat areas (~2,604 ha; O'Connor 2019, pers. comm.). These areas were selected to assure representation (e.g. multiple plant communities), and redundancy (e.g. multiple areas). They include high density Bell's sparrow habitat, assumed source populations, refugia spread geographically, and areas of elevation and topographic importance to Bell's sparrow. The intent of priority conservation areas is to facilitate future planning in a manner that avoids impacts to important Bell's sparrow habitat, and to protect the population against stochastic catastrophic events.

Final delineation of areas and management strategies will be identified within a San Clemente Bell's Sparrow Management Plan, which will be written Fall-Winter 2019-2020, and will focus conservation management within the following areas:

1) Boxthorn habitat on the west side of SCI from Mail Point north to the dunes: high density habitat that served as source population for recolonization in the past and has a low fire risk.
2) Shrublands at Cave Canyon (west side, edge of SHOBA): provides refugia and a population source of Bell's sparrows as well as a potential seed source for sage scrub recolonization of east side sage scrub (by both vegetation and Bell's sparrows) if there were a fire there.
3) Sagebrush dominated shrublands on the east side of SHOBA: high density habitat that is different in topography, presumably microclimate, aspect, soils and substrate than the west side boxthorn.
4) Shrublands from SHOBA to Stone Canyon: habitat is similar to the shrublands on the east side but has a lower risk of fire impacts and potential differences in fog effects.

Priority management of these areas will ensure conservation and management of large spatially distinct and ecologically different areas that support high density San Clemente Bell's sparrow habitat. The 4 areas will be exposed to different stressors due to differences in location, exposure, topography, and vegetative structure. Although the management plan is not finalized, with the inclusion of these habitat areas in the INRMP, we anticipate that the Navy will: 1) preclude significant development within these areas, to the extent feasible; 2) prioritize these 4 areas for protection under Fire Management Plans; and 3) prioritize these 4 areas for invasive species control, as needed.

The San Clemente Bell's sparrow also benefits from conservation efforts for the island night lizard, which is found in the high densities within the maritime desert scrub habitats on the western side of the island (US Navy 2013a, p. 3.222). A management area was created in 2004 to ensure the continued persistence of the island night lizard as an important area for impact minimization in future planning documents. The management area includes much of the western terraces and overlaps the majority of the northern boxthorn habitat strata (US Navy 2013a, pp. 3.222–3.223).

The EIS/OEIS and associated BO together allowed for an increase in the amount and intensity of training on SCI (US Navy 2008a, pp. 2.1–2.52), but the extent of training increase implemented has not been documented, and impacts to the San Clemente Bell's sparrow are difficult to assess. Soil erosion was a large concern associated with use of the AVMC, but an Erosion Control Plan (US Navy 2013b) was developed to minimize soil erosion and prevent it from adversely affecting federally listed or proposed species or their habitats and other sensitive resources.

In conjunction with the planned expansion of training activities, the Navy implements the SCI Wildland Fire Management Plan that is focused on fire prevention, fuels management, and fire suppression. Implementation of the fire management plan provides planning guidelines to reduce the potential for ignitions during the drier times of the year, ensures that adequate fire suppression resources were present to protect resources, and provides to provide flexibility for the timing of military training and to ensure that adequate fire suppression resources were present with an increased level of training activities (US Navy 2009, entire). The fire management plan stipulates a 200% sagebrush live fuel moisture threshold for fire season, such that when fuel moisture for this species is low (drier than 200%), the Navy is advised of the increased risk and declares fire season, which triggers fire management strategies specific to training (US Navy 2009, pp. 4.15–4.16). While fires are not fought in the Impact Areas, those that burn in the rest of SHOBA are fought on a case-by-case basis, depending on which habitats and structures they threaten and/or safety considerations. While most fires burn themselves out in a short amount of time, fires are monitored closely after ignition (Munson 2019, pers. comm.). If a threat is perceived to lives, structures, or sensitive species, the fire is fought unless there is a threat of unexploded ordnance or another a safety risk, such as high winds. These measures should minimize the frequency and spread of fires that could result in loss of San Clemente Bell's sparrows.

The Navy installs fuelbreaks around the Impact Areas to manage the spread of fire from the Impact Areas (USFWS 2012, p. 29118). Maintenance of these fuelbreaks reduces the likelihood and frequency of fires spreading to sensitive areas and habitats. The Navy conducts preseason briefings for firefighting personnel on the guidelines for fire suppression (USFWS 2008, pp. 97–98). To minimize the potential for effects to listed species, the Navy considered the documented locations of listed species on the island as fuelbreak lines were developed (USFWS 2012, p. 29119).

The Navy also conducts annual reviews of fire management and fire occurrences that allow for adaptive management and aim to minimize the frequency and spread of fires that could result in loss of individuals (USFWS 2012, p. 29121). For instance, for the 2019 fire season, fuelbreaks were installed along some of the existing roadways within SHOBA (Munson 2019, pers. comm.). As roads already serve as good fuelbreaks, increasing their effective width through application of fire retardant to adjacent vegetation is expected to help protect sensitive species and resources (Munson 2019, pers. comm.).

While many conservation measures to limit the introduction and spread of nonnative plants are included in the INRMP (US Navy 2013a, pp. 3.289–3.290) and required in the 2008 BO (USFWS 2008, pp. 58–66), the recently-completed Naval Auxiliary Landing Field San Clemente Island Biosecurity Plan (US Navy 2016, entire) will help more effectively control the arrival of potentially invasive propagules than similar plans on non-military islands. The plan contains actions recommended to avoid introduction of new invasive species and works to prevent and respond to new introductions of non-native species and bio-invasion vectors. The Navy is currently working on an Instruction that will contain feasible, enforceable measures from the plan. Through implementation of this plan and the ongoing island-wide nonnative plant control program, potential impacts from nonnative plants are expected to be minimized (O'Connor 2019, pers. comm.; Munson 2019, pers. comm.).

The current non-native wildlife program focuses on island-wide non-native predator management, which was initiated by the Navy in 1992 (USFWS 2008, p. 172). Complete eradication of feral cats, black rats, and house mice on SCI is currently infeasible as all known methods would severely impact native fauna. Non-native wildlife management focuses on control of feral cats (*Felis catus*) throughout the island and rodent control near San Clemente loggerhead shrike (*Lanius ludovicianus mearnsi*) nest sites (Meiman et al. 2013, p. 2). This program affords some protection to the Bell's sparrow, primarily through cat removal. Rodent control is conducted using traps and bait stations around loggerhead shrike nest sites using Terad (active ingredient choelcalciferol). The Navy has removed numerous cats, on average 211 annually (2001–2016; Burlingame et al. 2018, p. 29), and rodenticide was calculated to have impacted 26,473 rodents in 2000 (U.S. Navy 2002, pp. 4–66). The results of cat and rat control efforts varying according to predator population cycles. Cats removed from 2001-2006 averaged 290 annually, while 2006-2016 the annual average dropped to 177 (Burlingame et al. 2018, p. 29). Efforts to control rats are likely less effective than cat control. Rats are notoriously difficult to trap, and Terad requires multiple ingestions and has been documented to result in taste aversion, which would decrease the likelihood of consuming a lethal dose. In 2012, predator control biologists deployed rodent control measures in some historic sage sparrow habitats to assess their efficacy in protecting nesting San Clemente Bell's sparrows, but no difference was found in nest daily survival rates between treatment and control plots (Ehlers et al. 2013, pp. 2, 71). Drought appears to negatively affect island-wide rodent populations more than human control efforts. Black rats remain commonly recorded nest predators (Meiman et al. 2017, pp. 35–36; Meiman et al. 2018, p. 26). Despite the persistence of and current inability to eradicate black rats, the Bell's sparrow population expanded over the past two decades, increasing in both numbers and range.

5.8 Summary of Factors Influencing Viability

At the time of listing, the biggest threat to the San Clemente Bell's sparrow was habitat destruction and modification due to feral grazers (USFWS 1977, p. 40683). These habitat impacts had reduced the Bell's sparrow population greatly, contributing to their known numbers hitting a low of 38 individuals in 1984. Since the removal of the last feral goats in 1991, the San Clemente Bell's sparrow population has grown, expanding from the boxthorn it was thought to exclusively occupy into new habitats as these habitats have recovered on the island.

Remaining threats include predation, drought, climate change, facilities development and maintenance, military training, and fires. Invasive black rats and feral cats are known to depredate some individuals and nests, while an ongoing predator control program is working to control these invasive species on the island, it is highly unlikely that this threat will ever be removed completely. However, the population has grown despite this threat, and nest success estimates appear to be relatively high across the island (Meiman et al. 2018, p. 25). Drought is potentially a large threat to the San Clemente Bell's sparrow, especially if droughts become more frequent or severe or if other impacts create additional stress on the subspecies and impede its ability to rebound following the drought. However, data are lacking on how drought currently affects the island-wide population, and additional data is needed to clarify this relationship. Likewise, climate change has the ability to greatly impact the vegetation of SCI, but the full effects are unclear; we do not expect the long-term impacts of climate change to have substantial impacts to the Bell's sparrow in the next 20 to 30 years, although there may be impacts from drought or increased fire frequency or severity in the short term.

Facilities development and military training impacts have the potential to threaten some individuals or nests, but these impacts are expected to occur in the same general areas as current. Training that could have high intensity impacts occurs on less than 20% of the island, and those areas that are intensively used are currently either unoccupied or already support low densities of Bell's sparrows.

The largest potential known threat to the San Clemente Bell's sparrow is fire. Fires impact Bell's sparrows under current conditions, and several live fire training areas are situated in high density boxthorn habitat. Most ignition sources are distant (at least 3 miles) from high density boxthorn habitat, and the Navy actively implements fire prevention and containment measures as part of the fire management plan. Thus, although fires currently impact Bell's sparrows and their habitat (an estimated 241 territories were impacted by fires 2011-2013 (USFWS 2017, p. 26), and 223 Bell's sparrow territories were affected by fires in 2017 (Meiman et al. 2018, p. 30)), current fire patterns do not appear to threaten San Clemente Bell's sparrow population viability. In addition, recent fire patterns and modelling results suggest that these patterns will continue in the same locations if training areas and facilities remain in their current locations. However, fire patterns and severity are not entirely predictable, and climate change or new training activities/areas could alter historic fire patterns. If fire becomes more frequent or severe in the future or burns large areas of high-density sparrow habitat, a population-level impact is possible. Coupled with the unknown ways in which climate change will impact the timing and patterns of rainfall and drought in the next 20 to 30 years or, more likely, beyond, fire could become more frequent or severe and pose a potential threat to subspecies viability in the future. Based on their continued commitment to conservation of SCI taxa, we anticipate that the Navy will continue to implement a fire management plan to minimize the impacts of fire on sensitive species.

SECTION 6 – FUTURE CONDITIONS AND VIABILITY

We have considered what the San Clemente Bell's sparrow needs for viability and the current condition of those needs (Sections 2, 3, and 4), and we reviewed the factors that are driving the current and future conditions of the subspecies (Section 5). We now consider several plausible future conditions for the subspecies. We apply our future forecasts to the concepts of resiliency, representation, and redundancy to describe the future viability of the San Clemente Bell's sparrow.

6.1 Introduction

Since the removal of feral browsers and grazers from SCI, few of the original threats exist to the viability of San Clemente Bell's sparrows, and many ongoing management efforts minimize these threats. The subspecies currently is broadly distributed on the island, although approximately 40% of the population occurs along the northwestern side of the island. While these high-density locations are in close proximity to TARs 10 and 17, they have few roads, are inaccessible heavy foot traffic, and have thus far not experienced frequent or severe fires or erosion events. Imminent impacts to San Clemente Bell's sparrow habitat are minimal throughout much of its distribution.

Two factors that have the most potential to impact subspecies viability in the future are fire and climate change. Climate change might affect coastal fog or intensify drought cycles and indirectly affect fire frequency/intensity or have other compounded effects. However, we are unable to address the full impact of climate change because the long-term effects of climate change on SCI remain unclear. Specifically, it is unclear whether the coastal fog layer will persist; this fog provides moisture and could be a refuge from the full impact of projected warming. We assume that the impacts of climate change will not have significant impacts to San Clemente Bell's sparrows in the next 20 to 30 years, and therefore, we consider the future of the San Clemente Bell's sparrow in terms of its threats and conservation efforts within that timeframe. However, we account for possible short-term effects of climate change, such as increased fire frequency and/or severity, which we model, as well as extended periods of drought and periods of heavy rain which could cause localized erosion, which are not modeled but discussed.

Drought cycles are likely to continue and may become more frequent over the next 20 to 30 years. Drought is linked to low breeding effort and productivity output in San Clemente Bell's sparrows, and the Bell's sparrow population has declined significantly in low rainfall years. However, existing data from multiple recent years demonstrate Bell's sparrow population stability during the recent drought in California, although conditions on SCI vary from coastal California and vary from year to year. Data on rainfall and vegetation fuel moisture on SCI indicate that vegetation response to annual rainfall amounts is complicated, and timing of rain and other factors (humidity, fog drip, etc.) influence if and for how long the vegetation can be productive and provide food and cover to Bell's sparrows during their breeding season. While there is no clear relationship between rainfall totals and the population change after the next breeding cycle using data from the past decade, the possible mechanisms involved (increased survival, etc.) are unknown. Additional years of data may clarify this relationship. Still, Bell's sparrows appear able to sustain periods of low rainfall and low fuel moisture on SCI, aided by their ability to rebound in wet years, but the effects of a potential more sustained or more severe drought is unknown. We will discuss possible drought impacts in our discussion of species redundancy.

We also cannot predict the future of fire on the island, but we do know what the fire pattern has been in the past, despite the presence of non-native and invasive grasses and provided the implementation of fire management practices. Fire seasons have generally consisted of low-severity fires that do not kill the shrubs that San Clemente Bell's sparrows need for nesting substrate; however, in 2017, fires were generally larger and of an unprecedented severity for their size. Whether 2017 was an outlier or will become more common in the future is unknown.

Another potential impact to San Clemente Bell's sparrows is land use, specifically if individuals exist within boundaries of training areas where current and future training occurs and may increase. We defined these high-use training areas as areas within the TARs, Impact Areas, and AVMAs, and the area within 50 ft of the AVMR or a road, which reflects the area of highest use within the IOA and to account for potential road effects elsewhere on the island. While territories are known to currently exist in these areas and have persisted under the current training impacts, future increases in the amount or location of training (including increased foot traffic along roads, new infrastructure, increased fires, or other disturbance) has the potential to impact the subspecies. We assume that impacts to Bell's sparrows in and around other training locations or facilities (within the rest of the IOA or SWATs, near buildings or other facilities, etc.) would be so dispersed, minimal, or impact so few individuals that we are not including these in our analyses. We presume in this analysis that land use will not change- no new training ranges or facilities will be constructed that will alter habitat condition.

Finally, San Clemente Bell's sparrow territory density is strongly linked to vegetation, which is reflected in the habitat strata, as classified in the 2015–2018 monitoring reports (Appendix A). As the vegetation on SCI continues to recover following the removal of feral ungulates, the composition of these habitat types could shift over time. For instance, in some areas, shrub density is increasing within the existing strata types. As shrubs provide for foraging and nesting sites, increased shrubs within an existing stratum likely to increase the potential sparrow territory density within that type. Further, sagebrush has been observed to be increasing on the island, expanding out of drainages and out onto the plateaus (Booker 2019, pers. comm.). The shrub composition of these habitat types on the island could influence the total population size of San Clemente Bell's sparrows and the carrying capacity of the island.

Considering the remaining threats to San Clemente Bell's sparrows, we considered the future realistic threats to be 1) if fire intensity or severity were to increase in all or some parts of already fire-prone areas (areas where >1 fire has burned in the last 20 years; we assume the fire pattern on SCI will not change), and 2) if the training temp were to increase within the high-use training areas (defined above; we assume training area boundaries will not change and no new facilities or infrastructure will be constructed). The designated training areas are unlikely to change dramatically, and ignition sources, also, are unlikely to vary from current. Therefore, to assess the future viability of the San Clemente Bell's sparrow, we considered several future scenarios that encompass the uncertainty associated with fire, military training, and vegetation on the island, as well as uncertainty in population growth and fluctuations over time.

6.2 Methods

To assess future resiliency of San Clemente Bell's sparrows, we addressed potential changes to the current condition and trends that could affect the future condition of the subspecies. We projected these changes by considering the following:

1) How much habitat will be available if we account for future impacts (and what is the minimum amount of habitat expected)?
2) Within that available habitat, what is the expected territory density of Bell's sparrows?

We present our methods for estimating each of these below:

How much habitat will be available?

To model how much habitat we expect will be available to San Clemente Bell's sparrows in the future, we accounted for future impacts from potential training increases within the existing footprint of training areas, and increased frequency or severity of fire within the existing fire footprint, both of which have the ability to degrade or remove habitat. While we do not expect a major change in the land use or fire pattern on SCI, the future of facilities development and training on the island is unknown. While the changes to training are likely to be incremental, increased training could cause adverse impacts to San Clemente Bell's sparrows through additional troop movements, maneuvers, live fire, or other unforeseen impacts that may affect the subspecies' behavior or productivity. Further, fires of increased severity or increased frequency could negatively impact the taxa. The 2017 fire year burned the second highest total acreage of the last 20 fire seasons as well as the largest acreage that was considered severe, but less than 6% of the total San Clemente Bell's sparrow population was estimated in those areas that burned. Over the course of 20 to 30 years, locations that experience a severe fire are likely to recover; for instance, vegetation is recovering within the 2017 burn polygon (SERG 2019, unpublished data). However, if fires become more frequent, fires could kill and prevent recolonization of shrubs that would provide nesting substrate for the Bell's sparrow.

While these impacts cannot be predicted spatially with a high degree of certainty, they are likely to occur in and around existing training ranges and are unlikely to preclude San

Clemente Bell's sparrows entirely from the areas in which they occur. Similarly, many larger fires burn at varying intensities across the landscape: such fires could remove habitat in localized areas but are unlikely to preclude San Clemente Bell's sparrows within an entire burn footprint for any length of time, given both the patchy nature of fires and vegetation regeneration.

However, while most of the San Clemente Bell's sparrow's range lies outside areas where high-use training occurs and where fires have burned, some of the range also lies inside these training areas and where fires have burned. Therefore, instead of estimating the number of territories or amount of habitat that might be lost to future training impacts, which is difficult to predict, we instead estimated the amount of habitat in each habitat stratum that would not be expected to experience future impacts from potential frequent fires or impacts of increased training. Therefore, for each habitat stratum, we calculated the area that would be unaffected by future impacts, or the minimum available habitat, modeled at two levels:

- Status quo: No additional impacts (assumes current habitat extent and no future development)
  With no future impacts greater than those currently experienced on SCI, we expect San Clemente Bell's sparrows to continue to occupy the total area within each habitat stratum using the current estimate.
- Increased impacts: Some future impacts (assumes reduced habitat extent)
  With future additional impacts from increased training and/or fire, but without knowing the full footprint or severity of these increased impacts, we provide an estimate of the area that is not projected to see additional impacts, representing the minimum amount of habitat that will be available in the future (Figure 30).

To calculate this minimum available habitat area, we used the total area within each stratum and subtracted both 1) the sum of the area in that stratum that lies within an area that experiences potentially high-impact training (the Impact Areas, TARs, AVMAs, and areas within 50 feet of the AVMR or a road), and 2) the sum of the area in that stratum that has experienced more than 1 fire in the last 20 years. This provides an estimate of the habitat that lies outside the footprint of existing high intensity training areas. Since habitat lies outside existing training areas and previously burned areas, we project it will remain unaffected by increased intensity of training (within the existing footprint) or increased fire frequency or severity (Figure 30). However, we expect this estimate represents the minimum amount of habitat that will be available and unimpacted; we expect additional areas will remain unimpacted or will remain occupied, although perhaps at lower densities, in this "increased impacts" scenario.

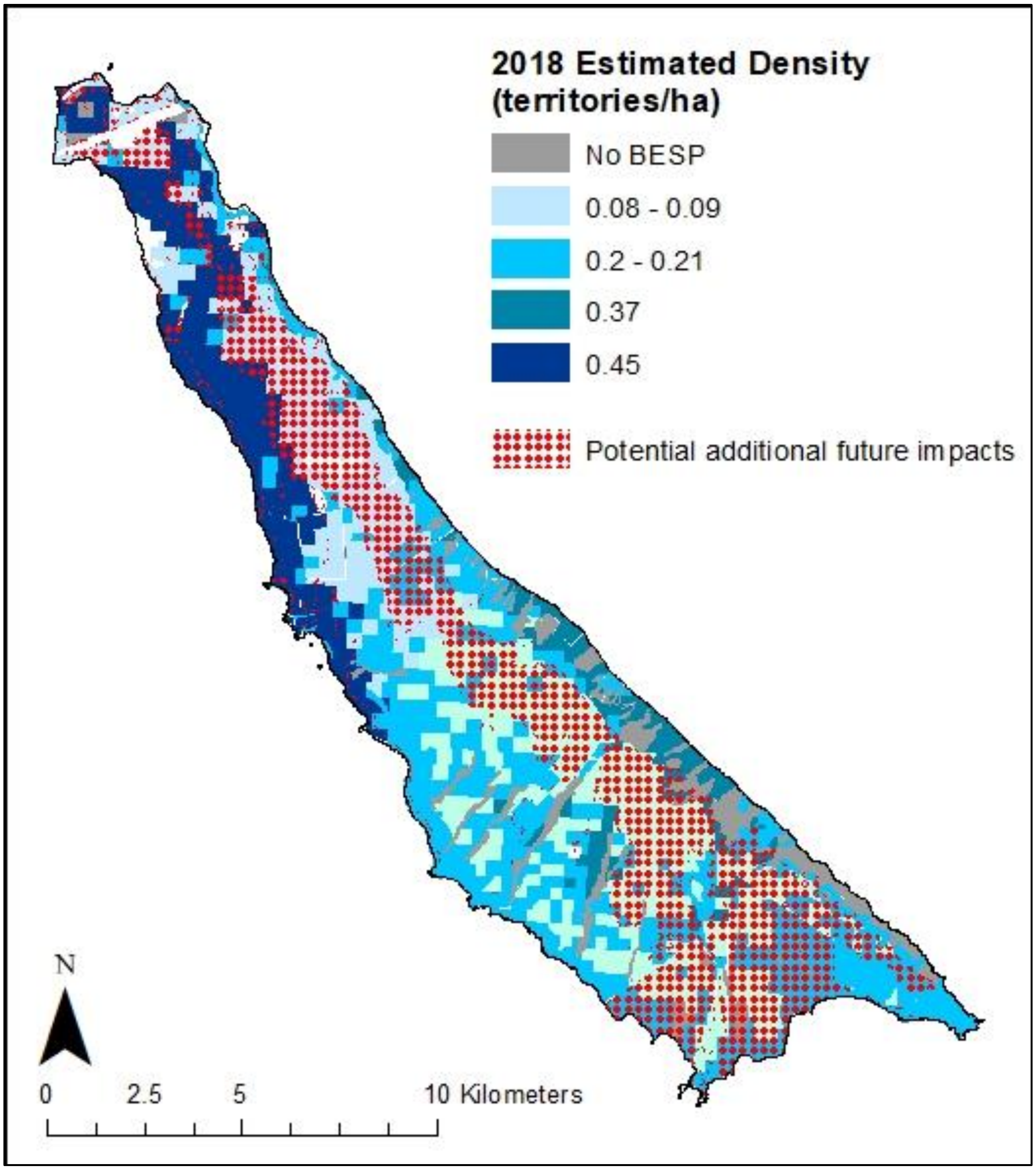

Figure 30. Estimated territory density of San Clemente Bell's sparrows (BESP) in 2018 (considered current) overlaid with the area where additional potential future impacts are projected to occur. Habitat outside these impacted areas are assumed to remain under status quo conditions, and only these areas contribute to the population values presented in the "increased impacts" scenario.

Territory density

While the island-wide population estimate of San Clemente Bell's sparrows has greatly increased since listing, the rate of this increase is unknown. While the population undergoes normal fluctuations, we also do not know if the carrying capacities of the different strata have been reached; in the future, the population could either continue to climb or it may have reached a plateau in some or all strata.

The underlying quality of the habitat will in part drive territory density within each stratum, and habitat quality (and territory density) can vary spatially and temporally. Territory density has been estimated within each stratum for the past six years (2013–2018), and the current strata classifications have been used for the past four (2015–2018). Given the subspecies' ability to delay or forego breeding in some years and produce multiple clutches in others, as well as demographic stochasticity and other factors, territory densities fluctuate annually. To estimate the range of territory densities we might expect within each stratum, and to further portray potential fluctuations in density based on habitat quality, specific annual conditions, and other stochastic factors, we projected future density at two levels:

- Future low density: The lowest estimated density within a single stratum recorded between 2015 and 2018 minus one standard error of the mean.
- Future high density: The highest estimated density within a single stratum recorded between 2015 and 2018 plus one standard error of the mean.

We used these two density levels to represent the range of likely densities. Using the density range, we calculated a range for the number of territories we project in the future within each stratum.

Future Scenarios

We projected the future number of San Clemente Bell's sparrow territories within each stratum using the range of low and high densities for both the current occupied habitat (assuming no increase in future impacts), and for an estimate of the minimum available habitat (assuming some impacts from training or fire within the high-use training and fire-prone areas).

We then summed the projected territory numbers from each stratum to get a projected island-wide population size under the two scenarios: the "status quo" within the current habitat extent (no increase in impacts) and under the "increased impacts" within the unimpacted areas (some impacts). Thus, we provide the total territories (within a range, using low to high densities) for these two projected habitat extents.

We model the minimum amount of available habitat that we might expect under a scenario where both military training and fires increase within the existing footprint, and we again stress that the resulting population estimates represent the minimum number of territories we would predict to be outside the boundaries of training and fire impacts island-wide.

Thus, in our optimistic scenario, we assume conditions will remain the same throughout SCI, whereas in our pessimistic scenario (with additional impacts), we assume conditions will remain the same only outside high-use training and fire-prone areas, and thus we ignore any individuals that remain inside those areas. Again, we assume fire, infrastructure, and training footprints will not change in the future.

6.3 Results

Our projected range of possible densities are given in Table 11. The northern boxthorn habitat stratum, even at the projected low density, maintained a density of 0.34 territories/ha, and only 13% of the area within this habitat stratum is anticipated to have any future impacts (Table 11). Sagebrush has a similar high density estimate as that of the northern boxthorn habitat, although the low-density estimate is lower. Under a scenario where training or fire increase, over 50% of the southern boxthorn strata, close to 60% of the southern grassland strata, and about 30% of the cactus and northern grassland habitat strata are located in areas that could see future impacts.

Table 11. For each stratum, the low- and high-density estimates (territories/ha), total area of that stratum, % of each stratum in a high-use training area or that experienced >1 fire in 20 years, and the resulting low and high number of territories projected under both scenarios.

							Territories			
Strata	Low Density (Avg - 1 SE)	High Density (Avg + 1 SE)	Total Area (Ha)	% with Training	% >1 fire in 20 yrs	% Area Affected	Some impacts, Low	Some impacts, High	Status quo, Low	Status quo, High
Boxthorn – N	0.34	0.66	2,034.5	13.3%	0.5%	13.8%	596.3	1,157.6	691.7	1,342.8
Boxthorn – S	0.06	0.28	677.1	51.8%	0.1%	51.9%	19.6	91.3	40.6	189.6
Cactus	0.1	0.26	1,678.3	21.9%	13.6%	35.5%	108.3	278.1	167.8	431.1
GrassHerb – N	0.05	0.19	2,279.5	31.6%	0.2%	31.8%	77.7	295.2	114.0	433.1
GrassHerb – S	0.04	0.22	3,356.6	19.4%	37.9%	57.3%	57.3	315.1	134.3	738.4
Mixed Shrub	0.08	0.42	2,359.2	9.5%	6.2%	15.8%	159.0	834.7	188.7	990.9
Sagebrush	0.15	0.7	748.5	2.0%	13.7%	15.8%	94.6	441.4	112.3	523.9
Total							**1,112.7**	**3,413.3**	**1,449.4**	**4,649.8**

A geographic overlay of the projected area where increased impacts may occur compromises 33% of the current habitat (Figure 30). By multiplying the estimated densities by both the current habitat and the minimum available habitat, our scenarios indicate that a minimum of 1,112 and up to 3,413 territories (2,225–6,826 individuals) could exist outside the current high intensity training and fire footprint, and within the habitat projected to be unaffected by a training increase or increase in fire severity on the island (Table 12). If the current habitat remains occupied, at least 1,449 and up to 4,650 territories might be expected, or 2,889 to 9,300 individuals.

Table 12. Total island-wide population projections of San Clemente Bell's sparrows territories and individuals within a range of low to high expected densities for two future impact scenarios.

	Increased impacts (minimum habitat)	"Status Quo" No further impacts (current habitat)
territories	1,113–3,413	1,449–4,650
(individuals)	(2,225–6,826)	(2,899–9,300)

Again, we stress that our population estimates within the minimum available habitat (scenario with increased future impacts within the current fire/training footprints) are not a projection of the entire island population, but instead a projection of the territories and individuals that we project would not be affected by any training or fire frequency increase if they are within the existing footprint. We anticipate an undetermined acreage of habitat to retain suitability within these impacted areas, but how much and what densities it would support would be purely speculation; thus, we present the Bell's sparrow population that would inhabit the area outside the existing high intensity fire and training footprint.

Therefore, under the best conditions, in 20 to 30 years, given no increased effects of training or fire, we expect the island-wide population of San Clemente Bell's sparrows to be between 2,899 and 9,300 individuals. Under conditions that support increased training and fire within the existing footprint, at least 2,225 and 6,828 individuals would be expected to occur outside the areas experiencing additional training and fire impacts., The estimated population within these impacted areas that might persist cannot be predicted.

6.4 Future Resiliency

We expect that, without major impacts from increased training or fire, the island-wide population of San Clemente Bell's sparrows will continue to fluctuate but will remain stable. Projected future high and low population estimates remain within the range of current population estimates as they have fluctuated over the past five years (Table 12, Figure 15). Currently (2018), there are an estimated 1,494–3,859 territories (95% CI) on SCI; our increased impacts scenario projects between 1,113 and 3,413 territories, just counting outside the future impacted areas; thus, the population is not expected to decrease drastically.

The projected population that would exist outside the high intensity training areas and current fire footprint remains over 2,000 individuals. In addition, since we do not expect that these areas (33% of the current available habitat; Figure 30) where future impacts might occur would exclude San Clemente Bell's sparrows entirely, the actual population would be higher, possibly much higher, depending on the extent and severity of the impacts. Given the continuation of current management efforts, we would not expect significant impacts from either training or fire, but the future of training and fire on SCI is largely unknown. Therefore, while increased training or fire impacts could reduce population resiliency, we expect the population to remain resilient to stochastic factors.

6.5 Future Representation

While there is no evidence of genetic units within the population of San Clemente Bell's sparrows, we do not project a change in their ability to successfully breed in a wide range of elevations nor utilize a wide range of habitats under future scenarios. However, individuals within localized regions could possibly be lost under a scenario where training or fire frequency increases. For instance, the southern boxthorn population drops below 100 territories in our impact scenario if we discount individuals in impacted areas (Table 11). All the habitat strata remain occupied (although some in low numbers) in our scenarios; thus, we expect some level of representation will persist in the current habitats in all instances short of some unprecedented, catastrophic impact to the island. This subspecies has rebounded from a huge habitat restriction in the past by having a stronghold in the northwest boxthorn, although we cannot guarantee its continued ability to do so under a different set of circumstances.

6.6 Future Redundancy

Even under a scenario in which there are anticipated additional impacts within the existing intensively used areas and previously burned areas, our models indicate that a significant number of Bell's sparrow territories will remain on the island, and that future population estimates are comparable to current population estimates. Thus, we expect that the subspecies will retain enough redundancy to sustain most major catastrophic events, such as unprecedented fires, major erosion events (such as caused by periods of heavy rainfall), or drought cycles. Most of these events would be localized and unlikely to affect a large part of the population. Further, management efforts on the island make the possibility of an extreme fire or major erosion event unlikely.

However, a catastrophic impact in high density habitat has the potential to reduce the population substantially. The northern boxthorn strata along the upper west shore is forecast to comprises up to 48% of the population under the scenario with no additional impacts, and up to 54% given major additional impacts (Table 11). Unforeseeable changes in military training or fire patterns or any other impact that would cause a loss of a substantial portion of boxthorn habitat in this area could have major consequences to the subspecies. An invasion of nonnative grasses or other vegetative species within the boxthorn habitat could make the area more susceptible to fire. While there are no proposed plans currently, further development of the west shore road and construction of facilities in this area could be proposed in the future. While this area is already recognized as a management area for the island night lizard, further prioritization of this area for San Clemente Bell's sparrow habitat could help conserve this high-density habitat and support the subspecies' ability rebound from catastrophic impacts. Prioritization of conservation and impact minimization within the four core Bell's sparrow management areas identified in Section 5.7 would further help ensure the future redundancy, and thus viability, of this subspecies.

An impact that affects the entire island could also threaten the viability of the subspecies. Drought, for instance, has the ability to impact the vegetation island-wide. While the most recent drought cycle did not appear to threaten viability, the effects of more prolonged or more extreme droughts is unknown. Given the breeding response to drought and the effects of drought on plant phenology, the effects of multiple, severe drought years, perhaps coupled with other stressors, could have substantial impacts to subspecies viability by impacting the food and cover resources of Bell's sparrows across broad areas of the island. Still, given their wide distribution in several habitat types, and that vegetative responses to drought vary by species, we'd expect at least some of the population would be able withstand the drought. However, depending on the length and severity of drought, impacts to the subspecies could be substantial.

The population size of San Clemente Bell's sparrows appears to be able to fluctuate significantly from year to year, depending on survival and breeding success from year to year. The population has rebounded rather quickly from past decreases in population size due to drought; the future viability of this subspecies will hinge on its continued ability to rebound quickly, which is likely a product of maintaining quality habitat across several locations on the island.

Because San Clemente Bell's sparrows are limited to San Clemente Island, they would be unable or unlikely to disperse elsewhere in the event of an impact that affected the entire island.

6.7 Limitations and Uncertainties

In any species status assessment, the process of projecting a population into the future requires making strategic simplifications of reality. We must account for multiple uncertainties and make informed assumptions when necessary. Our assessment addressed some of the key uncertainties and yielded useful predictions for characterizing the future status of the San Clemente Bell's sparrow, and through the use of predictive constructs and multiple scenarios, we captured a range of possible conditions in the future. However, there are still limitations to these predictions; we outline these uncertainties and assumptions of the analyses below.

First, due to the new survey methodology implemented across SCI in 2013, island-wide population estimates are only comparable between 2013–2018. Since the current habitat strata being implemented in 2015, density estimates within each stratum are comparable only between 2015–2018. The long-term population trajectory and normal range of annual population fluctuations, for instance, are not well known or understood. Especially given the wide confidence intervals around the annual population estimates and density within each stratum, the effects of drought years on the population size are hard to predict and may be higher. While the data do not detect limitations to subspecies viability, these data represent a short timeframe, and additional years of data would be useful to further clarify these patterns and relationships.

We did not attempt to predict the actual impacts from additional fire or training and thus avoided making those assumptions; instead, we forecast the population within areas that would remain unimpacted. However, we did assume that future additional training and fire would impact the same areas as they have historically, and we assumed that no new development would occur outside existing footprints. Thus, our scenarios do not account for a change to training area footprints, infrastructure, or changes to ignition source locations or something else that would affect where fires are likely to burn. While we do not anticipate these sorts of changes, they cannot be ruled out.

We also assumed that the Navy will continue to manage habitats on the island into the future, continuing their efforts to manage fire, invasive species, and erosion. If the Navy were to cease being good land stewards, our conclusions would likely be invalidated.

The final major uncertainty regarding the future of SCI is climate change. Climate change could greatly alter the vegetative communities on SCI in the coming century, which could affect the frequency, footprint, or intensity of fires or shift the habitat use and distribution of San Clemente Bell's sparrows. However, how these habitats might be affected and the magnitude of the impacts to the subspecies are unknown, and we hesitate to speculate beyond our 20 to 30-year timeframe. As climate science is growing and improving, we assume refined future models will become available in the coming decade. Thus, we recommend that the impacts to Bell's sparrows from climate change be revisited when updated data become available such that the full effects of climate change can be more adequately represented and the viability of the Bell's sparrow can be predicted further into the future.

6.8 Conclusions

Despite historic and current land uses, historic drought, historic and current fire patterns, and other existing threats, the San Clemente Bell's sparrow has recovered from an apparent population bottleneck in the 1980s and has substantially increased both its distribution and population size on SCI. Currently, we expect that the Bell's sparrow has adequate resiliency, redundancy, and representation to withstand stochastic impacts, environmental changes, and reasonably possible potential catastrophic events on SCI. Projecting the population into the future, if current the current training and fire footprint does not change, but fire frequency, fire severity, and training, within the footprint increase, we find that the majority of the high density habitat and a substantial proportion of the population will persist. Thus, even under our increased impacts predictions, barring any unprecedented catastrophic impacts to SCI and provided that 1) no additional training areas are created, 2) the fire footprint does not change dramatically, and 3) the Navy continues conservation and management practices conducive with protecting habitats that are important to the Bell's sparrow, we expect the population will retain much of its current resiliency, representation, and redundancy.

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APPENDIX A

Stratification assigned to Bell's Sparrow Survey Plots on SCI, California**.** Plot classifications were assigned using a combination of ground truthing and aerial images. The classifications are a hierarchical system, and do not (necessarily) represent the dominant cover type for each plot. Rather, they are based on a minimum amount of cover present that we expect to be important for sparrows.

Stratum	Island Zone	Plot-Level Vegetation Assessment Classification Rules	2017 25m Point Sampling Classification Rules	Total Plots	Total Area (ha)
Boxthorn	N – North of Mail Point/Stone Station line	Sum of all boxthorn in plot covers ≥25%	Average boxthorn in plot ≥15%	144	2,050.5
	S – South of Mail Point/Stone Station line			68	677.1
Sagebrush	All island	Sum of all boxthorn in plot covers < 25% AND sum of all sagebrush covers ≥ 25%	Average boxthorn in plot <15% AND average sagebrush in plot ≥15%	93	750.4
Mixed Shrub	All island	Sum of all boxthorn in plot covers < 25% AND Sum of all sagebrush covers <25% AND Sum of all shrub species covers ≥ 25%	Average boxthorn and sagebrush individually <15%, average of all shrub species covers ≥ 15%.	237	2,317.6
Cactus	All island	Sum of all shrub species covers <25% of plot AND grass and herbaceous cover < cactus cover	Average of all shrub species <15% AND grass and herbaceous cover < cactus cover.	164	1,669.3
Grassland/ Herbaceous	N – North of Mail Point/Stone Station line	Sum of all shrub species covers <25% of plot AND cactus cover < grass or herbaceous cover	Average of all shrub species covers <15% of plot AND cactus cover < grass or herbaceous cover	160	2,279.5
	S – South of Mail Point/Stone Station line			303	3,387.1
Canyon/ Woodland or Bare	All island	Cover consists of tree and woodland species at bottom of canyons, steep and inaccessible eastside slopes, OR Nonvegetated due to human disturbance, such as at the air terminal, Little Baghdad, REWS facility. These plots are not surveyed and are not expected to contribute to the Bell's sparrow population		154	1,044.0