**Conservation Action Plan for**

**Ashy Storm-Petrels (*Oceanodroma homochroa*)**

**In California and Baja California**

**Michael Parker**

**California Institute of Environmental Studies**

**3408 Whaler Avenue**

**Davis, CA 95616 USA**

**DRAFT PLAN (19 FEBRUARY 2016)**

Suggested Citation: Parker, M.W. 2016.Conservation action plan for Ashy Storm-Petrels (*Oceanodroma homochroa*) in California and Baja California. Unpublished report, California Institute of Environmental Studies, Davis, California. 68 p.

**TABLE OF CONTENTS**

[Acknowledgements 4](#_Toc443651236)

[Section I. Introduction and Background: Need For A Conservation Plan 5](#_Toc443651237)

[Section II. Ashy Storm-Petrel Species Account 8](#_Toc443651238)

[Life History 8](#_Toc443651239)

[Breeding Habitats 8](#_Toc443651240)

[Timing Of Breeding 9](#_Toc443651241)

[Diet 10](#_Toc443651242)

[At-sea Distribution 10](#_Toc443651243)

[Colony Distribution 11](#_Toc443651244)

[Breeding Colony and Population Estimates 22](#_Toc443651245)

[At-sea Surveys and World Population Estimates 24](#_Toc443651246)

[Threats 26](#_Toc443651247)

[Section III. Conservation Actions 29](#_Toc443651248)

[Purpose 29](#_Toc443651249)

[Conservation Action Prioritization Narrative 29](#_Toc443651250)

[Goals, Objectives, and Strategies 30](#_Toc443651251)

[Artificial Habitat/Nest Structures Goal 31](#_Toc443651252)

[SE Farallon Island - Objectives for Artificial Habitat/Nest Structures: 31](#_Toc443651253)

[Prince Island - Objectives for Artificial Habitat/Nest Structures: 33](#_Toc443651254)

[Santa Cruz Island and associated islands, islets and sea caves - Objectives for Artificial Habitat/Nest Structures: 35](#_Toc443651255)

[San Clemente Island and associated islands, islets and sea caves - Objectives for Artificial Habitat/Nest Structures: 38](#_Toc443651256)

[Reduction of Predation at Breeding Colonies Goal 41](#_Toc443651257)

[South Farallon Islands - Objectives for Reduction of Predation at Breeding Colonies: 41](#_Toc443651258)

[San Miguel Island Area - Objectives for Prevention and Reduction of Predation at Breeding Colonies: 43](#_Toc443651259)

[Santa Cruz Island Area - Objectives for Prevention and Reduction of Predation at Breeding Colonies: 45](#_Toc443651260)

[Survey and Research Goal 47](#_Toc443651261)

[Colony Survey and Colony Size Estimate Objectives 47](#_Toc443651262)

[At-sea Survey Objectives 50](#_Toc443651263)

[Research Objectives 52](#_Toc443651264)

[Index Monitoring Program Goal 54](#_Toc443651265)

[Section 4. Consideration For Other Storm-Petrel Species 57](#_Toc443651266)

[Leach’s Storm-Petrel 57](#_Toc443651267)

[Black Storm-Petrel 58](#_Toc443651268)

[Section 5. References 60](#_Toc443651269)

# Acknowledgements

Funding for the development of this plan was provided by the National Fish and Wildlife Foundation (NFWF) with key assistance from Scott Hall. In-kind contributions were provided from a number of individuals and organizations including U.S. Fish and Wildlife Service (Gerry McChesney and Bill McIver); National Park Service (David Mazurkiewicz and Ben Becker); U.S. Geological Service (Josh Adams); Bureau of Land Management (David Ledig); Audubon California (Anna Weinstein, Katie Krieger, and Liling Lee); Carter Biological Consulting (Harry Carter); Point Blue Conservation Science (Jaime Jahnche and Russell Bradley); and California Institute of Environmental Studies (Frank Gress and Jessica Brenner). Specifically I would like to thank Scott Hall (NFWF), Anna Weinstein (Audubon California), Shaye Wolf (Center for Biological Diversity), and Harry Carter (Carter Biological Consulting) for assistance in the development of the grant proposal. Key administrative support at CIES was provided by Frank Gress and Jessica Brenner.

I would like to thank Katie Krieger and Liling Lee from Audubon California for their excellent work on the development of the Ashy Storm-Petrel colony distribution maps. In addition, special thanks go to Jaime Jahncke of Point Blue Conservation Science for providing the Ashy Storm-Petrel at-sea distribution map that was a collation of numerous researchers’ data. We thank all those willing to allow their data to be utilized for the purposes of the figure to be included in this plan.

The development of this plan has benefitted from the advice, knowledge and assistance of many individuals. I wish to sincerely thank and gratefully acknowledge the following individuals who allowed me to interview them for a significant amount of time in order to obtain information for this plan and I apologize to anyone whose name was inadvertently omitted from this list:

Josh Adams (U.S. Geological Survey); David Ainley (H.T. Harvey & Associates); Ben Becker (National Park Service); Yuliana Bedolla (Grupo de Ecología y Conservacíon de Islas); Jennifer Boyce (NOAA Restoration Center); Russell Bradley (Point Blue Conservation Science); Harry Carter (Carter Biological Consulting); Jaime Jahncke (Point Blue Conservation Science); David Ledig (Bureau of Land Management); Annie Little (U.S. Fish and Wildlife Service); David Mazurkiewicz (National Park Service); Gerry McChesney (U.S. Fish and Wildlife Service); Bill McIver (U.S. Fish and Wildlife Service); David Pereksta (BOEM); Anna Weinstein (Audubon California) and Shaye Wolf (Center for Biological Diversity).

# Section I. Introduction and Background: Need For A Conservation Plan

The Ashy Storm-Petrel (*Oceanodrama homochroa*) (hereafter ASSP) has always been regarded as a relatively rare seabird (<10,000 breeding pairs), with a restricted breeding range almost entirely in California (Ainley et al. 1990; Carter et al. 2008a; Ainley 1995). The largest known colony at the South Farallon Islands (hereafter “Farallones”) was first estimated at ~3000-4,000 individuals in 1959 and 1971-72 (Ainley and Lewis 1974). Most of the colony occurs on Southeast Farallon Island which was protected within the Farallon National Wildlife Refuge (managed by the U.S. Fish and Wildlife Service) when this refuge was expanded in 1969. The next largest colonies at Prince Island (~300 pairs) and Santa Barbara Island (~150 pairs; including Sutil Island) were not surveyed until 1975-1977 (Hunt et al. 1979). Santa Barbara Island had been included earlier in the Channel Islands National Monument (managed by the National Park Service) when formed in 1933 but Prince Island has been under management by the U.S. Navy since 1934. Both islands were included in Channel Islands National Park when formed in 1980. By the 1980s, all three major colonies were protected in public ownership and introduced predators (primarily feral cats *Felis catus*) had been removed from the Farallones and Santa Barbara Island. As a result of these land protection and conservation actions, the species appeared to be secure by the 1980s despite still being considered a relatively rare seabird. Even so, the California Department of Fish and Game had designated it a Species of Special Concern (Remsen 1978).

In the 1990s, concerns for the conservation of ASSP were heightened based on studies that indicated the species was in decline and faced major threats, despite the protection of major colonies. Sydeman et al. (1998) documented a 44% decline in the population size at the Farallones in 1992 compared to 1971-72 based on a comparison of mist-net captures, and they updated the population estimate to ~995 pairs. The cause of this decline appeared to be relatively high predation by an expanded breeding population of Western Gulls (*Larus occidentalis*) and migratory Burrowing Owls (*Athene cunicularis*). Carter et al. (1992) also had completed a detailed seabird survey throughout California from 1989-1991. This survey reported higher estimates of ASSP at Santa Barbara Island (~730 pairs, including Sutil Island), and Prince Island (~577 pairs), apparently the result of increased survey effort (Carter et al. 1992). However, only 38% of the global population would have been considered to occur at the Farallones in the early 1990s if Carter et al. (1992) had used the ~995 pair estimate for the Farallones in 1992 (instead of the 2,000 pair estimate for 1971-72). Additional colonies also were discovered in 1994-1996 in the Channel Islands which further lowered the percentage of the world breeding population at the Farallones in the 1990s.

Despite larger population size estimates in the Channel Islands in 1991-1996, concern for ASSP increased greatly when high levels of organochlorine pollutants (DDTs and PCBs) were found in eggs from Santa Cruz Island in 1992-1997 and impacted nesting success (Fry 1994; Kiff 1994; Carter et al. 2008a, b; McIver et al. 2009). Ainley and Hyrenbach (2010) provided further evidence that the global population was declining; at-sea estimates of ASSP declined 76% from 1985-1994 to 1997-2006. In short, by the early 21st century the best available science indicated that the ASSP population was declining and major threats remained.

As a result of major threats and decline in ASSP populations, several changes in status and management actions have occurred since 2000:

**2001** – The International Union for the Conservation of Nature (IUCN) designated ASSP as endangered and declining on its Red List (version 3.1).

**2002** – The U.S. Fish and Wildlife Service listed ASSP as a Bird of Conservation Concern (USFWS 2002).

**2005** – The U.S. Fish and Wildlife Service identified the ASSP as “highly imperiled” in its Pacific Region Seabird Conservation Plan (USFWS 2005). Restoration of ASSP was included in the Montrose Settlements Restoration Program (MSRP 2005).

**2006** – The National Audubon Society included ASSP as one of the 10 most endangered birds in the United States (National Audubon Society 2006).

**2007** – The Center for Biological Diversity petitioned the U.S. Fish and Wildlife Service to list the ASSP as threatened or endangered pursuant to the Endangered Species Act (Wolf 2007).

**2008** – The California Department of Fish and Wildlife released their updated list of Bird Species of Special Concern, which again included ASSP but with an elevated priority 2 (Carter et al. 2008a). Restoration actions are initiated at Santa Cruz Island (McIver et al. 2016).

**2009** – The U.S. Fish and Wildlife Service announced a 12-month finding of “not warranted at this time” for listing the ASSP under the Endangered Species Act (USFWS 2009).

**2010** – The ASSP is listed as “endangered” under Mexican Law, NOM-059-SEMARNAT-2010 (SEMARNAT 2010).

**2012-2014** – Audubon California hosted meetings of ASSP experts and management agencies to discuss range-wide monitoring and conservation efforts.

**2013** – The U.S. Fish and Wildlife Service announced a second 12-month finding of “not warranted at this time” for listing the ASSP under the Endangered Species Act (USFWS 2013). This second examination of the status of the species had been conducted by the U.S. Fish and Wildlife Service as part of a settlement agreement with the Center for Biological Diversity.

**2015** – A special paper session on ASSP was hosted at the Pacific Seabird Group meeting in San Jose, California. Several papers from this paper session are in the process of publication in the scientific journal *Marine Ornithology*.

Regardless of both USFWS findings on endangered species act protections, improved conservation and monitoring efforts are still needed for this rare species. The National Fish and Wildlife Foundation (NFWF) sponsored the development of this plan to help identify priority management, research and conservation needs for ASSP. In addition, this plan will hopefully encourage greater cooperation among stakeholders working toward conservation of ASSP. Four areas of focus for this conservation plan that have been identified by management agencies and ASSP experts are: (1) artificial nest structures and habitat; (2) reduce predation levels at breeding colonies; (3) conduct surveys and research to find locations, population sizes and conservation issues of breeding colonies; and (4) establish an index monitoring program range-wide.

# Section II. Ashy Storm-Petrel Species Account

## Life History

### Breeding Habitats

At most colonies, ASSP nest within rock crevices, formed on the surfaces of offshore islands and nearshore rocks, as well as within large sea caves on certain offshore islands (James-Veitch 1970; Ainley et al. 1990; Ainley 1995; McIver 2002; Carter et al. 2008a; Carter et al. 2015; McIver et al. 2009a; McIver et al. 2016). At the largest known colony at the Farallones, a large proportion also breed in human-built rock walls and human-modified talus slopes developed after 1800 (Ainley et al. 1990; Carter et al. 2008a). At Prince Island, natural habitats likely have been modified due to guano harvesting and bombing practice by the U.S. Navy (Carter et al. 2008c). At Bat Cave (the largest sea cave colony at Santa Cruz Island), many nests are found within piles of driftwood inside the cave (McIver 2002). ASSP also may nest in cliffs on offshore islands, nearshore rocks and mainland cliffs, based on captures near these habitats, but breeding has not yet been confirmed in cliffs (e.g. Point Reyes Headlands; Becker et al. 2016). Nesting on offshore islands and nearshore rocks are thought to be an adaptation that prevents or greatly reduces mammalian predation. However, islands and rocks are still accessible to avian predators (e.g. Common Ravens, Burrowing Owls, and Western Gulls) (Sydeman et al. 1998; McIver 2002; McIver et al. 2016) and nearshore rocks are likely accessible by some mammalian predators (e.g. river otters). Both mammalian and avian predators are known to prey on adults, eggs, and chicks (Ainley et al. 1990; McIver 2002; McIver and Carter 2006; McIver et al. 2016).

Throughout the breeding range, natural breeding habitats are relatively stable and do not change substantially between years. However, erosion of coastal islands (from water, wind and earthquakes) does occur over time with either the creation of small sections of new habitat (through rockfall crevices), and loss of small sections of habitat, especially in sea caves. The loss or creation of habitats from different forms of natural erosion has not been well studied but is unlikely to be a major impact on the conservation of ASSP in the next 10-15 years.

High water/wave events has impacted nesting habitats in certain sea caves, by changing driftwood configurations or moving smaller rocks/boulders that provide nesting habitat, mainly causing the loss of breeding habitats (H. Carter, pers. comm.). Increase in sea level and storm frequency is resulting due to climate change (IPCC 2014). Low-lying nesting habitats, mainly in sea caves but also some nearshore rocks are at risk of being lost in the next few decades. However, actions could be taken at certain colonies to prevent or reduce such impacts (see later).

### Timing of Breeding

The breeding season is protracted and visits to breeding colonies can occur year-round, although visitation is most frequent from February through October (James-Veitch 1970; Ainley et al. 1974). Visitations can be divided into three general periods: pre-egg, incubation and chick-rearing. ASSP begin visiting breeding colonies in late December and courtship or maintenance of sites (including pair retention from previous years) can last up to 3 months (Ainley 1995; Ainley et al. 1990). Egg-laying is asynchronous and extends from late April through October with most egg-laying in late June/early July (James-Veitch 1970; Ainley et al. 1990; McIver 2002). Clutch size is one egg and parents alternate incubation duties every 1-8 days (average 2-3 days) during an average incubation period of about 45 days with a range of 42 to 59 days (Ainley 1995). Replacement eggs have been documented after failure of a first egg (Ainley et al. 1990; McIver 2002). Once hatched, a nestling is brooded for approximately 5 days, after which they remain in the nest site alone during the day (Ainley et al. 1990). Nestlings are fed irregularly, an average of about once every 1 to 3 nights, during brief parental visits. ASSP chicks fledge at an average age of 85 days ranging from 72 to 119 days old (Ainley et al. 1990). Most fledging occurs between late September and late October but some chicks fledge as early as June and as late as January in some years (Ainley et al. 1990; McIver 2002).

### Diet

While the diet of ashy storm-petrels has not been well-studied, it likely includes euphausiids (e.g., *Euphausia pacifica*, *Thysanoessa spinifera*) and other crustaceans (including the young of spiny lobsters), fish eggs, small fish, and young squid all taken at the ocean’s surface (Anthony 1898; Ainley 1995, Carter et al. 2008a; McChesney 1988). This diet of high-lipid prey likely makes the ashy storm-petrel susceptible to bioaccumulation and/or biomagnification of contaminants. In addition, plastic particles have been found in storm-petrel species that forage in the California Current (Blight & Burger 1997; Shuiteman 2006). Similar plastic pellets collected from beaches around the world have been shown to contain PCBs and organochlorine pesticides and ingestion by storm-petrels represents an additional pathway for these toxins to be absorbed by storm-petrels (Mato et al. 2001).

### At-sea Distribution

ASSP are known to forage widely within the central and southern portions of the California Current System between northern California and central west Baja California, based on information from extensive at-sea surveys and birding pelagic trips (Figure 1; Stallcup 1976; Briggs et al. 1987; Ainley 1995; Howell and Webb 1995; Mason et al. 2007; Spear & Ainley 2007; Ainley & Hyrenbach 2010; Howell 2012). They primarily occur in waters seaward of the continental shelf break (over the continental slope domain from 200 – 2000 m depth), near offshore islands, and closer to the coast within the southern parts of its range. ASSP are non-migratory and exhibit little post-breeding dispersal (Ainley 1995; Adams & Takekawa 2008). Off southern California, concentrations of ASSP have been recorded in 3 main areas: the continental slope SW of Point Buchon, western Santa Barbara Channel and in the Santa Cruz Basin area (Mason et al. 2007; Adams & Takekawa 2008; Point Blue Conservation Science, unpubl. data). Off northern California, ASSP concentrations occur along the continental slope west of the South Farallon Islands, over the Cordell Bank and in the Monterey Bay (Ainley et al. 1990; Spear and Ainley 2007). Anecdotal information from birding pelagic trips indicates that some ASSP “hotspots” in this region have shifted. For example, a major late summer and fall hotspot over the Monterey Submarine Canyon (~36.5° N) which had been known since the 1970s appears to have shifted to the Cordell Bank area (~38° N) sometime in the early 2000s (D. Shearwater, pers. comm.).

At-sea distribution and seasons of occurrence of ASSP at the northern and southern extremes of the range are less well known. ASSP have been observed as far north as latitude 47° N (off the coast of Westport, Washington) on two occasions in 2006 and 2008 (Washington Ornithological Society, http://wos.org/documents/WBRC/wbrcaccepteddec2014.pdf, accessed October 19, 2015). To date, six sightings of single or small numbers of birds (<10) have been accepted by the Oregon Bird Records Committee since 2007 with 4 of the 6 sightings occurring in 2014 (Oregon Birding Association, http://www.orbirds.org/obrcrecordsmay2015.pdf , accessed October 19, 2015). At-sea observations of ASSP south of the San Benito Islands, Mexico (latitude 28° N) are unusual, although this is based on birding pelagic trip information as extensive at-sea surveys have not been conducted in this region (D. Ainley, pers. comm.).

### Colony Distribution

Ashy storm-petrels have been confirmed to breed at 31 locations between Point Cabrillo, Mendocino County, California, south to the Coronado Islands, Baja California, Mexico (Table 1; Figures 2-6)(Carter et al. 2008a; Carter et al. 2015). Breeding at Todos Santos Islands (south of

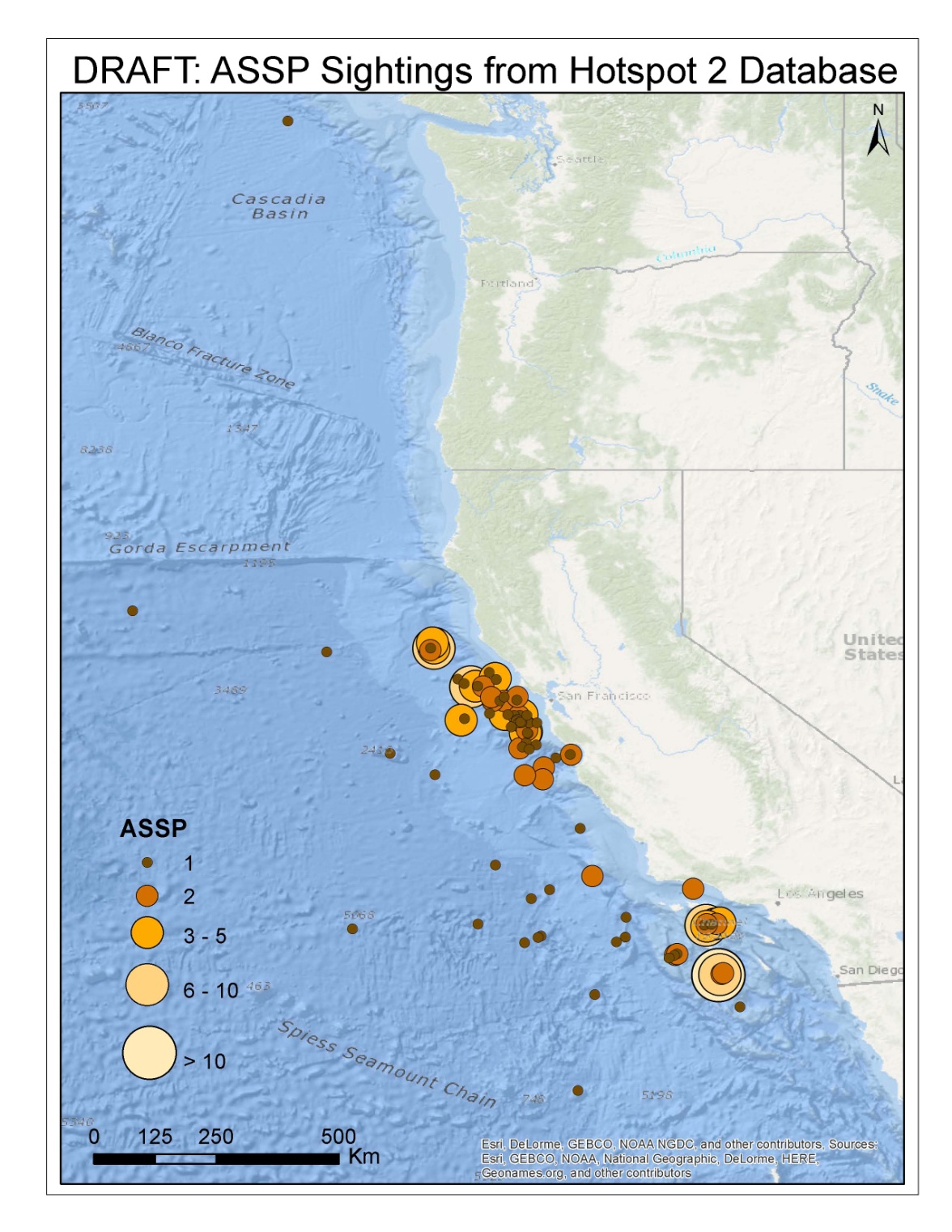


Figure 1. Distribution of ashy storm-petrels in the eastern North Pacific Ocean. Data were obtained from at-sea surveys by eight research and monitoring programs including: 1. California Co-operative Oceanic Fisheries Investigation (CalCOFI, 1997-2007); 2. National Marine Fisheries Service California Current Ecosystem Study (National Marine Fisheries Service NMFS CCES - National Oceanic and Atmospheric Administration [NOAA]; 2006-2008); 3. California Current Cetacean & Ecosystem Assessment Surveys (NOAA Southwest Fisheries Science Center; 2001-2008; 4. Line P and other North Pacific surveys (Canadian Wildlife Service [CWS] and Environment Canada; 1997-2010); 5. NMFS Rockfish Surveys (1998-2009); 6. NMFS Sardine Surveys (2006-2008); 7. Global Ocean Ecosystem Dynamics Northeast Pacific Northern California Current (GLOBEC NEP NCC; 2000-2002); and 8. Ocean Salmon Ecology (OSE), Southern Resident Killer Whale (SRKW) and Ships-of-Opportunity (SoO) surveys (NOAA Northwest Fisheries Science Center; 2003-2012). Map produced by Dori Dick, Point Blue Conservation Science.

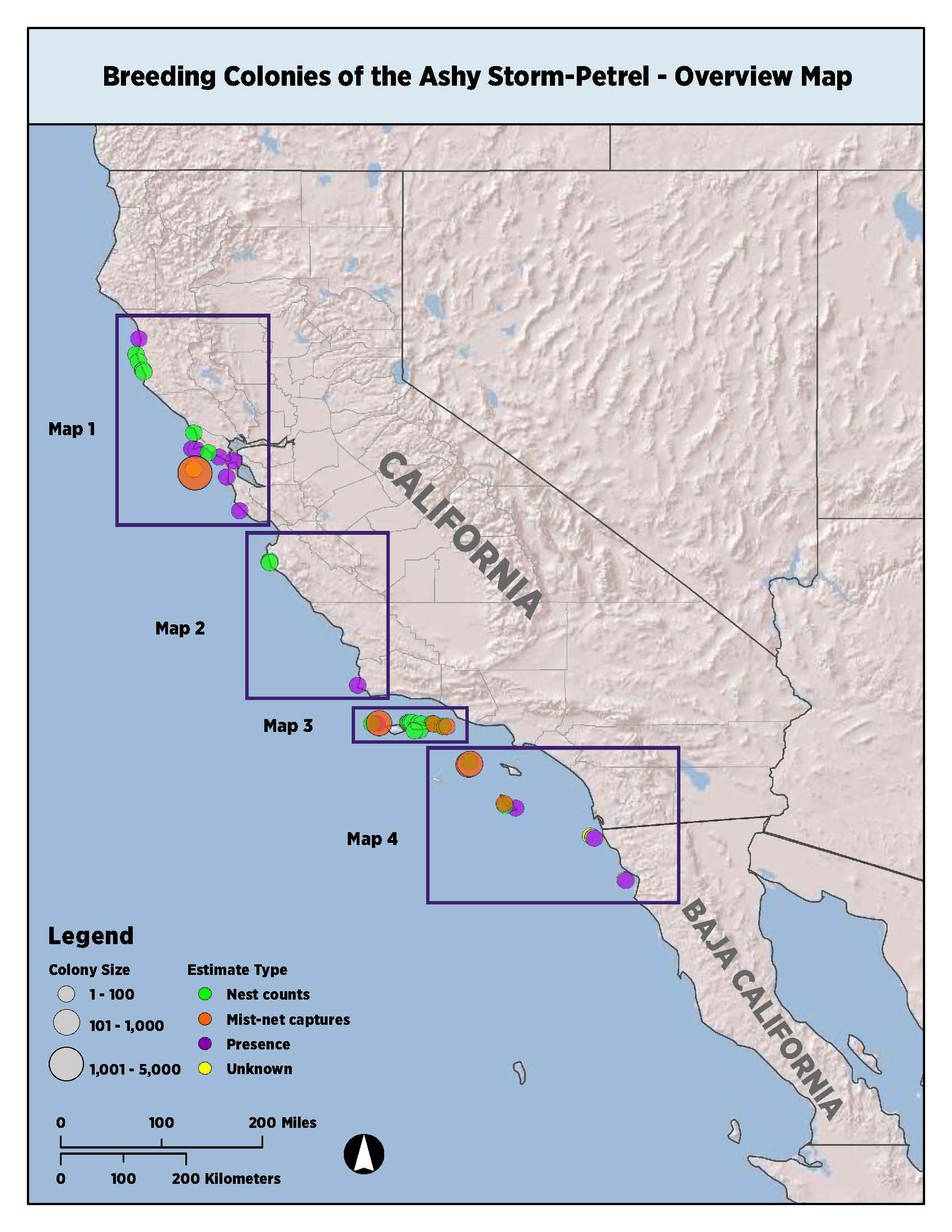


Figure 2. Map of Ashy Storm-Petrel breeding distribution in California and Mexico.

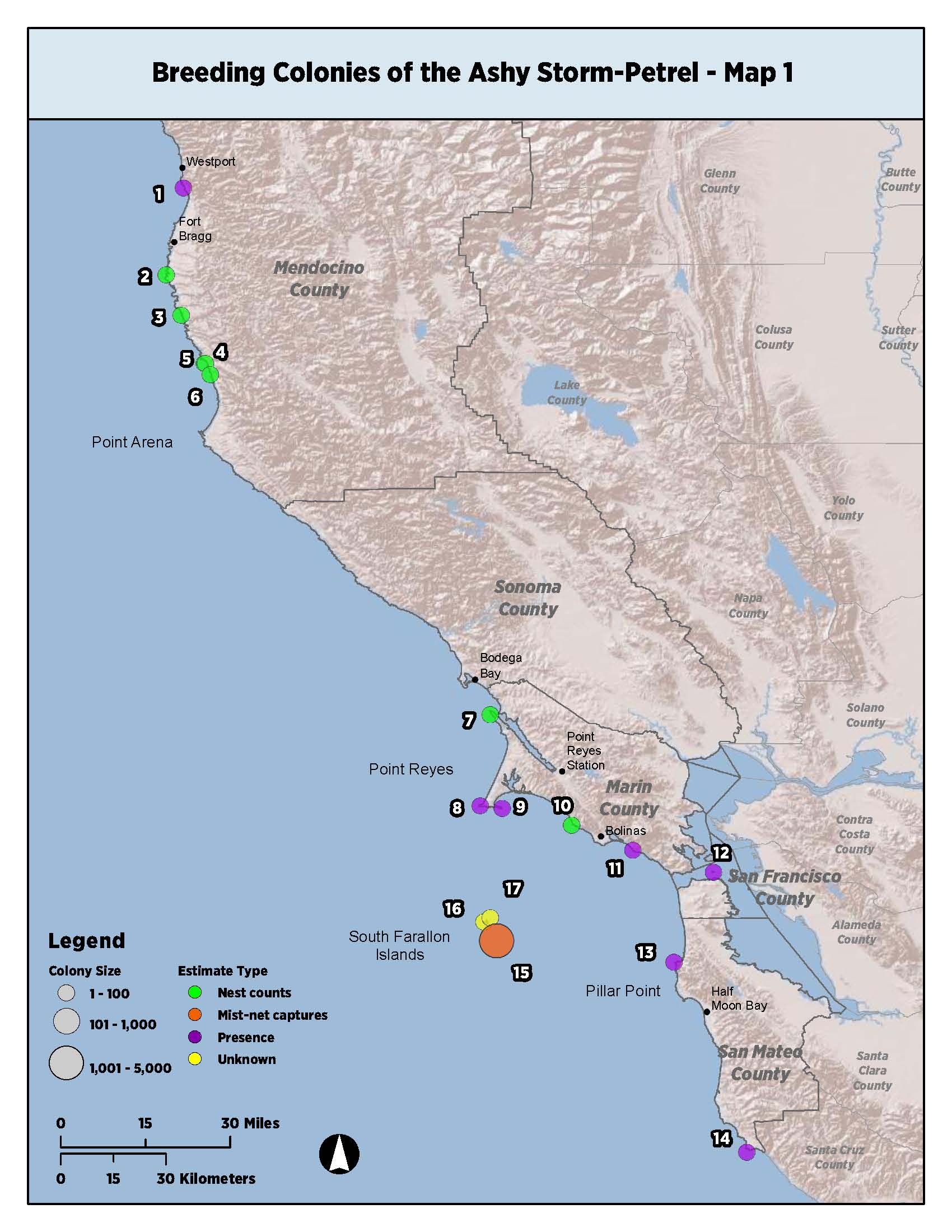


Figure 3. Map of Ashy Storm-Petrel breeding distribution in Mendocino, Sonoma, Marin, San Mateo and northern Santa Cruz counties, California.



Figure 4. Map of Ashy Storm-Petrel breeding distribution in southern Santa Cruz, Monterey, San Luis Obispo and Santa Barbara counties, California.

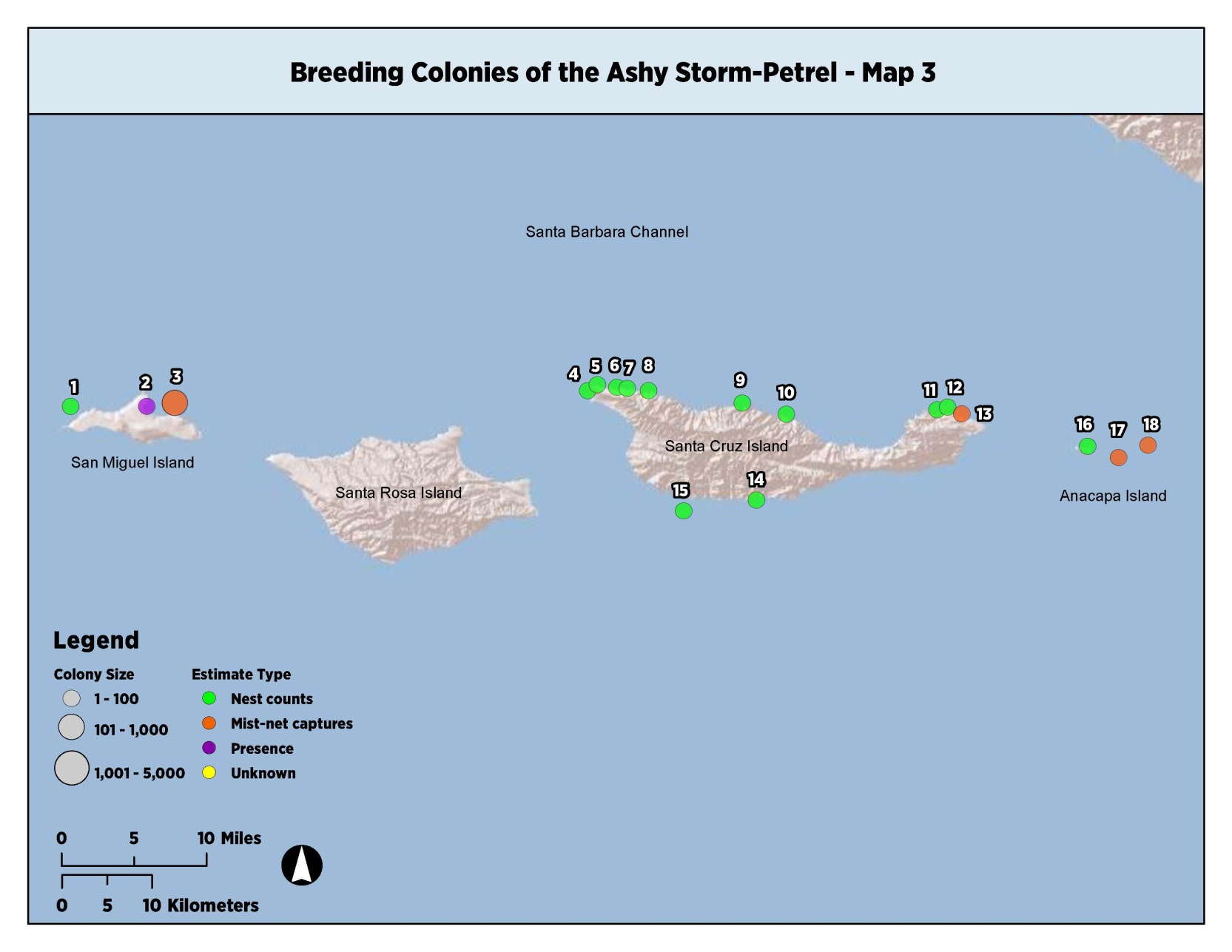


Figure 5. Map of the Ashy Storm-Petrel breeding distribution on San Miguel, Santa Rosa, Santa Cruz and Anacapa islands, California.

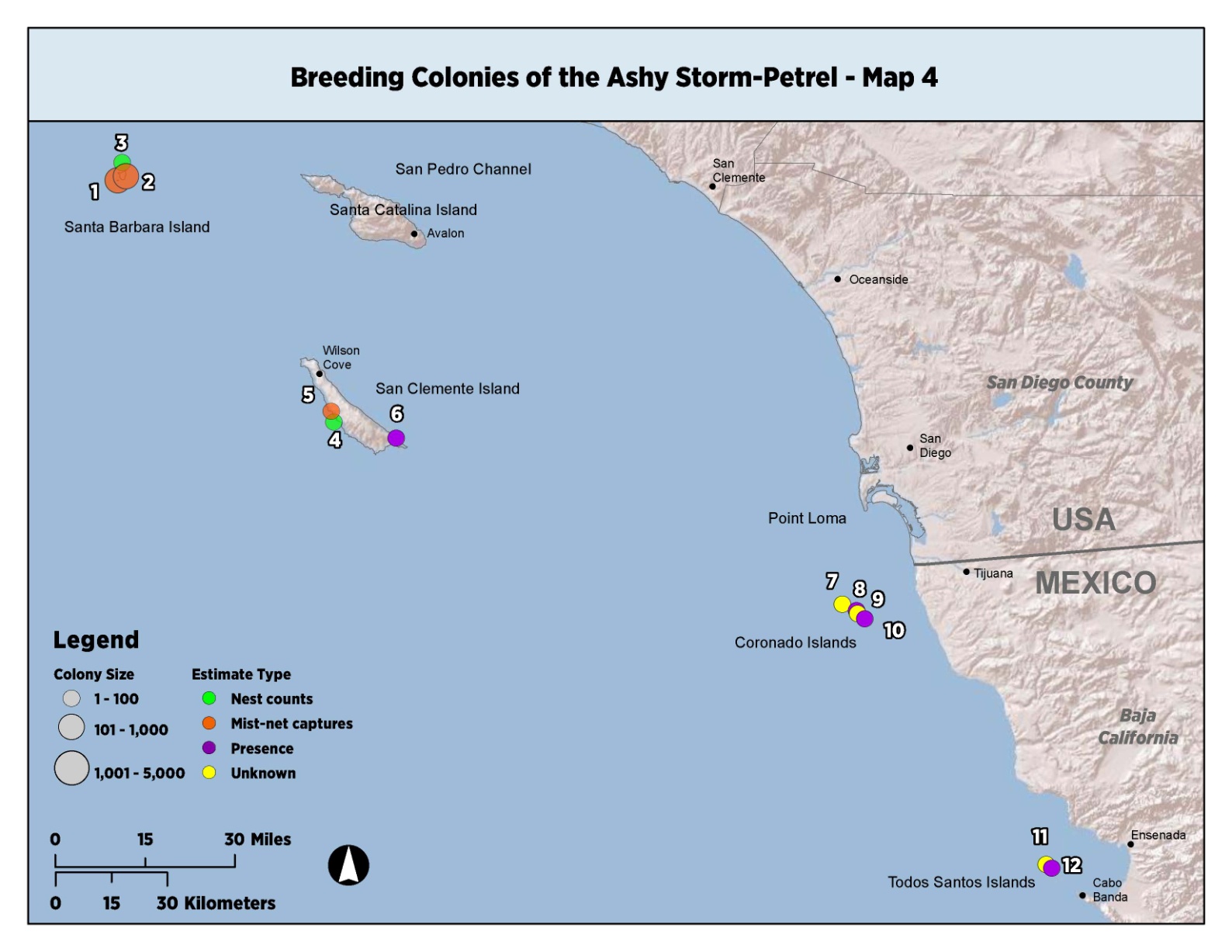


Figure 6. Map of Ashy Storm-Petrel Santa Barbara, Santa Catalina, and San Clemente islands, California, USA and Coronado, Todos Santos islands, Baja, Mexico.

the Coronado Islands) was first determined from a single nest found in 2005 (Carter et al. 2006a, 2008a) but recently the species identification of this nest has been questioned and it is no longer considered confirmed (Carter et al. 2016a). In addition, species identification of birds inside nest sites at the Coronado Islands in 2005 also was questionable (Carter et al. 2006b) but earlier occurrence and breeding was documented there so this colony is confirmed (Everett & Anderson 1991; Carter et al. 2016b).

Twenty-six breeding locations (84%; n=31) are owned by U.S. federal agencies, including the National Park Service (11 locations or 35% in Channel Islands National Park; 2 locations or 6% Point Reyes National Seashore), Bureau of Land Management (9 locations or 29% in the California Coastal National Monument), U.S. Navy (2 colonies or 6% at San Miguel Island) and U.S. Fish and Wildlife Service (1 location or 3% at the Farallon National Wildlife Refuge). The National Park Service also co-manages San Miguel and Santa Cruz islands and the U.S. Navy manages San Clemente Island and adjacent rocks. A non-governmental organization (i.e., The Nature Conservancy) owns and manages 4 locations (13%) at western Santa Cruz Island. The government of Mexico owns and manages 1 location (3%) at the Todos Santos Islands.

**Table 1. Breeding population estimates for Ashy Storm-Petrels.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Colony Name** | **Map No. – Location No.** | **Most Recent**  **Survey Year** | **Survey**  **Method1** | **No. of**  **Breeding Pairs** | **Population Size Category**  **(Pairs)** | **Source** |
| ***Humboldt and Mendocino County Coast*** | | | | | | |
| Steamboat Rock | unmapped | 1914 | EC | P | P | 18 |
| Kibesillah Rock | 1-1 | 2012 | NS | P | P | 1 |
| Casper-Point Cabrillo Rock | 1-2 | 1926 | EC | P | P | 1 |
| Stillwell Point Rock | 1-3 | 2012 | NS | 1-102 | 1-100 | 1 |
| Casket Rock | 1-4 | 2012 | NS | 1-102 | 1-100 | 1 |
| Wharf Rocks | 1-5 | 2012 | NS | 1-102 | 1-100 | 1 |
| Franklin Smith Rock | 1-6 | 2012 | NS | 1-202 | 1-100 | 1 |
| *Subtotal* |  |  |  | *4-50* |  |  |
| ***Point Reyes National Seashore*** | | | | | | |
| Bird Rock | 1-7 | 2015 | NS | 5-10 | 1-100 | 2 |
| Point Reyes Lighthouse | 1-8 | 2013 | MN | P | P | 2 |
| Chimney Rock | 1-9 | 2001 | MN | P | P | 2 |
| Stormy Stack | 1-10 | 2015 | NS | 10-15 | 1-100 | 2 |
| *Subtotal* |  |  |  | *15-25* | *1-100* |  |
| ***Golden Gate Area*** | | | | | | |
| Steep Ravine | 1-11 | 2001 | V | P | P | 3 |
| Alcatraz Island | 1-12 | 2014 | DB | P | P | 4 |
| *Subtotal* |  |  |  | *P* |  |  |
| ***San Mateo County Coast*** | | | | | | |
| San Pedro Rock | 1-13 | 1998 | NS | P | P | 17 |
| Año Nuevo Island | 1-14 | 2005 | MN | P | P | 19 |
| *Subtotal* |  |  |  | *P* |  |  |
| ***South Farallon Islands*** | | | | | | |
| SE Farallon Island | 1-15 | 2010-2012 | MN | 2,884 | 1,001-5,000 | 5 |
| West End Island | 1-16 | ? | MN | P? | P? | 9 |
| Islets | 1-17 | ? | MN | P? | P? | 9 |
| *Subtotal* |  |  |  | *2,884* | *1001-5000* |  |
| ***Monterey County Coast*** | | | | | | |
| Bench Mark-227x | 2-1 | 1997 | NS | 2-102,6 | 1-100 | 6 |
| Castle Rocks and Mainland | 2-2 | 1997 | NS | 1-52,6 | 1-100 | 6 |
| Hurricane Point Rocks | 2-3 | 1997 | NS | 1-152,6 | 1-100 | 6 |
| *Subtotal* |  |  |  | *4-30* | *1-100* |  |
| ***Northern Santa Barbara County Coast*** | | | | | | |
| Vandenberg Air Force Base | 2-4 | 2001 | MN | P | *P* | 7 |
| ***San Miguel Island*** | | | | | | |
| Castle Rock | 3-1 | 1968 | NS | 1003 | 1-100 | 8 |
| San Miguel Island (Harris Point to Cuyler Harbor) | 3-2 | 1976 | MN | P | *P* |  |
| Prince Island | 3-3 | 1991 | MN | 577 | 101-1,000 | 9 |
| *Subtotal* |  |  |  | *677* | *101-1000* |  |
| ***Santa Cruz Island*** | | | | | | |
| Shipwreck Cave | 3-4 | 1997 | NS | 74 | 1-100 | 10 |
| Dry Sandy Beach Cave | 3-5 | 2010 | NS | 294 | 1-100 | 11 |
| Del Mar Rock | 3-6 | 1991 | NS | 15 | 1-100 | 9 |
| Cave of the Bird’s Eggs | 3-7 | 2014 | NS | 30 | 1-100 | 12 |
| Painted Cave | 3-8 | 1994 | NS | 05 | 0 | 10 |
| Diablo Rocks | 3-9 | 1994 | NS | 45 | 1-100 | 10 |
| Orizaba Rock | 3-10 | 2014 | NS | 324 | 1-100 | 12 |
| Bat Cave | 3-11 | 2014 | NS | 924 | 1-100 | 12 |
| Cavern Point Cove Caves | 3-12 | 2014 | NS | 54 | 1-100 | 12 |
| Scorpion Rocks | 3-13 | 1991 | MN | 707 | 1-100 | 9 |
| Willows Anchorage Rocks | 3-14 | 1991 | SC | 56 | 1-100 | 9 |
| Gull Island | 3-15 | 1991 | NS | 14,8 | 1-100 | 13 |
| *Subtotal* |  |  |  | *327* | *101-1000* |  |
|  | | | | | | |
|  | | | | | | |
|  | | | | | | |
| ***Santa Barbara Island*** | | | | | | |
| Sutil Island | 4-1 | 1991 | MN | 293 | 101-100 | 9 |
| SBI (main island) | 4-2 | 1991 | MN | 437 | 101-100 | 9 |
| Shag Rock | 4-3 | 1996 | NS | 15 | 1-100 | 10 |
| *Subtotal* |  |  |  | *731* | *101-1000* |  |
| ***San Clemente Island*** | | | | | | |
| Seal Cove South Rock | 4-4 | 2015 | NS | 2 | 1-100 | 14 |
| Seal Cove Cliffs | 4-5 | 2015 | MN | 33-43 | 1-100 | 14 |
| Knob Canyon | 4-6 | 2013 | MN | P | P | 14 |
| *Subtotal* |  |  |  | *35-45* | *1-100* |  |
| ***Coronado Islands*** | | | | | | |
| North Island | 4-7 | ? | ? | ? | ? |  |
| Middle Rock | 4-8 | 2005 | NS | P? | P? | 15 |
| Middle Island | 4-9 | ? | ? | ? | ? |  |
| South Island | 4-10 | 2005 | NS | P? | P? | 15 |
|  | *Subtotal* |  |  |  | *P?* | *P?* |  |
| ***Todos Santos Islands*** | | | | | | |
| North Island | 4-11 | 2015 | NS | - | ? |  |
| South Island | 4-12 | 2015 | NS | 17 | P? | 16 |
| *Subtotal* |  |  |  | 1710 | *P?* |  |
| ***All Known Breeding Sites*** | | | | | | |
| **Totals** |  |  |  | *4,694-4,786* |  |  |

|  |
| --- |
|  |

1 NS, nest search; MN, mist-net captures with estimates based on mark-recapture data; SC, site count; V, vocalizing heard only;

DB, dead bird only; EC, egg collection.

with estimates using a L correction factor for occupancy.

2 Low end of range = number of nests found; high end of range = estimated number of pairs.

3 Rough estimate of “several hundred birds”. One nest was found in October 1991.

4 Complete nest count in all suitable nesting habitat.

5 Incomplete nest count with some inaccessible habitat.

6 Estimate of 10-30 breeding pairs divided into nearby colonies based on nests found and amount of suitable habitat.

7 No nests were found in 1991 but most of this colony is inaccessible. In recent years, a couple of nests have been

found on Scorpion Rock (D.M. Mazurkiewicz, unpubl. data).

8 No nests were found during a nest search in October 1991 but eggshells may have been missed (Carter et al. 1992).

9 Past breeding by small numbers.

10Population Estimate includes both islands (North and South)

Sources: 1 (Carter et al. 2015a); 2 (Becker et al. 2016); 3 (Whitworth et al. 2002); 4 (Carter et al. 2015b); 5 (Nur et al. 2013); 6 (McChesney et al. 2000); 7 (Brown et al. 2003); 8 (Crossin and Brownell 1968); 9 (Carter et al. 1992); 10 (H.R. Carter, unpubl. data); 11 (McIver et al. 2011); 12 (W.R. McIver and

D. Mazurkiewicz, unpubl. data); 13 (Hunt et al. 1979); 14 (Carter and Henderson 2016); 15 (Everett and Anderson 1991); 16 (Y. Bedolla, GECI, pers. comm.); 17 (USFWS, unpubl. data); 18 (Carter et al. 2016); 19 (Carle et al. 2014).

## Breeding Colony and Population Estimates

Obtaining direct counts of all ASSP nests at breeding islands or rocks is extremely difficult, as is true with most crevice/burrow nesting seabird species. Breeding population estimates of ASSP in California have been determined through two primary methods:

1. capture-recapture analyses, using data collected on 2 or more nights of mistnetting (usually with vocalization luring) of adults and subadults during the main breeding season at the largest colony at SE Farallon Island (1,001-5,000 pairs; Ainley & Lewis 1974; Sydeman et al. 1998; Bradley 2011), certain medium-sized colonies (101-1,000 pairs) at Prince Island, Sutil Island and Santa Barbara Island (Hunt et al. 1979; Carter et al. 1992), and certain small colonies such as South Cove Seal Rock at San Clemente Island (Carter & Henderson 2015, 2016). The main values of using this method at these locations is most habitat is not accessible during the breeding season, a population estimate can be derived using a standardized method, other information is gathered that documents presence and relative abundance (e.g., capture rates), and vital population variables can be estimated with long-term capture studies (e.g., adult survival rates). The main drawbacks are that data collection is relatively labor intensive and limited to good weather conditions, nightly capture rates and colony attendance are variable, birds may avoid recapture, adults are difficult to separate from subadults based on brood patch development, analyses involve assumptions that are violated or cannot be validated, and the accuracy of estimates is difficult to determine; and
2. direct counts of nests at some small colonies (<100 pairs) and certain medium-sized colonies (101-1,001 pairs) at largely accessible rocks and sea caves (e.g., Bird Rock, Stormy Stack, Orizaba Rock and Santa Cruz Island sea caves; Becker et al. 2016, McIver et al. 2016). The main value of using this method at these small to medium sized colonies is that the raw total count can be close to the actual number of nests (if the raw total count occurs after most egg laying and before fledging, accounts for failed nests, and few or no nests are inaccessible), a population estimate can be derived using a standardized method, estimates can be based on the raw count or with an adjustment for inaccessible habitats if needed to better indicate approximate colony size, the accuracy of these types of estimates is relatively high and defensible, and other information can be gathered (e.g., reproductive success and predation rates). The main drawback of this method is that eggs are laid asynchronously and colonies should be visited monthly (or more frequently) through the breeding season to determine total nest counts and account for failed nests, this method is also relatively labor intensive, and in certain crevice habitats inaccessible nest sites are present making a complete count difficult.

In addition, various other methods have been used for certain small colonies to obtain rough estimates of population size, such as counting suitable crevices in accessible habitats and adjusting with a correction factor for occupancy, finding a few nests and extrapolating for areas not searched, or conducting one night of mistnetting for determining capture rate then making a rough adjustment based on habitat available to estimate colony size (Hunt et al. 1979; Carter et al. 1992; H. Carter, unpubl. data).

World breeding population estimates of ASSP have been determined through summing colony estimates. Sowls et al. (1980) estimated 5,187 breeding ASSP (~2,590 pairs) in California, based on data gathered at 9 colonies in 1975-1980 and substituting past estimates for 2 colonies (including 2,000 nests at SE Farallon island in 1972 and 100 nests at Castle Rock in 1968). Carter et al. (1992) updated this estimate to 7,209 birds (~3,600 pairs), based on data gathered at 7 colonies in 1989-1991 and substituting past estimates for 5 colonies (again including SE Farallon Island and Castle Rock). However, in 1992, the South Farallon Islands estimate was revised from ~2,000 pairs to ~995 pairs (Sydeman et al. 1998). Using this 1992 value, the California breeding population size in 1989-1992 was 5,199 birds (~2,600 pairs). Approximately 99% of the population bred on 4 island groups: South Farallon Islands (38%), Santa Barbara Island (28%), San Miguel Island (26%), and Santa Cruz Island (6%). All of these past estimates do not include any birds breeding in Baja California but very few birds have been confirmed to breed there. Thus, California and world breeding population sizes are essentially the same.

Table 1 provides the most recent available estimates of numbers of breeding ASSP at all documented breeding locations in California and Baja California, Mexico. Most importantly, a recent updated population estimate is available from South Farallon Islands in 2010-2012 (Nur et al. 2013) and recent estimates are available for several small colonies in Mendocino County (Carter et al. 2015), Point Reyes National Seashore (Becker et al. 2016), and Santa Cruz Island (McIver et al. 2016, unpubl. data; H. Carter unpubl. data). However, most recent data for the largest colonies in the Channel Islands at Prince Island, Sutil Island and Santa Barbara Island were gathered over two decades ago in 1991 and certain small colonies have not been re-estimated since 1968 (Castle Rock), 1977 (Gull Island), and 1991 (Diablo Rocks, Willow Anchorage Rocks, and Scorpion Rocks). Insufficient effort has been expended to obtain estimates of small numbers breeding at the Coronado Islands in Baja California. For this plan, we have summed these most-recent estimates to obtain a total breeding population of 4,679 pairs (9,538 breeding individuals). Based on this estimate, approximately 96% of the population breeds at 4 island groups: South Farallon Islands (60%), Santa Barbara Island (15%), San Miguel Island (14%), and Santa Cruz Island (7%). We caution that this summary of colony estimates likely may not be an accurate reflection of the true proportions of the current breeding populations at these four island groups because mist-net based population estimates utilized at the three largest island populations have either not been validated or have large ranges for population estimates, major population fluctuations have occurred at SE Farallon Island over time based on best available data, and estimates from Santa Barbara Island and San Miguel Island from 1991 are outdated. However, we are confident that the vast majority of the world population breeds at these four island groups. We suggest that it is most reasonable to consider that roughly half of the world population breeds at the South Farallon Islands and half at the three Channel Islands (Santa Barbara, San Miguel, and Santa Cruz). Greater survey effort at major colonies in the future hopefully will refine our knowledge of such proportions as well as population trends at these locations. To estimate the world population size of breeding adults and subadults combined, one can add estimated numbers of subadults (based on estimated demography) to the breeding population estimate. However, this process makes many assumptions and the accuracy of such an estimate is questionable and not provided in this plan.

## At-sea Surveys and World Population Estimates

At-sea population surveys provide an independent method of estimating the world population size of adults and subadults because these surveys include breeding and non-breeding birds foraging at sea and ASSP are largely resident year round within the breeding range. Population estimates obtained at the colony typically focus on breeding birds that visit the colony and attend nests during the breeding season (Ainley 1995; Sydeman et al. 1998; McIver et al. 2009a, 2009b, 2016). Mistnetting at colonies does capture both breeding and non-breeding birds but it is difficult to separate them and non-breeding birds may attend the colony less or more frequently than adults, depending largely on the age of subadults, time within the breeding season and time of night. At-sea surveys are not affected by these issues. However, ASSP spatial distribution on the ocean varies between seasons as well as from year to year and is largely driven by upwelling areas and food resources (Briggs et al. 1987; Mason et al. 2007; Ainley & Hyrenbach 2010). ASSP also typically occur at low densities at sea. However, ASSP have been documented in large concentrations during the fall months. For example, large flocks of ASSP have been documented in Monterey Bay ranging in size from 1000 to 7,000- 10,000 birds (Ainley 1976; Briggs et al. 1987; Roberson 1985; D. Shearwater, pers. comm.). With a distribution that has low density and high patchiness, a rigorous and relatively high-effort sampling design would be needed to obtain accurate, unbiased estimates of population size. However, compared with many other seabird species which have larger population sizes, greater variation in the timing of colony attendance and breeding, and greater migratory behavior, variation in population sizes at sea around the major breeding colonies at the South Farallon Islands and Channel Islands is reduced. A thoughtful analysis of available at-sea survey data is needed to independently estimate current world population size (adult and subadults). This estimate can be compared to colony estimates of breeding adults plus estimated subadults to help validate true overall population size and ensure that colony estimates are reasonable. In addition, at-sea survey data can be treated using estimated demography to remove the subadult fraction and obtain an estimated breeding population size. However, this process also makes many assumptions and the accuracy of such an estimate would be questionable.

Some existing at-sea studies have estimated ASSP population sizes, although not all of these surveys were specifically designed for this purpose. Briggs et al. (1987) estimated 1,400 ASSP south of Point Buchon and a range of 5,600 - 11,200 north of Point Buchon for a total population of between 7,000 and 12,600 ASSP in California. Spear & Ainley (2007) estimated the ASSP population at 4,500 – 9,100 (95% confidence interval) but this only included surveys well north of Point Buchon where densities of ASSP increased between 1975-1983 and 1999-2002 (Mason et al. 2007).

## Threats

In 2013, the U.S. Fish and Wildlife Service (2013) prepared a species report during their evaluation of whether or not to list the ASSP under the Endangered Species Act of 1973. In this report, a list of threats was summarized from various sources. We have replicated this table (Table 2) and commented briefly on each threat listed below (Table 2).

**Table 2. Potential threats to Ashy Storm-Petrels.**

|  |  |
| --- | --- |
| THREAT | LOCATION WHERE THREAT IS PRESENT |
| Climate Change: Warming: Increased El Niño years and decreased ocean productivity | Entire Range |
| Climate Change: Ocean acidification | Entire Range |
| Climate Change: Sea level rise | Low lying nest locations, particularly sea caves and low lying islets (e.g. Orizaba Rock) |
| Human presence | Entire Range except SE Farallon Island |
| Introduced non-native vegetation (e.g. New Zealand spinach) | SE Farallon Island – may occur elsewhere |
| Military Activities | San Clemente Island, Seal Cove Rocks |
| Scientific purposes | Everywhere nests are accessible |
| Recreational purposes | All locations, except for SE Farallon Island |
| Burrowing Owl predation | SE Farallon Island |
| Western Gull predation | SE Farallon Island – may occur elsewhere |
| Mouse predation | Santa Cruz Island, SE Farallon Island, potential on San Miguel Island |
| Common Raven predation | Santa Cruz Island area (e.g. sea caves, Orizaba Rock) |
| Barn Owl predation | Santa Barbara Island, Santa Cruz Island |
| Island spotted skunk predation | Santa Cruz sea caves |
| Disease | Entire range – potential |
| Artificial light: Squid fishery | Everywhere squid fishing is permitted |
| Artificial light: Oil platforms | Channel Island breeding locations |
| Oil spill: Offshore energy platforms | Channel Island breeding locations |
| Oil spill: Vessels | Entire range |
| Organochlorine contaminants | Entire range |
| Ingestion of plastics | Entire range |

**Climate Change:** Coastal warming may affect timing and degree of prey availability (Roemmich & McGowan 1995). Low lying nest locations, particularly sea caves and low lying islets, may lose nesting habitat (e.g., McIver et al. 2016).

**Human Presence:** All breeding colonies are currently protected and managed. Except on nearshore rocks and islets within the California Coastal National Monument, humans are not permitted on breeding colonies without permission. Some sea cave colonies at Santa Cruz Island are visited by humans without permits but no impacts have been noted (e.g., McIver et al. 2016, D. Mazurkiewicz, pers. comm.).

**Introduced non-native vegetation:** Introduced House Mouse populations at SE Farallon Island and native Deer Mouse populations at Santa Barbara Island (proper) may have increased population sizes due to introduced non-native vegetation. Increases in these mouse populations have been attributed to increased predation both directly and indirectly (Nur et al., in prep., Harvey et al. 2013). On SE Farallon Island, invasive New Zealand spinach (*Tetragonia tetragonoides*) can spread in thick patches when left uncontrolled, covering rock crevice breeding habitat and likely rendering those crevices inaccessible to storm-petrels (G. McChesney, pers. comm.).

**Military Activities:** Bright lights and noise in nearshore waters could lead to disturbance of nests at San Clemente Island but nesting habitat at South Rock Seal Cove and adjacent cliffs are not directly affected by current activities. Past military activities (e.g. bombing exercises in the 1940s and 1960s) have affected nesting habitats at Prince Island but the degree of impacts has not been determined.

**Scientific Purposes:** Extensive egg collecting for museum and private collections may have impacted colonies at SE Farallon Island and Santa Cruz Island in the late 19th and 20th centuries. Egg collecting for organochlorine pollution studies occurred in 1992-1997 and 2008 at Santa Cruz Island; the small Orizaba Rock colony may have been impacted somewhat in 1992 (Carter et al. 2008b; McIver et al. 2016).

**Recreational Purposes:** Some sea cave colonies at Santa Cruz Island are visited by kayakers without permits and Orizaba Rock also has been visited apparently by recreationalists but no impacts were noted at these sites (McIver et al. 2016). The nearshore islets that are included in the California Coastal National Monument are currently open to the public for recreational purposes. Kayakers and perhaps other boaters may access these sites without permits. However, we do not know of recreationalists accessing ASSP colonies within the California Coastal National Monument.

**Avian Predation:** Extensive avian predation beyond expected natural levels has been recorded at SE Farallon Island (Burrowing Owls and Western Gulls) and Santa Cruz Island (Common Ravens and Barn Owls). Elevated Burrowing Owl predation at SE Farallon Island is related to large cyclic populations of introduced House Mouse (for details see below “Reduction of Predation At Breeding Colonies” and Nur et al., in prep.). The Western Gull breeding population on the South Farallones has increased and expanded dramatically since the early 1970s and they now occur abundantly in prime ASSP breeding habitat (Ainley et al 1990; Penniman et al. 1990). Common Ravens have become an issue in recent years at certain sea caves on Santa Cruz Island and Orizaba Rock (McIver et al. 2016).

**Mammalian Predation:** ASSP typically do not breed at locations with mammalian predators. However, on occasion, extensive predation by island Spotted Skunks has been noted at Bat Cave and Cavern Point Cove Caves at Santa Cruz Island (Carter et al. 2008a; McIver et al. 2009b). House Mouse occasionally prey on ASSP chicks at SE Farallon Island but this predation is not considered to be significant. Deer Mouse may prey upon ASSP eggs or chicks at Santa Barbara Island but to date predation or scavenging at this site has only been documented on Scripps’s Murrelet (*Synthliboramphus scrippsi*) and Cassin’s Auklet (*Ptychoramphus aleuticus*). At Anacapa Island and San Miguel Island, introduced Black Rats likely have restricted ASSP to breeding in inaccessible habitats (Harvey et al. 2016). Rats were eradicated at Anacapa Island in 2002 (Howard et al. 2005) but remain at San Miguel Island proper and pose a threat if they move to nearby colonies at Prince Island and Castle Rock. Coastal nearshore islets may occasionally experience predation by mammalian predators (e.g., river otters) as was reported in Carter et al. (2015).

**Disease:** No evidence of disease has been documented.

**Artificial Light:** Illumination of breeding colonies at night with bright lights can occur during squid fishing near islands and from boats anchored near shore. Impacts from squid boats were suspected at Orizaba Rock in 1995-1997 (Carter et al. 2008; McIver et al. 2016). Large numbers of ASSP were captured on research support vessels with bright deck lights anchored beside colonies in 1994-1996 at Orizaba Rock, Scorpion Rocks and Santa Barbara Island (McIver et al. 2016; H. Carter, unpubl. data).

**Oil Pollution:** Oiled ASSP have never been recovered on beaches or colonies. However, they likely die before reaching shore and are removed rapidly from the ocean surface and beaches by predators. A large oil spill where birds are concentrated at sea could have significant population level impacts for ASSP.

**Organochlorine Pollution:** Extensive pollution occurred in the Southern California Bight region in the 1940s to 1970. Pollutants are entrained in marine sediments and continue to be released into the environment. Impacts on ASSP, including eggshell thinning and reduced hatching success, were documented in 1992-1997 at Santa Cruz Island (Fry 1994; Kiff 1994; McIver 2002; McIver et al. 2009; Carter et al. 2008a, c). In 2008, pollutant levels were much reduced and hatching success had improved but these pollutants will likely continue to reduce reproductive success of some individuals for decades.

**Ingestion of Plastics:** Plastic ingestion has not been documented in ASSP but has been found to be common in other storm-petrel species. Impacts may include interference with digestion leading to starvation and introduction of toxic chemicals to birds.

# Section III. Conservation Actions

## Purpose

The three main purposes of this plan are:

1. to provide a framework for future conservation actions that will reduce threats to the ASSP population and help ensure its long-term viability and retention of breeding colonies throughout its current range;
2. to assist management and funding decisions by U.S. and Mexican government agencies and provide organizations (e.g. NFWF, Audubon); and
3. to foster the creation of an Ashy Storm-Petrel Working Group that will coordinate research, monitoring and conservation activities.

## Conservation Action Prioritization Narrative

Each action has been assigned a priority according to a determination of what is most important for the recovery of the species based on the life history, ecology, distribution, abundance, threats, and knowledge gaps that exist. Three categories of priorities have been developed:

Priority 1 (High Priority): An action that can be taken to prevent the extirpation or extensive decline likely to lead to extirpation of a population. In this usage, a population is defined as an individual rock, island, sea cave or section of cliff that contains ASSP nests. An isolated colony can be considered to be a population, but when several colonies occur adjacent to each other and likely interact as if they were one larger colony, they also can be considered to be one population or a “colony complex”.

Priority 2 (Medium Priority): (A) An action that can be taken to prevent any decline of an ASSP population or some other negative impact short of extirpation or extensive decline. (B) An action that will provide essential information needed to advance the management and/or conservation of ASSP at a colony or throughout its range.

Priority 3 (Low Priority): Actions necessary to track changes in population size, distribution, reproduction, or other important demographic variables related to the continued existence of an ASSP population.

## Goals, Objectives, and Strategies

The following narrative discusses the goals, objectives, strategies and rationales that serve as the steps needed to develop and implement this conservation strategy for ASSP. A goal has been developed for each of the 4 areas of focus in this conservation action plan. The 4 areas of focus were identified by key stakeholders at the 15 October 2014 meeting at the National Fish and Wildlife Foundation office in San Francisco as follows:

1. Artificial habitat/nest structures
2. Predation Reduction
3. Surveys and Research
4. Index Monitoring Program (to include: population size, reproductive success and predation rates).

Goals direct efforts toward improving population conditions for ASSP, with approaches for management of ASSP populations. A goal is a descriptive, broad statement of desired future conditions that conveys a purpose, but does not define measurable units.

Objectives have been developed based on input from key stakeholders during discussions in 2015-2016 about the conservation action plan, with additional information obtained from the published and unpublished scientific literature. An objective is a concise statement that indicates what is to be achieved, the desired extent of the achievement, who is responsible, and when and where the objective should be achieved.

Strategies highlight and describe the actions needed to achieve the objectives. A strategy is a specific action, tool, technique or combination of these used to meet objectives.

Rationales for each objective provide context such as background information, assumptions, and technical details.

## Artificial Habitat/Nest Structures Goal

Goal: As appropriate, provide and maintain artificial habitat and/or nest structures at breeding colonies to aid in the long-term survival of the ASSP (and Leach’s Storm-Petrel (LHSP) colony through increased nesting habitat availability, increased nesting success, or increased adult survival by reducing the risk of predation at the nest site.

### SE Farallon Island - Objectives for Artificial Habitat/Nest Structures:

SE Farallon Island Objective 1: Farallon National Wildlife Refuge (NWR) will permanently maintain and when feasible enhance rock foundation walls on the Lighthouse and Auklet trails with additional dry stone construction in order to provide a minimum of 70 available nesting sites with a minimum of 50% occupancy rate and a mean breeding success rate of 60% for monitored sites over the next 10 years. Rock walls associated with these 2 extensive trails are the most difficult and expensive to maintain and enhance but they also contain most of the artificial habitats currently used by ASSP at SE Farallon Island, potentially with hundreds of egg-laying sites which constitute a fairly large proportion of the overall population (Priorities 1 and 2). Most other rock walls on SE Farallon Island also will be permanently maintained and when feasible enhanced for greater potential future use by ASSP (Priority 2). LHSP are not known to use rock walls at SE Farallon Island.

SE Farallon Island Objective 2: Over the next 10 years, Farallon NWR will remove certain foundations of dismantled buildings on SE Farallon Island and use the materials to create additional artificial breeding habitats, as appropriate and feasible (Priority 2). Creation of additional artificial habitats could potentially add dozens of additional nest sites once they are colonized. LHSP also may use this new habitat which could increase population size.

Strategies:

* Utilize appropriate (e.g. contaminant-free) excess materials that may be available from unused infrastructure to maintain and enhance (e.g. create additional) crevice nesting habitat along Lighthouse Trail and Auklet Trail.
* Continue to monitor ASSP reproductive success on SE Farallon Island.
* Provide for annual inspection of the Lighthouse Trail and Auklet Trail, particularly in areas where crevice nesting habitat for ASSP already occurs or has been created. Utilize dry stone construction or similar technique that creates crevice nesting habitat within the trail’s foundation.
* Utilize appropriate (e.g., contaminant-free) materials from structure and debris removals to construct additional ASSP artificial nesting sites.
* Annually assess any newly constructed artificial nest sites for ASSP breeding activity.
* As appropriate, utilize vocalization broadcasting and other social cues to encourage ASSP to utilize newly constructed artificial nest sites.

Rationale:

Historically, Farallon Island seabird populations were dramatically reduced by human harvesting of adults and eggs, disturbances and habitat degradation (Doughty 1971, Ainley & Lewis 1974, Ainley & Boekelheide 1990, White 1995, Carter et al. 2008, 2016). In the mid- to late- 19th century, degradation of ASSP and LESP nesting habitats on SE Farallon Island came in the form of removal of rocks taken from the island to construct walls and other temporary structures (White 1995, USFWS 2009, Carter et al. 2008, 2016). In most cases, no mortar was used to hold rock walls or foundations together (i.e., dry stone construction), allowing access for crevice-nesting species such as ASSP. However, later construction of cement pads and use of mortar to hold rock walls together, especially during the World War I and II eras, further reduced natural nesting habitat for ASSP; some earlier-built rock walls used by ASSP also may have been replaced with walls that did not contain habitat for ASSP at this time (Carter et al. 2016). The first record of ASSP breeding in natural cavities under rocks on SE Farallon Island was in 1885 (Ingersoll 1886). Between 1886 and 1911, extensive use of rock walls, rock slides and drift wood areas (i.e., on Franconia Beach) was first noted and the ASSP population was thought to have increased, possibly related to the stoppage of murre egg harvesting which also likely had caused damage to crevice-nesting habitats for ASSP on many parts of SE Farallon Island annually from 1849 to 1886 (Dawson 1911, Loomis, 1918, Carter 2001). This apparent increase may have resulted from: (1) population recovery from past decline (i.e., population decreased soon after impacts in the 1850s and 1860s due to egging and building of Lighthouse Trail, lighthouse, railway bed and many other rock walls, and remained relatively low until 1896 when murre egging largely stopped, and then ASSP had to nest mainly in rock walls at this time because little natural habitat was suitable at the time) (Carter et al. 2008, 2016); or (2) greater use of these types of “man-made” habitats as more rock walls were built in the late 19th century, although the building of rock walls at this time was not mentioned in the literature (Ainley 1990; Carter et al. 2008, 2016). A small population of LHSP breeds at SE Farallon Island (Ainley et al. 1990) Breeding by LHSP was first documented there in 1896 (Loomis 1896; see Carter et al. 2015). It is not clear if this population always has been small or if it also was greatly reduced by the loss of crevice-nesting and burrow-nesting habitats.

The importance of the dry stone construction in providing nesting habitat for the ASSP may be underscored by the apparent loss of a large amount of natural habitat for storm-petrels on the island since 1850. The dry stone construction, which forms the foundation for several sections of the trail and in other structures on the island, creates crevices that are utilized by ASSP. Several of these “man-made” crevices also provide relatively easy access which allows for monitoring of ASSP reproductive success. In fact, approximately 75% of monitored ASSP site in the Lighthouse Hill area occur in habitat created by dry stone construction and many others throughout the SE Farallon Island occur under or adjacent to other man-made structures (Russ Bradley, pers. comm.). The Lighthouse and Auklet trails are located within the area where a a large proportion of ASSP nests occur on SE Farallon Island (Ainley et al. 1990). Maintaining these trails with a dry stone foundation, and creating additional nesting habitat should aid the recovery of the ASSP population to a greater population size on SE Farallon Island, if adequate prey resources continue and high avian predation does not occur. Contributing to this objective will support objectives identified in the USFWS Regional Seabird Conservation Plan (Objective 1c) and the Farallon National Wildlife Refuge Comprehensive Conservation Plan (Objective 2.1).

Objective 1 metrics of 50% occupancy for a minimum of 70 “maintained” crevices along Lighthouse Trail is based on mean site occupancy of 54.3% (Ainley et al. 1990) and the breeding success objective of 60% is based on the long-term mean of 67% for ASSP at SE Farallon Island (USFWS 2009). However, these metrics would not apply if the population undergoes another major decline.

### Prince Island - Objectives for Artificial Habitat/Nest Structures:

Prince Island Objective 1: Within 10 years from the completion of this plan, the U.S. Navy, Channel Islands National Park and other cooperators will determine the current extent of nesting habitat for ASSP and LESP on Prince Island. For ASSP, nesting habitat includes rock crevices and a large fraction likely nest in Cassin’s Auklet (*Ptychoramphus aleuticus*) (CAAU) burrows (Carter et al. 1992, 2008c, 2016b). For LESP, even though birds have been captured in mist nets, nests have not been found (Carter et al. 1992, 2016b) and they also may currently nest to a large extent in CAAU burrows. The unusual use of CAAU burrows by ASSP and possibly LESP may reflect a shortage of natural crevices. In addition, estimate the extent of habitat degradation for ASSP caused by guano harvest, military practice bombing and any other on-island human activities (Priority 3).

Prince Island Objective 2: If the study above (objective 1) finds that greater than 25% of historic potential crevice-nesting or burrow-nesting habitat for ASSP and LESP has been removed, deploy sufficient artificial habitat for both species to mitigate for lost habitat. Gather baseline and post-restoration monitoring data on population size (Priority 2).

Strategies:

* Review the history of guano harvesting and military training activities and evaluate erosion, sedimentation and other aspects of the geology of current soil and rock habitats to determine the probable extent of habitat damage that was caused by these activities
* If review indicates moderate to extensive habitat degradation, develop a restoration plan incorporating artificial habitat and/or nest structures to mitigate for damaged and lost habitat for ASSP and LESP
* Develop a monitoring plan for ASSP and LESP that measures use of artificial and natural habitats, reproductive success and changes in indexes for overall breeding population size at Prince Island. The monitoring protocol should be designed to allow for comparison of monitored parameters across the species range.

Rationale:

Prince Island is an important breeding location for the ASSP. Approximately 12% of the ASSP breeding population occurs on Prince Island and best estimates indicate that nearly 33% of the breeding population within CINP occurs here. The island is owned by the US Navy and is jointly managed by the U.S. Navy and CINP. Little management or monitoring for ASSP on Prince Island has occurred but since 1975, limited data have been gathered by various research groups including the University of California, Irvine (Hunt et al. 1979, 1980), Humboldt State University (Carter et al. 1992, 2016b), and U.S. Geological Survey (Adams 2016, Adams et al. 2016).

Historically, two main human activities are known that likely altered ASSP breeding habitat on the island. On October 10, 1895 the first cargo of guano harvested off Prince Island arrived in Santa Barbara (San Francisco Call 1895). In this first haul, ten tons of guano was removed by workers that hauled the guano off the island by the sack load. The harvesting of guano from Prince Island likely had an impact on breeding habitat for ASSP by removing soil containing CAAU burrows and altering scree piles as workers moved about the island harvesting guano. The extent of the damage is unknown but likely affected the accessible SE side of the island to the greatest extent.

Prince Island was utilized for extensive training operations consisting of air to ground target practice by a variety of military services during World War II as well as the Korean and Vietnam wars (US Navy 2015). This activity likely altered nesting habitat for ASSP, particularly in areas where the birds nested under boulder/scree piles but also any burrow-nesting areas (since ASSP use CAAU burrows at this location for nesting). The ammunition that was targeted on Prince Island could easily have altered nesting sites in boulder piles, scree habitat and soils with burrows that existed on the island. Researching military documents and historical photographs may help identify the extent of the damage to nesting habitat.

Restoration of ASSP nesting habitat on the island might consist of providing artificial habitat to replace lost habitat, increase breeding population size, and allow for adequate monitoring of reproduction and population size. If evidence of moderate or extensive impacts can be more fully established, artificial habitats are deployed successfully and conditions for population increase are favorable, this restoration action could have a major effect on increasing population size in the Channel Islands and for the species overall.

### Santa Cruz Island and associated islands, islets and sea caves - Objectives for Artificial Habitat/Nest Structures:

Santa Cruz Island Objective 1: At Orizaba Rock, CINP and its cooperators will maintain a minimum of 30 avian predator proof artificial nest sites (similar to the number of sites in place in 2008-2001 and 2014-2015; McIver et al. 2016) with an eventual occupancy rate of at least 50% and an annual breeding success rate (chicks fledged per pair) > 45% (mean breeding success of 49% from 2008-2011; McIver et al. 2016) (Priority 1).

Santa Cruz Island Objective 2: At Bat Cave and Cavern Point Cove Caves, CINP and its cooperators will maintain a minimum of 30 avian predator and mesopredator proof artificial nest sites with an eventual occupancy rate of at least 50% and a annual breeding success rate > 60% (mean breeding success rate ~66.7% from 2006-2007; McIver et al. 2009a) (Priority 1).

Santa Cruz Island Objective 3: At Cave of the Birds’ Eggs and Dry Sandy Beach Cave, the Nature Conservancy and their cooperators will deploy and maintain a minimum of 30 avian predator and mesopredator proof artificial nest sites with an eventual occupancy rate of at least 50% and an annual breeding success rate > 60% (mean breeding success ~65% at Cave of the Birds’ Eggs between 2005 and 2007; McIver et al. 2009a, 2016) (Priority 1).

Strategies:

* CINP and it cooperators should continue to monitor ASSP population size and reproductive success at Orizaba Rock, Cave of the Bird’s Eggs, Bat Cave and Cavern Point Cove Caves. Monitoring efforts should be designed to allow for comparison with other monitoring programs throughout the range of the ASSP.
* Utilize appropriate artificial nest habitat designs that allow for protection of nesting ASSP from avian and mesopredator predation, as well as bright lights at certain colonies (e.g. Orizaba Rock; McIver et al. 2016), and allow for effective monitoring of nest sites. In sea caves, evaluate the need to place artificial habitats on elevated platforms to reduce impacts from low to moderate amounts of flooding due to sea level rise and high water events from storm surges. Currently, the “bread loaf” module is the preferred artificial habitat design being utilized in the Santa Cruz Island area.
* As needed and appropriate, utilize social facilitation cues (e.g. sound recordings, olfactory cues, etc.) to encourage ASSP nesting in artificial nest habitat modules.
* Continue to utilize mesopredator traps in caves with ASSP nesting in an effort to reduce the risk of a predation event causing loss of adult breeding ASSP as well as eggs and chicks. Once artificial habitats are well occupied in sea caves, discontinue mesopredator trapping on a regular basis but immediately resume trapping if a mesopredator is detected. None have been detected in 2009-2015.
* Continue to educate park visitors about ASSP nesting and sensitivity to disturbance and limit access to only permitted activities in ASSP nesting habitats.

Rationale:

Santa Cruz Island is the largest of the eight major Channel Islands and is jointly managed by the Nature Conservancy and the National Park Service. ASSP have been found nesting at 12 locations at Santa Cruz Island, including islets, sea caves and Gull Island (see Table 1). The current estimated number of ASSP nests at Santa Cruz Island is 327 nests. This represents 7% of the world breeding population and ~18% of the Channel Islands breeding population. Since 1995, the reproductive performance and trends in population size of ASSP at Santa Cruz Island have been studied at 5 locations: Orizaba Rock, Bat Cave, Cave of the Birds’ Eggs, Cavern Point Cove Caves, and Dry Sandy Beach Cave (McIver 2002; McIver et al. 2009b, 2016). Prior to 1995, all information on the reproductive biology of ASSP was limited to work conducted at Southeast Farallon Island. The monitoring of ASSP at Santa Cruz Island has provided key knowledge about population trends and breeding performance, and impacts from various sources in the southern portion of the breeding range. Santa Cruz Island has been utilized as a monitoring site for ASSP because monitored locations are accessible under most weather conditions, nests are easily accessible (more so than all other nesting locations, except SE Farallon Island), and adequate sample sizes at each monitored location were available to assess both population trends and reproductive performance (McIver et al. 2009b, 2016). The ASSP monitoring program at Santa Cruz Island has documented several important conservation issues over the years: (1) organochlorine contaminants have impacted reproductive success of ASSP in the southern portion of the range since the 1940s when this pollution became heavy (Carter et al. 2008b; MSRP 2005; McIver et al. 2009b); (2) avian predation of adults and chicks common ravens is relatively high and greatly impacting reproduction at certain locations (McIver et al. 2016); (3) spotted skunk predation events, although infrequent, can result in the near extirpation of a breeding location from a “one time” predation event that impacts colony nesting numbers for years after the event (McIver et al. 2009a); (4) flooding of portions of low-lying nesting habitats in some sea caves (i.e., Cave of the Birds’ Eggs and Dry Sandy Beach Cave) is occurring (McIver et al. 2016) and is likely to increase in severity due to sea level rise and storm surges due to climate change; (5) bright lights (e.g., during squid fishing) can impact certain colonies (e.g., Orizaba Rock) and cause nest abandonment or mortality leading to a decrease in colony size (Carter et al. 2008a, McIver et al. 2016).; and (6) unauthorized human activities at locations with relatively easy access (e.g., park tourists landing kayaks at Bat Cave and exploring cave habitats) may reduce reproductive success (McIver et al. 2009b).

Several of these conservation issues could be reduced with the use of artificial nest structures. Appropriately designed artificial nest structures could reduce avian and mesopredator predation of ASSP adults, chicks and eggs at nest sites and ensure the survival of at least 15 nests per location (based on 30 artificial sites deployed and 50% occupancy) during major predation events. Common ravens and barn owls are suspected to be the main avian predators while spotted skunks have been infrequent but impactful mesopredators at Santa Cruz Island. From 1995-1997, 75 adults and 6 chicks were killed mainly by barn owls at Bat Cave and Orizaba Rock (McIver 2002). In 2005 and 2008, spotted skunks killed at least 75 adult ASSP in Bat Cave and 32 adult ASSP in Cavern Point Cove Caves, respectively (McIver & Carter 2006; McIver et al. 2009b). Both colonies appeared to have taken several years to recover to pre-event breeding population sizes (McIver et al. 2013). In 2013, 42 distinct ASSP feather piles indentified in Bat Cave were attributed to common raven predation (McIver et al. 2015). Common ravens have been documented as being very adept at accessing artificial nest structures which allowed researcher access for monitoring purposes (McIver et al. 2014). As such, artificial nest structures were redeveloped in 2012-2013 to prevent ravens from gaining access to nesting ASSP but allow researchers to look into structures for monitoring purposes without direct access to the “nest chamber”. This design should also prevent spotted skunks from gaining access to nesting petrels, eggs and chicks. In 2014, 10 “bread loaf” artificial nest structures with a total of 30 nest sites (3 nest sites per structure) were deployed at Orizaba Rock but no eggs were laid that year. In 2015, eggs were laid in 4 sites and 2 chicks fledged. This suggests that, over time, these redeveloped artificial nest structures will be utilized by ASSP even without vocalization broadcasting. More rapid initial use occurred in 2008 when artificial nest sites were initially deployed with vocalization broadcasting on Orizaba Rock in 2008 and occupancy rates increased from 2008 to 2011 (McIver et al. 2016). Artificial nests sites were also deployed in Bat Cave in 2015 when 5 artificial structures with a total of 15 nest sites were deployed however eggs were not laid in the first year of deployment (D. Mazurkiewicz, pers. comm.).

In sea caves, predator-proof artificial sites should be placed on elevated platforms to reduce impacts from flooding. Flooding of portions of sea caves, resulting in deaths of a few adults and some loss of nesting habitat, has been recorded in most years since 2008 at Cave of the Birds’ Eggs (McIver et al. 2016; W.R. McIver, pers. comm.) and in certain years at Dry Sandy Beach Cave. Flooding appears to result when storm conditions occur during high tides and is expected to increase in frequency and severity with increasing sea level and storm frequency during the breeding season due to climate change. The first step at mitigating for flooding impacts to sea cave colonies is to place artificial sites on elevated platforms. This action will ensure the survival of at least 15 nests per location (based on 30 artificial sites deployed and 50% occupancy) during major flooding events that could affect the entire floors of sea caves.

Since the purchase of the eastern part of Santa Cruz Island by the National Park Service in 1996, Santa Cruz Island has become a popular destination for tourists. Each year, thousands of tourists and recreationists visit and camp at the island (D. Mazurkiewicz, pers. comm.). Common activities along the shoreline include sea kayaking, fishing and diving. The exploration of the sea caves on eastern Santa Cruz Island is a common but unauthorized activity among visitors. Peak numbers of visitors to the island likely coincides with the pre-egg through incubation periods of the ASSP (roughly April through July). Visitors exploring sea caves destroy ASSP nests that are made in shallow crevices among rocks, along cave walls and in driftwood resulting in the death of adults, chicks or eggs. The National Park Service and Nature Conservancy have made efforts to reduce impacts of visitors to seabirds nesting in sea caves by conducting interpretive and education programs for kayakers, as well as placing closure signs at the entrances to monitored sea caves. However, researchers still regularly identify visitors accessing ASSP nesting locations (D. Mazurkiewicz, pers. comm.). The use of artificial nest structures would help protect some nesting ASSP in locations where visitors are known to regularly access sea caves and ASSP nest in vulnerable sites (e.g., amongst driftwood). The use of artificial nest structures for protecting ASSP nests from unauthorized visitor impacts might be particularly useful at Bat Cave and Cavern Cove Point Caves based on limited data that documents non-researcher visitation to these locations and their close proximity to the popular Scorpion Anchorage which likely increases human activity in this part of the island (McIver et al. 2009).

### San Clemente Island and associated islands, islets and sea caves - Objectives for Artificial Habitat/Nest Structures:

San Clemente Island Objective 1: At Seal Cove South Rock, the U.S. Navy, Bureau of Land Management, and their cooperators will install a minimum of 30 artificial nest sites in order to maintain an eventual minimum occupancy rate of at least 50% and a breeding success rate > 50% (Priority 1).

San Clemente Island Objective 2: At Seal Cove mainland, The U.S. Navy, Bureau of Land Management, and their cooperators should conduct a trial effort to create a new colony in an accessible location at higher elevation along the edge of the bluff top that prevents flooding and is protected from avian and mammalian predators. A minimum of 30 avian predator and mesopredator proof artificial nest sites should be deployed, enhanced with vocalization broadcasting, at a protected location using a predator fence and other techniques as necessary. An eventual occupancy rate of at least 50% and an annual breeding success rate >50% would be expected (Priority 1).

Strategies:

* Utilize appropriate artificial nest habitat designs that allows the monitoring of nest sites for reproductive success and provides protection of nesting ASSP, chicks, and eggs from avian predators and flooding on Seal Cove Rock South.
* Monitor ASSP nests at Seal Cove South Rock. Given only a few nest crevices on this rock, limited nest monitoring efforts are appropriate to detect egg laying but are not currently sufficient for documenting reproductive success. Mist-net monitoring is being used for examining trends in population size at this rock and the nearby main island cliffs. This effort is designed to allow for comparison with other mist-net monitoring programs throughout the range of the ASSP.
* As needed and appropriate, utilize social facilitation cues (e.g. sound recordings, olfactory cues, etc.) to encourage ASSP nesting in artificial nest habitat modules.

Rationale:

At present, San Clemente Island appears to be maintaining the existence of a small breeding population of ASSP. In 2014, Carter and Henderson (2015) estimated a breeding population size of 35-40 pairs based on mist-net captures at Seal Cove South Rock. Nests have only been found on Seal Cove South Rock where these researchers documented 3 nest crevices containing 5 storm-petrel eggs in 2014 (Carter and Henderson 2015). The presence of multiple eggs in a crevice suggests that nesting habitat is limited. The ASSP population at San Clemente Island likely has very limited habitat on the main island due to mammalian predators including Island Fox (*Urocyon littoralis*), introduced Black Rats (*Rattus rattus*), and feral cats (*Felis Catus*). As such, it appears nesting is limited to one offshore islet that has suitable nesting habitat and is free of predators (Seal Cove South Rock) and likely at inaccessible cliffs located on the main island at Seal Cove.

Maintaining this small breeding population at San Clemente Island is important in order to prevent the loss of a colony within the southern end of the breeding range. In the past, larger numbers likely bred at this island. For example, China Point Island has limited crevice-nesting habitat but no evidence of breeding found there in 1991 and 1994 (Carter et al. 1992, 2009). It is currently located inside a military weapons testing area and nesting habitats appear to have been altered by military activities and use of remaining crevices has likely been prevented by human disturbances (e.g., explosions, etc.) in this area. To assist this small population, artificial nest sites should be placed on Seal Cove South Rock to increase the number of nests on this mammalian-predator free islet which likely acts as the only refuge for breeding ASSP at this island. However, since this rock is low-lying and susceptible to impacts from flooding (e.g., wave wash – see above), an effort to establish breeding on the mainland within the cliff tops in the Seal Cove area will help ensure that ASSP do not cease nesting on San Clemente Island (should ASSP stop nesting on Seal Cove South Rock due to flooding or other stochastic events that could extirpate this colony). These measures are needed until introduced Black Rats and feral cats are eradicated from San Clemente Island.

Control of feral cats has been underway at San Clemente Island for many years (Bridges et al. 2015). Since 2013, the U.S. Navy and the Institute for Wildlife Studies has implemented efforts to reduce Black Rats in the Seal Cove area on the main island in an effort to improve conditions for crevice nesting seabirds. Although until introduced predators are eradicated on the main island, they pose a great threat to nesting ASSP and limit nesting to only one possible nesting area on the main island (i.e., cliffs at Seal Cove). If cats and rates were eradicated other areas where suitable habitat exists and has little or no visitation by island fox, also may become nesting habitat, especially with the use of artificial nest sites and vocalization broadcasting.

The first step for installing artificial nest sites at Seal Cove South Rock would increase the number of protected nest sites with little or no predation. In the absence of predation, adult survival would likely be increased for this small population. Adult survival has been demonstrated to be a key demographic in the persistence of ASSP populations (Sydeman et al. 1998; Nur et al. in press). The addition of suitable nest habitat would also aid in the reduction of nest-site competition and increase breeding success by reducing egg abandonment (Carter and Henderson 2015). This conservation action would aid in the development of a larger San Clemente Island ASSP population overall and increase the probability of continued breeding until colonies can be established on the main island and introduced mammals are eradicated there. Finally, the monitoring of additional nest sites created by the artificial habitat will allow nest monitoring to be used for determining population trends, rather than mist-net captures. Rapid occupation of newly created nest sites would likely occur but may take several years to reach an occupancy of 50% for the proposed 30 additional nest sites (see McIver et al. 2013).

## Reduction of Predation at Breeding Colonies Goal

Reduce predation by avian and mammalian predators to a low level as to eliminate predation as a significant risk to the continued survival of ASSP breeding colonies.

### South Farallon Islands - Objectives for Reduction of Predation at Breeding Colonies:

South Farallon Islands – Objective 1: Within the next 2 years, the Farallon National Wildlife Refuge , PBCS and other cooperators will reduce impacts of burrowing owl (*Athene cunicularia*) predation to the South Farallon Islands ASSP population by capturing and relocating owls to reduce the annual burrowing owl abundance index by at least 50% to about 3.1 (based on the current mean owl abundance index of 6.29 for 2009-2012, – see Nur et al., in press) and maintain this reduced level until house mouse (*Mus musculus*) eradication can be accomplished and its efficacy on reducing owl predation of ASSP assessed (Priority 1).

South Farallon Islands – Objective 2: Within the next 3 years of the completion of this plan, determine the current extent of western gull (*Larus occidentalis*) predation on ASSP populations at South Farallon Islands. If warranted and feasible, implement management options to reduce predation to levels that result in the projection of a stable ASSP population based on population index values obtained from mist-net capture studies (Priority 2).

Strategies:

* Until mice are eradicated, capture and relocate burrowing owls that overwinter on Southeast Farallon Island to the mainland
* Continue to finalize and implement the South Farallon Islands Invasive House Mouse Eradication Project
* Continue to monitor ASSP reproductive success and population trends on SE Farallon Island
* Continue to conduct monitoring that will inform management decisions regarding predation of ASSP including but not limited to determining a monthly owl abundance index and monthly storm-petrel predation index

Rationale:

Since 2006/2007, the ASSP population at the South Farallon Islands has been in decline based on trend analysis of ASSP capture rates (Nur et al., in press). One major factor that has contributed to this recent decline is reduced adult survival of ASSP caused by burrowing owl predation (Nur et al., in press). To investigate the impact of owl predation on the South Farallon Island ASSP population, Nur et al. (in press) considered three population growth scenarios when modeling plausible future populations trends based on reducing owl abundance at South Farallon Islands; Scenario A, the “observed steep decline” = 7.19 percent annual decrease in ASSP population; Scenario B, “moderate decline” = 3.36 percent annual decline in ASSP population; and Scenario C, “near stable” = 0.63 percent annual increase in ASSP population. Results of the population modeling indicate that a 50% reduction in owl abundance is expected to increase survival probability by 2.4% to 3.8% (Nur et al., in press). This corresponds to changing a population that is strongly declining to weakly declining (Scenario A), from declining to nearly stable (Scenario B) or from nearly stable to increasing (Scenario C). This level of increase in survival rates, particularly in a long-lived species such as the ASSP, will have strong positive population impacts based on modeling with various assumptions. Of course, reducing owl abundance by more than 50% would likely result in higher ASSP survival rates which would translate into greater population growth potential. In short, Nur et al. (in press) presented a compelling argument for attributing the recent decline of the ASSP population at South Farallon Islands mainly to burrowing owl predation. The South Farallon Island population is likely to continue to decline as long as the documented level of owl predation continues. A direct conservation measure that likely would result in reversing the recent ASSP population decline at South Farallon Islands involves reducing predation events attributed mainly to burrowing owls.

Nur et al. (in press), as well as others (Mills 2006, 2016; USFWS 2009; USFWS 2013), argue that the high owl predation levels are due to a somewhat complex hyper-predation interaction between owls, non-native house mice and ASSP. In short, migrating owls arrive to the islands in the early fall and feed primarily upon the abundant mouse population. By late fall, ASSP populations at the islands reach their lowest levels of the year. In winter, mouse populations decline substantially and owls switch to preying upon storm-petrels (both ASSP and LESP) that are returning in greater numbers to the island, to begin site attendance and courtship/breeding activities. Owls continue to prey upon storm-petrels until they leave the island in spring, presumably to migrate back to their breeding locations. It is anticipated that the eradication of house mice from South Farallon Islands would result in reduced numbers of fall migrant owls from remaining on the islands through the winter due to a lack of suitable food source (USFWS 2009 and 2013). The USFWS, Farallon National Wildlife Refuge staff have initiated the planning process to eradicate house mice from the South Farallon Islands to benefit storm-petrel populations as well as other native species (e.g., endemic arboreal salamander, and endemic Farallon camel cricket) residing on the Farallon National Wildlife Refuge (USFWS 2013). However, the planning process will likely take several years before eradication efforts are initiated. As such, an immediate benefit to the South Farallon ASSP population would occur by reducing owl predation via removal of owls from the island during the late fall and winter months. A reduction of 50% in the owl abundance index will likely aid in stabilizing the ASSP population at the South Farallon Islands until house mouse eradication is conducted.

Western gull predation was shown to have a negative impact on the ASSP population in the 1970s and 1980s, especially as gulls expanded their nesting distribution into prime ASSP nesting habitats on the slopes of of Lighthouse Hill (Ainley et al. 1974; Sydeman et al. 1998). A very large gull population of 8,000 – 13,000 pairs has been present at least since 1959 (Penniman et al. 1990, Warzybok et al. 2015). Nur et al. (in press) did not specifically analyze the impact of western gull predation on storm-petrel populations, but the authors noted that per individual, the predation rate of owls on storm-petrels was about 775 times that of western gulls during 2003-2010 (Bradley 2011). Even though this may be an underestimate of gull predation at present, a large number of western gulls likely would need to be culled to substantially reduce gull predation levels on storm petrels island-wide. However, location reductions in predation may be possible through discouraging or preventing gull nesting in certain habitats used by ASSP and where heavy predation of ASSP has been documented. Reducing gull predation likely would have benefits for the ASSP population, especially in certain areas, but the current analysis suggests that a reduction in gull predation is not required for reducing the decline currently documented in the ASSP population; a large reduction in burrowing owl predation will suffice. However, an assessment of impacts of gull predation on ASSP should be conducted to better evaluate the benefits of potential management actions to reduce WEGU predation on the South Farallon Islands.

### San Miguel Island Area - Objectives for Prevention and Reduction of Predation at Breeding Colonies:

San Miguel Island Area – Objective 1: Implement biosecurity measures at Castle Rock and Prince Island in order to ensure the early detection of black rats that may disperse from San Miguel Island and eliminate any dispersed rats before they establish a substantial population (Priority 1).

Strategies:

* Until rats can be eradicated on San Miguel Island, establish protocols and processes to monitor for rat presence at Castle Rock and Prince Island and deploy eradication methods for these islets if any rats are detected.
* Implement biosecurity measures to ensure that visitors (e.g. researchers) to Castle Rock and Prince Island do not inadvertently release any rodents (i.e., mice or rats) onto these islets.

Rationale:

San Miguel Island and its two major associated islets, Prince Island and Castle Rock, support important and diverse seabird colonies, including approximately one-third of the breeding seabirds in the Channel Islands (Carter et al. 1992; Wolf 2000). Approximately 14% - 15% of the entire ASSP breeding population occurs on Prince Island and Castle Rock and best estimates indicate that approximately 38% of the CINP breeding population occurs at these locations. The island is owned by the U.S. Navy but is managed by USN and CINP. Currently there is no active management for ASSP in the San Miguel Island area but limited monitoring has been conducted in recent years by U.S. Geological Survey (USGS) and CINP.

It is unclear when rats were introduced to San Miguel Island. In the late 1980s, a small rat population appeared to be restricted to the west side of the island along the shoreline, near Castle Rock (Erickson & Halvorson 1990). In 2004, a limited survey by Island Conservation documented rats distributed along shorelines and within canyons on the island. However, a more comprehensive survey would be needed to understand the full extent of rat distribution on the island. In 2007, the California Institute of Environmental Studies (CIES) and Carter Biological Consulting (CBC) documented black rat predation on Scripps’s murrelet eggs on the east side of San Miguel Island at Bay Point (Carter et al. 2008c). Currently there are no rats on Prince Island or Castle Rock. However, these islands are located 0.8 km (0.5 miles) and 1.0 km (0.62 miles) from San Miguel Island, respectively. The presence of rats throughout most of San Miguel Island represents a serious threat to the ecologically and regionally important seabird colonies on Prince Island and Castle Rock. It is possible that rats could disperse on their own to these adjacent islets and threaten these important seabird colonies. Rapid detection of such dispersal and removal of rats before larger rat populations develop would have major potential benefits to the ASSP populations. While the risk of biologists introducing rats is very low, protocols can eliminate the risk of rat introduction by biologists at these islets, also a benefit to these populations.

In 2001 and 2002, the American Trader Trustee Council successfully implemented the Anacapa Island Restoration Project, involving eradication of black rats in an effort to restore seabird populations on the island. Given the similar goals and biological setting between these projects, the Anacapa Island Restoration Project should serve as a successful model for the eradication of rats from San Miguel Island. In 2005, the MSRP released a seabird restoration plan which included rat removal from San Miguel Island (MSRP 2005). However, subsequent planning determined that eradication was not possible at this time due to concerns about impacts to the recently-restored island fox population. The non-target risk was too high given the decline in the island fox population. This fox population underwent a major population crash in the 1990s due mainly to golden eagle (*Aquila chrysaetos*) predation, a few surviving individuals were taken into captivity, golden eagles were relocated, captive-held fox were reintroduced back to San Miguel Island, and by 2011 the population had increased to pre-decline levels of about 400 individuals. Although currently not considered feasible, future eradication could occur if new methods were developed (i.e., development of a rat-specific toxicant) that would not impact island fox or require taking hundreds of individuals into captivity. The benefits of a rat eradication project for San Miguel Island likely would have important benefits for breeding crevice nesting seabirds as well as other nesting birds and native plants and wildlife. For example, after the eradication of rats from Anacapa Island the number of nesting Scripps’s murrelets (*Synthliboramphus scrippsi*) increased 14% per annum post-eradication, reoccupation of previously vacant study plots occurred within 1 to 3 years and hatching success nearly tripled (Whitworth et al. 2013). The first breeding record of Cassin’s auklets was documented less than one year after rat eradication (Whitworth et al. 2015). In addition, the first breeding record of ASSP was documented on Anacapa Island in 2012, approximately 10 years post rat eradication (Harvey et al. 2016).

In short, the implementation of a rat eradication on San Miguel Island, when feasible, should result in: prevention of loss of small number of crevice nesting Scripps’s murrelet (and possibly ASSP) breeding between Cuyler Harbor and Harris Point and at Hoffman and Bay points; protection of the important seabird colonies on islets adjacent to San Miguel (e.g. Prince Island and Castle Rock); decreased predation on other wildlife on San Miguel (e.g. other nesting birds); and broad ecological benefits to the entire San Miguel Island ecosystem.

### Santa Cruz Island Area - Objectives for Prevention and Reduction of Predation at Breeding Colonies:

Santa Cruz Island Area – Objective 1: Maintain a minimum of 3 lethal “body-grip” skunk traps during the ASSP breeding season in Bat Cave, Cave of the Bird’s Eggs and Cavern Cove Point Caves to prevent skunk predation in these sensitive nesting areas (Priority 1).

Santa Cruz Island Area – Objective 2: Maintain a minimum of 73 avian predator proof artificial nest sites (approximately 50% of the 3-year average total nests monitored in the Santa Cruz Island area from 2001-2013) as outlined above in (*Santa Cruz Island and associated islands, islets and sea caves - Objectives for Artificial Habitat/Nest Structures*) each breeding season to reduce avian predation on ASSP caused by common ravens and barn owls (Priority 1).

Santa Cruz Island Area – Objective 3: Within 5 years of plan approval, avian predation rates, as measured by counts of distinct feather piles, will be reduced to less than 5 distinct feather piles found each breeding season at each breeding location within the Santa Cruz Island area (Priority 2).

Strategies

* Continue to conduct nest monitoring that will inform management decisions regarding predation of ASSP including carcass/feather pile counts during nest check visits
* Continue to deploy lethal “body-grip” skunk traps at Bat Cave and Cavern Point Caves that were impacted by skunk predation events in 2005 and 2008.
* Install avian proof artificial nest sites in order to provide protective cover for ASSP nesting in habitats that are accessible by avian predators and skunks.
* Assess the status of common ravens and barn owls at Santa Cruz Island and examine impacts of predation on ASSP adult survival and breeding success. Determine if avian predation is a factor limiting population size.
* Evaluate additional measures that might be taken to reduce common raven predation on ASSP (e.g. reduction of food sources near ASSP nesting sites, targeted removal of individual common ravens).

Rationale:

The ASSP monitoring work that has been conducted at Santa Cruz Island since 1995 has documented the importance of this breeding location to the overall ASSP population (as noted above) as well as raising several concerns regarding predation on ASSP at Santa Cruz Island including: (1) avian predation of adults and chicks by barn owls and common ravens that may play a significant role in reducing the viability of certain colonies and the overall Santa Cruz Island population and (2) spotted skunk predation events, although infrequent, can result in the near extirpation of a breeding location from a one-time predation event (McIver 2002; McIver et al. 2009). Management actions (e.g. limited trapping and avian proof artificial nest sites deployed) have been initiated to help reduce the impacts of predation on the Santa Cruz Island ASSP population. These actions will likely play a key role in maintaining higher population sizes at certain colonies and for the overall Santa Cruz Island population which comprises an important portion of the world breeding population and helps sustain the southern half of the breeding range.

Avian predation and impacts from mesopredators could be reduced or eliminated with the use of artificial nest structures and the deployment of lethal “body-grip” snap traps in ASSP caves (designed to target mesopredators). Appropriately designed artificial nest structures could reduce avian and mesopredator predation of ASSP adults, chicks and eggs at nest sites that are exposed or easily accessible, such as those that occurred in sea caves and on Orizaba Rock. Common ravens and barn owls are suspected to be the main avian predators while spotted skunks have been infrequent predators but with major impacts at Santa Cruz Island. From 1995-1997, 75 adults and 6 chicks were killed by barn owls at Bat Cave and Orizaba Rock although barn owls have not been identified as causing heavy predation in recent years (McIver 2002, W. McIver pers. comm.). In 2005 and 2008, spotted skunks killed at least 75 adult ASSP in Bat Cave and 32 adult ASSP in Cavern Point Cove Caves, respectively (McIver & Carter 2006; McIver et al. 2009). Bat Cave began to recover soon after the skunk predation event but Cavern Point Cove Caves has had a much delayed response but started to increase several years later; neither had recovered to pre-event population sizes by 2013 (McIver et al. 2015). Heavy predation by common ravens began to be observed in 2012 at Orizaba Rock and in 2013 at Bat Cave. In 2013, 45 distinct ASSP feather piles indentified in Bat Cave were attributed to common raven predation (McIver et al. 2015). In 2014 and 2015, heavy predation by common ravens also occurred at Bat Cave and Orizaba Rock (D. Mazurkiewicz, pers. comm.).

Common ravens have been documented as being very adept at accessing initial artificial nest structures in 2008-2012 designed to allow researchers to access the nesting chamber of the artificial nest structure for monitoring purposes (McIver et al. 2016). While most sites accessed by ravens did not contain ASSP adults or chicks, a few did. To prevent raven impacts, artificial nest structures have been redeveloped in 2013. The new design prevents ravens from gaining access to nesting ASSP and limits researchers to only looking into structures for monitoring purposes (i.e., there is no direct access to the “nest chamber” for handling eggs or chicks). This design likely will also prevent spotted skunks from gaining access to nesting petrels, eggs and chicks although this has not been tested. In 2014, 10 “bread loaf” artificial nest structures with a total of 30 nest sites (3 nest sites per structure) were deployed at Orizaba Rock without vocalization broadcasting. Active nests sites increased from two in 2014 to four in 2015 with two fledged ASSP. This suggests that, over time, these artificial nest structures will be utilized by ASSP without the use of vocalization broadcasting.

The current rate of common raven predation, as measured by ASSP feather piles collected during monitoring visits to the nesting sites, is alarming. To date, there has not been an analysis to determine the impacts of the documented predation on the Santa Cruz ASSP population. At a minimum, monthly monitoring should continue at all five locations to quantify predation until modeling can be conducted to examine its long-term impacts on breeding success and population size (see section on survey and research below). Additional efforts, beyond artificial nest structure implementation, should be considered for controlling common ravens, particularly at Bat Cave and Orizaba Rock, to prevent continued high impacts in the near future which will likely result in population decline.

## Survey and Research Goal

Conduct surveys within the range of the ASSP to assess and identify breeding locations and relative breeding population size at coastal rocks with unsurveyed suitable nesting habitat, evidence of ASSP presence, or important colonies without updated information on population size. Develop and conduct research activities to fill information gaps on known and potential threats as well as to enhance the overall understanding of conservation actions necessary for the continued existence of ASSP.

### Colony Survey and Colony Size Estimate Objectives

Southern Humboldt, Mendocino, Sonoma and Marin Counties – Objective 1: Conduct surveys for nesting ASSP at all accessible coastal rocks with apparently suitable nesting habitat from southern Humboldt County to Dillon Beach, northern Marin County (excluding central Mendocino County between Kibesillah Rock and Franklin Smith Rock where ASSP nesting was documented in 2012) within 10 years of plan approval. Highest priorities are: (a) Steamboat Rock, Sugarloaf Island and False Cape Rocks to confirm current nesting and estimate population sizes; and (b) Fish Rocks and Gull Island where LHSP nesting has been documented. (Priority 2)

Monterey, San Luis Obispo and northern Santa Barbara Counties – Objective 2: Conduct surveys for nesting ASSP at all accessible coastal rocks with apparently suitable nesting habitat from Bird Rock, Monterey County to Point Conception, Santa Barbara County within 10 years of plan approval. Highest priorities are: Cape San Martin, the largest nearshore rock in this region that has potential to host a relatively large colony; and (b) cliffs and offshore rocks near Vandenberg Air Force Base to evaluate possible nesting near locations where ASSP have been captured in mist nets. (Priority 2)

San Francisco and San Mateo Counties – Objective 3: Conduct surveys for nesting ASSP at portions of the South Farallon Islands (i.e., West End Island and Islets), the North Farallon Islands, and nearshore rocks along the mainland within 10 years of plan approval. Highest priorities are: (a) West End and Islets because they may host an important portion of the population at the South Farallon Islands; and (b) Alcatraz Island, San Pedro Rock and Año Nuevo Island to evaluate past ASSP presence at these locations. At the North Farallon Islands, three of the four major islets were surveyed for ASSP in September 1994. No ASSP were found and available nesting habitat was considered to be limited (McChesney et al. 1994). (Priority 2)

Channel Islands – Objective 4: Conduct surveys for nesting ASSP on San Miguel Island, Santa Rosa Island, Santa Cruz Island and Santa Barbara Island (exclude Anacapa, San Clemente and Santa Catalina islands which have been recently surveyed) within 10 years of plan approval. Highest priorities are: (a) Prince Island, Santa Barbara Island and Sutil Island to update mist-net based population size estimates for ASSP, LHSP and BLSP; (b) Castle Rock to confirm current ASSP nesting and estimate breeding population size; and (c) cliffs on the north sides of San Miguel, Santa Rosa and Santa Cruz islands for evaluation of potential breeding because these areas are suspected of hosting undetected populations (Priority 2).

Baja California – Objective 5: Conduct surveys for nesting ASSP at Coronado, San Martin, San Jeronimo and San Benitos islands (exclude Todos Santos islands which have been recently surveyed) within 10 years of plan approval. Highest priority is: (a) Coronado Islands to update species ratios and develop population estimates for ASSP, LHSP and BLSP. (Priority 2).

Strategies:

* For previously unsurveyed habitats identified above, conduct searches for potential nesting habitat and nests (using small hand-held flashlights and burrow scopes as needed) and call playback (using vocalization recordings played at potential nest site entrances to elicit a vocal response) at accessible cliffs and rocks. Conduct surveys in the incubation period (June-July) to allow identification of incubating adults or in late summer-early fall (August-September) if necessary to avoid disturbance to surface nesting seabirds.
* To detect continued presence and determine relative abundance at known colonies, use automatic acoustic sensors (e.g., song meters) to detect vocalizations over the breeding season.
* To estimate population size at relatively large colonies with large amounts of relatively inaccessible breeding habitat, use mist-netting with vocalization luring and banding on several nights within a breeding season to gather data related to species of storm-petrel present and numbers captured per unit effort, and possibly using capture-recapture analyses with mist-netting data.
* Estimate population sizes for relatively small colonies using numbers of nests found, estimated number of nest sites and estimated site occupancy.
* .

Rationale:

Three major problems affect our knowledge of ASSP distribution and relative breeding population sizes: (1) surveying ASSP breeding colonies is very difficult given their rock crevice nesting habitat and nocturnal colony behavior; (2) past surveys for ASSP breeding colonies in California and Baja California were incomplete, and many rocks were not searched either to avoid disturbance to surface-nesting seabirds, difficulty of access, or time limitations; and (3) current population size at several important colonies is poorly known, especially at Prince Island (2nd largest colony) and Santa Barbara/Sutil islands (3rd largest colony) where sizes were determined with mist-netting in 1991. In 2012, Carter et al. (2015) confirmed breeding by ASSP along the central coast of Mendocino County, California in a region where ASSP nesting had not been detected since 1926 despite major seabird surveys conducted in 1979-1980 (Sowls et al. 1980) and 1989 (Carter et al. 1992). Even more recently Carter et al. (2016a) also discovered that northernmost ASSP breeding was documented in 1914 at Steamboat Rock off Cape Mendocino. In this area, no surveys of rocks for breeding storm-petrels were conducted in 1979-1980 or 1989, yet large rocks exist with potential nesting habitats that may host a major population of ASSP or LHSP at Steamboat Rock, Sugarloaf Island and False Cape Rocks (Carter et al. 2015a, 2016a). In 1996 and 1997, McChesney et al. (2000) reported ASSP nesting in coastal rocks within Monterey County in areas that also were not searched before. It has become clear that much suitable nesting habitat in northern and central California has not been surveyed and may contain significant numbers of breeding birds or represent small poorly documented populations. To ensure that conservation actions are applied appropriately throughout the range of the species, knowledge of all larger colonies is imperative (e.g., Prince Island, Santa Barbara/Sutil islands). To ensure that ASSP are sufficiently protected throughout their range, knowledge of almost all small colonies is imperative. The additional knowledge of whether or not ASSP nest in these areas will be important to developing appropriate management, monitoring and conservation actions for agencies and organizations responsible for management of ASSP population in these areas.

Population estimates for ASSP at Prince Island and the Santa Barbara Island area were based on capture-recapture analyses in 1991 (Carter et al. 1992) and have not been re-estimated since then. Prince and Santa Barbara areas hold about 10% of the known ASSP breeding population (Table 1). These colonies need to be resurveyed to verify 1991 population estimates and to determine if major changes have occurred. Populations have fluctuated at some nearby Santa Cruz Island colonies between 1995 and 2015 due mainly to reduction of organochlorine pollution impacts and major mammalian and avian predation events (McIver et al. 2016). Population estimates at Bird Rock (Marin County) in 1989 also had been based on capture-recapture analyses but extensive nest searches in almost all habitats in 2012-2015 did not find sufficient nests to support those estimates (Becker et al. 2016). More work is needed to verify mark-recapture estimates of ASSP at Prince Island and for the Santa Barbara Island area to determine if changes in status have occurred at these important colonies. In addition, Castle Rock off San Miguel Island also has never been adequately assessed for estimating population size, mainly due to issues with disturbance to surface nesting seabirds and presence of marine mammals year round. Surveys in late summer or early fall on the east rock only (i.e., fewer marine mammals) are needed to assess population size. At Santa Barbara Island area, preliminary comparisons by Harvey et al. (2013) to earlier ASSP work (Wolf et al. 2000) suggests that this colony may have experienced a negative trend between 1991 and 2011. However, insufficient data was collected in both years for a valid comparison and much larger data sets gathered in 1991 (Carter et al. 1992) and 2005-2007 (Adams 2016) were not considered in this analysis. A new extensive updated survey is needed to both set a solid baseline for future comparisons and to compare with all past data sets to best assess current status.

ASSP populations at Todos Santos islands were recently assessed using a variety of techniques including nest searches, mist-netting and recording calls. A population size of 17 breeding pairs was estimated using these techniques (Table 1) (Y. Bedolla, pers. comm.). However, populations at the Coronado Islands still need to be adequately assessed. Carter et al. (2006a) reported greater numbers of ASSP at Middle Rock than the few pairs reported for all 4 islands by Everett and Anderson (1991). However, LHSP and BLSP are known to breed at these islands in relatively large numbers, it was difficult to identify species of storm-petrel inside nest crevices, methods were not fully standardized between observers, and subsequently methods of separating ASSP from LHSP were considered suspect (Carter et al. 2016a,b). Extensive mist-netting may be the best approach available to assessing population size at the Coronado Islands and some past mist-net data exists for 1989-1991 for comparison (W.T. Everett, unpubl. data).

### At-sea Survey Objectives

At-sea Survey – Objective 1: Every decade or until ASSP specific survey methodology are developed and implemented, collate ASSP data from existing at-sea surveys using standardized protocols to determine at-sea distribution and world population size. Compare estimated population size between periods for a general measurement of overall change in population size and to identify any changes in foraging hotspots. (Priority 2)

At-sea Survey – Objective 2: Develop and implement at-sea survey methodologies specific for ASSP, likely utilizing adaptive sampling with a stratified random approach, to determine at-sea distribution and estimate world population size every 3 to 5 years.

Strategies:

* Collate data from aerial surveys (e.g., Briggs et al. 1987, Mason et al. 2007)
* Collate data from shipboard surveys (e.g. Briggs et al. 1985; Spear et al. 2004; Spear and Ainley 2007)
* Until at-sea census specific for ASSP is developed and implemented, collate and analyze data from existing at-sea seabird surveys every decade and determine major changes in estimated population size and distribution
* Develop and implement a periodic (3-5 years) at-sea survey protocol specific for ASSP that can effectively monitor trends in at-sea distribution and world population size.

Rationale:

An important part of conservation of the ASSP is to monitor population size and at-sea distribution in order to identify significant changes in populations over time and to identify marine conservation issues that may affect ASSP. Monitoring populations at certain breeding locations can be adequate for assessing colony trends but not all colonies can be monitored closely or surveyed in the same year, some colonies likely have not yet been discovered, it is often unclear what proportion of the non-breeding population is being monitored, and no information is obtain about at-sea distribution. Some experts have shown that for nocturnal cavity nesting seabirds, at-sea estimates can provide an independent estimate of the world population size over a period of time for validation of the traditional approach of determining world population size based on the sum total of colony-based estimates. Also, differences in at-sea estimates between periods of time can be compared with colony-based measures of trends to determine if trends at those colonies represent the entire population. Given the restricted range of the ASSP and their behavior of aggregating (especially during fall months), at-sea surveys for ASSP may be relatively accurate compared with more wide ranging seabird species. Collating and summarizing information on the at-sea distribution of ASSP also is critical for assessing potential at-sea impacts (e.g., oil pollution, military activities at sea, commercial fisheries, etc.) and changes in prey resources and the marine environment expected with climate change throughout the range of ASSP.

Furthermore, a well designed at-sea survey specific for ASSP, would likely allow for the best estimate of the world ASSP population. Given the restricted range of the ASSP and the ability to survey ASSP via aircraft, conducting periodic, broad-scale, nearly instantaneous at-sea surveys to estimate total population size of ASSP may be the best method to analyze world population trends and evaluate the cumulative success of conservation efforts at the world population level.

### Research Objectives

#### Santa Barbara Island Area – Objective 1: Determine the current extent of predation on ASSP nesting on Santa Barbara and Sutil islands and investigate need for management actions (e.g. barn owl roost site alterations, mouse control, owl removals) to benefit the ASSP populations in the Santa Barbara Island area (Priority 2).

Strategies:

* Continue efforts similar to Thomsen et al. (2014) to include ASSP in the study
* Conduct ASSP population estimates/monitoring on Santa Barbara Island and Sutil Island
* Investigate roost site alterations as a means to reduce barn owl predation on ASSP
* Monitor native mouse, western gull and peregrine falcon population sizes/trends

Rationale:

Currently the breeding population size of ASSP in the Santa Barbara Island area (including the main island, Sutil Island and Shag Rock) is estimated at 731 breeding pairs and comprises the second largest ASSP breeding area. However, this population estimate is dated and is based on mist-net captures conducted at the main island and Sutil in 1991 (Carter et al. 1992) and 1 nest found on Shag Rock in 1996 during an incomplete nest survey (H. Carter, pers. comm.). It is unclear what current ASSP population size and trends are in the Santa Barbara Island area. Several studies have implicated barn owls as potentially having an impact on the ASSP population in this area, although no direct evidence has been obtained (Wolf et al. 2000; Whitworth et al. 2011; Harvey et al. 2013). In addition to barn owl predation, ASSP adults have been documented being preyed upon by western gulls and ASSP eggs and chicks have been taken by native deer mice (*Peromyscus maniculatus elusus*) (Wolf et al. 2000, Whitworth et al. 2011). Conducting population size/trend studies in conjunction with a predation study is warranted given the significant impacts that predation, particularly owl predation, has been shown to have on ASSP populations at South Farallon Islands (Nur et al., in press).

#### Santa Cruz Island Area – Objective 1: Determine the current extent of avian predation on ASSP nesting in the Santa Cruz Island area (particularly at Bat Cave and Orizaba Rock) and investigate need for management actions (e.g. barn owl roost site alterations, common raven mitigation) to benefit the ASSP populations in the Santa Cruz Island area (Priority 2).

Strategies:

* Conduct ASSP population trend analysis and reproductive monitoring in the Santa Cruz Island area
* Investigate roost site alterations as a means to reduce barn owl predation on ASSP
* Conduct an evaluation of raven distribution and abundance at Santa Cruz Island, similar to Boarman and Coe (2002)
* Conduct an evaluation of raven responses to human presence at Santa Cruz Island, similar to Marzluff and Neatherlin (2006)
* Conduct and evaluation of barn owl predation on ASSP, similar to Thomsen and Plumb (2014)

Rationale:

Heavy predation by common ravens began to be observed in 2012 at Orizaba Rock and in 2013 at Bat Cave. In 2013, a “majority” of the 45 distinct ASSP feather piles indentified in Bat Cave were attributed to common raven predation although some may have been caused by barn owls (McIver et al. 2015). In 2014 and 2015, heavy predation by common ravens appears to have continued at Bat Cave and Orizaba Rock (D. Mazurkiewicz, pers. comm.). The Santa Cruz Island area holds the 4th largest nesting population of ASSP with an estimated 327 breeding pairs.

Blake (1887) described common ravens as common breeders at Santa Cruz Island. The main food source available for ravens from the mid-19th century to the late 20th century was dead livestock which ravens scavenged (Blake 1887, Schuyler 1993). Management of most of the island moved from a private ranch to The Nature Conservancy in the 1970s, although management of the east end did not move from a smaller private ranch to the NPS until the late 1990s (Schuyler 1993; Faulkner and Kessler 2011). Once part of the CINP, the east end was developed for tourism and thousands of visitors come to the island and many camp each year (D. Mazurkiewicz, pers. comm.). The primary campground is located at Scorpion Ranch and Scorpion Anchorage which is about 1 km from Bat Cave. Marzluff and Neatherlin (2006) hypothesize that food is the most important anthropogenic resource driving the increase of corvids near campgrounds. Ravens are known to be adept at obtaining food from campgrounds, including using techniques such as opening gate latches, backpack zippers and food containers (Janiskee 2010) and individuals can become specialized in their feeding behaviors (Marzluff and Angell 2005). Ravens visiting Orizaba Rock appeared to have learned how to access one type of artificial nest site in order to access the nest contents (McIver et al. 2016; W. McIver, pers. comm.). In recent years, ravens appear to have learned that ASSP nesting at Orizaba Rock and Bat Cave in shallow natural crevices and under driftwood are easily accessible to them (W. McIver, pers. comm.).

The current rate of predation, as measured by ASSP feather piles collected during monitoring visits to the nesting sites, is alarming. To date, there has not been an analysis to determine the impacts of the documented predation on the Santa Cruz ASSP population. However, studies at the South Farallon Islands have indicated that heavy and increased predation on adult storm-petrels resulted in a decrease in annual storm-petrel survival and a significant population decline of nearly 6% per annum over a 5-year period (Nur et al., in press). It is necessary to assess the impacts of avian predation on the Santa Cruz Island ASSP population in order to determine: (1) if management actions are warranted to protect this nesting population and (2) if action is warranted, utilize the best information available to implement the most appropriate and effective management actions in order to protect the ASSP breeding at this important location.

#### Investigate impacts from artificial nocturnal lights – Objective 1: Investigate the impacts to ASSP from artificial nocturnal lighting that is emitted from oil platforms and recreational and commercial vessels working near breeding colonies.

Strategies:

* Design and implement a study of ASSP breeding colonies located near anchorages or squid boat operations with brightly lit lights.
* Investigate ASSP response to light emitted from oil platforms and potential impacts on increased predation by peregrine falcons (*Falco peregrinus*) due to increased at-sea perches/roosts and the ability to hunt at night due to infrastructure lighting (See Hamer et al. 2014).
* Determine light levels that are currently emanating from squid boats with shields.
* Examine effects of recreational and commercial boat lights anchored or operating near colonies on ASSP and nocturnal predator behavior under differing environmental conditions.
* Conduct study of ASSP response to differing light intensities and wavelengths to obtain a better understand of attractions and potential ways to reduce attraction.

Rationale:

Evidence from several studies on seabird attractions to lights and anecdotal observations specific to ASSP indicate that ASSP are likely attracted to lights (Carter et al. 2000, Carter et al. pers. comm., D. Pereksta, pers. comm.). In addition, squid boats operating near breeding colonies have been implicated in causing reduced reproductive success due to the brightly lit lights used by this commercial fishery (McIver et al. 2016). Furthermore, peregrine falcons have been observed preying on Scripps’s murrelets at night utilizing the lights from offshore oil platforms to allow for this type of hunting. However, very little is known about the impacts of this light attraction and possible increased predation risk by falcons utilizing offshore oil platforms. It is necessary to assess the impacts of bright lights on ASSP in order to determine: (1) if management actions are warranted to protect nesting populations where bright light impacts may be occurring and (2) if management actions are warranted on offshore oil platforms to aid in the reduction of light impacts from possible collisions and possible increased predation by peregrine falcons.

## Index Monitoring Program Goal

Create and implement a range-wide monitoring program that will provide for the detection of “biologically significant” trends in population parameters (e.g., population size, breeding success, adult survival) and place an emphasis on attributes of sampling design (e.g., randomization, bias, detection probability) and the level of precision. Monitoring should be conducted at accessible sample colonies throughout the breeding range of ASSP and incorporate data collection from small to large colony sizes as well as offshore and nearshore colonies in an effort to detect significant changes that might signal different types of conservation issues for ASSP in different habitats and geographic areas. To develop this program, a major group effort by seabird biologists, managers and others is needed to discuss various approaches. For this plan, important concepts to consider in designing and implementing this program are summarized below.

Objective 1: Within 3 years of this plan, develop an ASSP monitoring plan that provides standardized protocols for data collection and data analysis in order to provide long-term time-series data that will allow “biologically significant” changes in population parameters such as population size, breeding success and adult survival to be detected in different parts of the breeding range of the ASSP (Priority 2).

Strategies:

* Establish formal guidelines that outline a standardized, repeatable approach to measuring ASSP population size indexes, estimating breeding population size and/or trends, and examining reproductive success and survival.
* Build upon existing monitoring programs and augment with additional locations and parameters to allow for trend monitoring analysis and comparisons across the breeding range of ASSP
* Establish the South Farallon Islands as the key monitoring and research location in the northern part of the range that will conduct annual monitoring of population size, reproductive success, and survival. In addition, annual or periodic monitoring should be conducted at nearshore rocks in PRNS for comparison.
* Establish Santa Cruz Island as the key monitoring location in the southern part of the range that will conduct annual monitoring of population size and periodic monitoring of reproductive success.
* Collate and analyze past mist-net data in the Channel Islands to provide the best historical information for comparison to newly-developed baseline data.
* Analyze past data, especially in the Channel Islands and Mexico, to provide the best “baseline” information on these populations
* Establish “sample” colonies (e.g., Prince Island, Santa Barbara Island, San Clemente Island, Todos Santos Islands) where periodic monitoring of population size is conducted
* Identify secondary parameters (e.g., environmental variables, organochlorine pollutants) that will be used to aid the interpretation of analyzed trends

Rationale:

Currently, there is no monitoring plan or formal guidelines that exist describing a standardized, repeatable approach to monitoring ASSP across its range. It is essential to develop standardized monitoring protocols and implement them throughout the range so that the conservation status of the ASSP can be tracked confidently and restoration efforts aimed at protecting and increasing ASSP populations can be effectively evaluated. Ultimately, the long-term monitoring program should be effective at detecting significant changes population size, reproductive success or survival for the ASSP population.

Because the ASSP population has 2 core breeding areas at South Farallon Islands and the Channel Islands, the monitoring programs must include key colonies in these areas, as well as smaller colonies that represent different habitat types. In the northern portion of the species range, the monitoring of a large colony would likely occur at Southeast Farallon Islands where ASSP monitoring has occurred since the early 1971 on an annual basis. In addition, small nearshore colonies at Bird Rock and Stormy Stack, monitored annually since 2012, also can be examined for comparison. Within the Channel Islands area, ASSP populations are concentrated within 3 islands and their islets: San Miguel, Santa Cruz and Santa Barbara. However, Santa Cruz Island should become the focal colony for monitoring in the Channel Islands because it is the only known location where reproductive success and population size has been measured annually through nest monitoring since 1995. However, population size must be monitored annually or periodically at Prince Island and Santa Barbara Island as well. In addition, estimates of ASSP population sizes have been made at various Channel Islands in 1975-1977 and 1991-1996 using a variety of techniques. All colonies should be resurveyed using standardized techniques to develop a better baseline for future monitoring. Since 2012, population assessment and monitoring work has been conducted at San Clemente Island where a small population breeds on an islet and likely on adjacent main island cliffs. This likely represents the best location to establish a long-term monitoring population for a small colony in the Channel Islands.

From the standpoint of ASSP conservation and management, trends in population size are the most important parameter to monitor in order to identify significant declines that may threaten species existence or result in loss of portions of the breeding range. However, evaluating causes of population change requires monitoring of reproductive success, predation and survival. Along with being long-lived, ASSP are a low-fecundity species in which adult survival is a key demographic parameter in population growth or decline (Nur & Sydeman 1999). As such, including adult survival in the ASSP monitoring program is important. Finally, monitoring the reproductive success of the ASSP also aids in detection of environmental conditions that have acute impacts (e.g. changes in prey resources or impacts from rising sea levels due to climate change, contaminants causing eggshell thinning, exposure of bright lights at a breeding colony, etc.).

The establishment of an ASSP monitoring plan that emphasizes a standardized and repeatable approach to data collection and analysis will go a long way toward the conservation of the ASSP. The collaboration of current monitoring programs across regions is essential for the success of the plan. In addition, the integration of ASSP data with data from other ongoing marine environment monitoring programs (e.g. CalCOFI cruises) will strengthen the interpretation of ASSP population trends. The ultimate goals for these monitoring efforts are: (1) to provide information that will assist and direct the long-term conservation and management of the ASSP; and (2) to better understand the biology of this very interesting storm-petrel species which is endemic to California and northwest Baja California.

# Section 4. Consideration For Other Storm-Petrel Species

This plan serves to summarize key published and unpublished information on ASSP for aiding conservation and management of this species. By indentifying priority management, restoration and research need, greater cooperation will result between management agencies, researchers and advocacy groups. In addition, the implementation of this conservation plan will aid in the protection of Leach’s Storm-Petrels and Black Storm-Petrels that breed at some of the same islands in California and Baja California as ASSP, as described briefly below.

## Leach’s Storm-Petrel

Leach’s Storm-Petrel (LHSP) is one of the most widespread nesting seabirds in the northern hemisphere (Huntington et al. 1996). In the Pacific Ocean, they breed from Japan, across the Aleutian Islands and south to central western Baja California, Mexico. There are 4 recognized subspecies (or 3 proposed species; see Ainley 1980; Howell et al. 2009; Howell 2012 for discussion) within this range but briefly described here: (1)Leach’s Storm-Petrel (*O. leucorhoa leucorhoa*) breeds from Japan to Alaska to southern California; (2) Chapman’s Storm-Petrel (*O. l. chapmani*) breeds on the Coronado Islands and San Benito Islands with “intergrades” of *leucorhoa* found from the Coronado Islands to the South Farallon Islands off central California; (3) Townsends Storm-Petrel (*O. l. socorroensis*) breeds at Guadalupe Island off central west Baja California in summer; and (4) Ainley’s Storm-Petrel (*O. l. cheimomnestes*) breeds at Guadalupe Island in winter.

In California, LESP breeding colonies occur throughout the State with the largest colonies occurring in northern California at Castle Rock (Del Norte County), Trinidad Bay Rocks and Little River Rock in 1989 (Carter et al. 1992). Recent assessments conducted by Parker et al. (2013) in 2012 indicated a substantial decline in breeding birds at Trinidad Bay Rocks and Little River Rock since 1989; only a few hundred birds likely remain at Trinidad Bay Rocks. In southern California, LESP are known or suspected to breed on Prince Island, Santa Barbara Island, Sutil Island, and Santa Catalina Island, with a combined population estimate of less than 350 breeding birds (Carter et al. 1992, 2016a). In Baja California, LESP are known to breed on Coronado Islands and San Benito Islands where population estimates are in the hundreds (Everett and Anderson 1991). At Guadalupe Island, Townsend’s Storm-Petrel has been estimated at around 7,000 birds (Crossin 1974) and Ainley’s Storm-Petrel is likely not in “excess of a few thousands birds” (Howell et al. 2009).

Goals and objectives in this ASSP Conservation Action Plan to conduct mist-net population estimates at Prince Island (San Miguel Island area), Santa Barbara Island, Sutil Island and Coronado Islands should include updating LESP population estimates and assessing the current degree of intergrades. In addition, certain management actions geared toward ASSP that are implemented at breeding locations on the South Farallon Islands, Prince Island, Santa Barbara Island, Sutil Island, Santa Catalina Island and Coronado Islands will also benefit these populations of LESP. Like ASSP, LESP nest in rock crevices in the southern portion of their range from Central California (South Farallon Islands) to Guadalupe Island. However, conservation issues and efforts for the vulnerable populations of LESP at Todos Santos Islands, San Benito Islands and Guadalupe Island are not identified in this ASSP conservation plan.

## Black Storm-Petrel

Black Storm-Petrels (*Oceanodroma melania*) (BLSP) breed primarily on islands in the Gulf of California, Mexico and off the west coast of Baja California, on Coronado and San Benito islands (Everett & Anderson 1991; Howell 2009), extending north to Santa Barbara and Sutil islands off southern California (Carter et al. 1992). Everett and Anderson (1991) considered this species to be the second most abundant seabird in the Gulf of California while population numbers on the west coast of Baja California range from “200 to 300 birds” at Coronado Islands (Everett & Anderson 1991) to perhaps tens of thousands at San Benito Islands (Crossin 1974, Boswall 1978, Everett & Anderson 1991). However, lack of information provided by Crossin and Boswall on survey methods and the lack of information since these informal assessments were conducted gives good reason to look at this rough estimate cautiously. In California, Carter et al. (1992) estimated 200 and 74 breeding birds at Santa Barbara Island and Sutil Island, respectively.

Goals and objectives in this ASSP Conservation Action Plan to conduct mist-net population estimates at Santa Barbara Island, Sutil Island and Coronado Islands should include updating BLSP population estimates. At Prince Island, BLSP were found in small numbers in 1991 and may breed with ASSP and LESP (Carter et al. 1992). In addition, certain management actions geared toward ASSP that are implemented at Prince Island, Santa Barbara Island, Sutil Island, and the Coronado Islands, will also benefit BLSP.

# Section 5. References

ADAMS, J. 2016. Ashy Storm-Petrel *Oceanodroma homochroa* mist-netting and capture rates in the California Channel Islands: 2004-2007. *Marine Ornithology*, in press.

ADAMS, J. & TAKEKAWA, J.Y. 2008. At-sea distribution of radio-marked Ashy Storm-Petrels *Oceanodroma homochroa* captured on the California Channel Islands. *Marine Ornithology* 36: 9-17.

ADAMS, J., CARTER, H.R., MCCHESNEY, G.J., & WHITWORTH, D.L. 2016. Leach’s Storm-Petrel *Oceanodroma leucorhoa* in the California Channel Islands. *Marine Ornithology,* in prep.

AINLEY, D.G. 1976. The occurrence of seabirds in the coastal region of California. *Western Birds* 7: 33-68.

AINLEY, D.G. 1980. Geographic variation in Leach’s Storm-Petrel. *Auk* 97: 837-853.

AINLEY, D.G., HENDERSON, R.P. & STRONG, C.S. 1990. Leach’s Storm-Petrel and Ashy Storm-Petrel. In Ainley, D.G. & Boekelheide, R.J. (eds.). Seabirds of the Farallon Islands: ecology, dynamics, and structure of an upwelling-system community. Stanford, CA: Stanford University Press. pp.128-162.

AINLEY, D.G. & BOEKELHEIDE, R.J. (Eds.). 1990. Seabirds of the Farallon Islands: ecology, dynamics, and structure of an upwelling-system community. Stanford, CA: Stanford University Press.

AINLEY, D.G. & LEWIS, T.J. 1974. The history of Farallon Island marine bird populations, 1854-1972. *Condor* 76: 432-446.

AINLEY, D.G., LEWIS, T.J. & MORRELL, S. 1974. Patterns in the life histories of storm-petrels on the Farallon Islands. *Living Bird* 13: 295-312.

AINLEY, D.G. 1995. Ashy Storm‑Petrel (*Oceanodroma homochroa*). In Poole, A. (ed.). The Birds of North America Online. Ithaca, NY: Cornell Lab of Ornithology.

AINLEY, D.G. and HYRENBACH, D. 2010. Long- and short-term factors affecting seabird population trends along the California Current System. *Progress in Oceanography* 84:242-254.

ANTHONY, A.W. 1898. Petrels of southern California.  *Auk* 15: 140-144.

BECKER, B.H., CARTER, H.R., HENDERSON, R.P., WEINSTEIN, A., & PARKER, M.W. 2016. Status and monitoring of Ashy Storm-Petrels *Oceanodroma homochroa* at Point Reyes National Seashore California, 2012-2015. *Marine Ornithology* (*in review)*.

BLAKE, E.W., Jr. 1887. Summer birds of Santa Cruz Island, California. Auk 4: 328-330.

BLIGHT, L.K., & BURGER, A.E. 1997. Occurrence of plastic particles in seabirds from the eastern North Pacific. *Marine Pollution Bulletin* 34: 323-325

BOARMAN, W.I. & COE, S.J. 2002. An evaluation of the distribution and abundance of Common Ravens at Joshua Tree National Park. Bulletin of the Southern California Academy of Sciences 101: 86-102.

BOSWALL, J. 1978. The birds of the San Benito Islands, Lower California, Mexico. *Bristol Ornithology* 11: 23-32.

BRADLEY, R. 2011. New assessment of Ashy Storm-Petrels on Farallon Islands. PRBO Conservation Science. 2p.

BRIGGS, K.T., TYLER, W.B., LEWIS, D.B. & CARLSON, D.R. 1987. Bird communities off California: 1975-1983. *Studies in Avian Biology* No. 11.

BRIDGES, A.S., SANCHEZ, J.N., & BITEMAN, D.S. 2015. Spatial ecology of invasive feral cats on San Clemente Island: implications for control and management. *Journal of Mammalogy* 96: 81-89.

BROWN, A., COLLIER, N., ROBINETTE, D. & SYDEMAN, W.J. 2003. A potential new colony of Ashy Storm-Petrels on the mainland coast of California, USA. *Waterbirds* 26: 385-388.

CARLE, R., BECK, J., CALLERI, D. & HESTER, M. 2014. Año Nuevo State Park Seabird Conservation and Habitat Restoration: Report 2014. Oikonos – Ecosystem Knowledge. 48 p.

CARTER, H.R., WHITWORTH, D.L., TAKEKAWA, J.Y., KEENY, T.W., & KELLY, P.R. 2000. At-sea threats to Xantus’s Murrelets (*Synthliboramphus hypoleucus*) in the southern California Bight, in Proceedings of the fifth California Islands symposium, 29 March to 1 April 1999 (D.R. Browne, K.L. Mitchell, and H.W. Chaney, eds.), pp. 435-447. U.S. Minerals Mgmt. Serv., Pacific Outer Continental Shelf Region, Camarillo, CA.

CARTER, H.R. 2001. Appendix B. Histories of Common Murre (*Uria aalge californica*) colonies in California, 1800-1978. In Manuwal, D.A., Carter, H.R., Zimmerman, T.S. & Orthmeyer, D.L. (eds.). Biology and conservation of the Common Murre in California, Oregon, Washington, and British Columbia. Vol. 1: Natural history and population trends. U.S. Geological Survey, *Information and Technology Report* USGS/BRD/ITR-200-0012. pp. 93-107.

CARTER, H.R., MCCHESNEY, G.J., JAQUES, D.L., STRONG, C.S., PARKER, M.W., TAKEKAWA, J.E., JORY, D.L. & WHITWORTH, D.L. 1992. Breeding populations of seabirds in California, 1989-1991. Volume I - Population estimates. Dixon, CA: Unpubl. draft report, U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center.

CARTER, H.R., GRESS, F., WHITWORTH, D.L., PALACIOS, E., KOEPKE, J.S. & HARVEY, A.L. 2006a. Seabird monitoring at the Coronado Islands, Baja California, Mexico, in 2005. Davis, CA: Unpubl. report, California Institute of Environmental Studies. 110 p.

CARTER, H.R., WHITWORTH, D.L., NEWMAN, S.H., PALACIOS, E., KOEPKE, J.S., HÉBERT, P.N., & GRESS, F. 2006b. Preliminary assessment of the status and health of Xantus’s Murrelets (*Synthliboramphus hypoleucus*) at Todos Santos Islands, Baja California, Mexico, in 2005. Unpublished Report, California Institute of Environmental Studies, Davis, CA; and Wildlife Trust, New York, New York.

CARTER, H.R., MCIVER, W.R. & MCCHESNEY, G.J. 2008a. Ashy Storm-Petrel (*Oceanodroma homochroa*). In Shuford, W.D. & Gardali, T. (eds.). California Bird Species of Special Concern: a ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Camarillo, CA: Western Field Ornithologists; and Sacramento, CA: California Department of Fish and Game. pp. 117-124.

CARTER, H.R., YEE, J.L., WELSH, D. & ANDERSON, D.W. 2008b. Organochlorine contaminants in Ashy Storm-Petrel eggs from Santa Cruz Island, California, in 1992-2008: preliminary findings. Victoria, BC: Unpubl. report, Carter Biological Consulting; and Sacramento, CA: U.S. Geological Survey, Western Ecological Research Center. 10 p.

CARTER, H, WHITWORTH, D., HEBERT, P., KOEPKE, J., CAPITOLO, P., MCCHESNEY, G., MCIVER, W., OCHIKUBO CHAN, L., PIERSON, M., HEBSHI, A. & MARTIN, P. 2008c. Status of breeding seabirds in the San Miguel Island group, California. Victoria, BC: Unpubl. report, Carter Biological Consulting; and Davis, CA: California Institute of Environmental Studies. 131 p.

CARTER, H.R., WHITWORTH, D.L., MCIVER, W.R., MCCHESNEY, G.J., OCHIKUBO CHAN, L.K., GRESS, F. & HERBERT, P.N. 2009. Status of the Xantus’s Murrelet, Ashy Storm-Petrel, and Black Storm-Petrel at San Clemente Island, California. Victoria, B.C.: Unpubl. report, Carter Biological Consulting; and Davis, CA: California Institute of Environmental Studies. 42 p.

CARTER, H.R., PARKER, M.W., KOEPKE, J.S. & WHITWORTH, D.L. 2015. Breeding of the Ashy Storm-Petrel in central Mendocino County, California. *Western Birds* 46:49-65.

CARTER, H.R., AINLEY, D.G., WOLF, S.G. & WEINSTEIN, A.M. 2016a. Range-wide conservation and science of the Ashy Storm-Petrel *Oceanodrama homochroa*. *Marine Ornithology (in review).*

CARTER, H.R., DVORAK, T.M. & WHITWORTH, D.L. 2016b. Breeding of the Ashy Storm-Petrel at Santa Catalina Island, California. *Marine Ornithology (in review)*.

CARTER, H.R. & HENDERSON, R.P. 2015. Ashy Storm-Petrel monitoring at San Clemente island, California, in 2014. Unpublished report, California Institute of Environmental Studies, Davis, California. 28 p.

CARTER, H.R. & HENDERSON, R.P. 2016. Ashy Storm-Petrel monitoring at San Clemente Island, California, in 2015. Unpublished Report, California Institute of Environmental Studies, Davis, California. 26 p.

CROSSIN R.S., & BROWNELL, R.L. 1968. Preliminary report of Channel Islands survey. Eastern area cruise no. 41. Unpublished report. Smithsonian Institute, Washington, D.C. 12 pp.

CROSSIN, R.S. 1974. The storm-petrels (Hydrobatidae). Pp. 154-205 in: King, W.B. (ed.), Pelagic studies of seabirds in the central and eastern Pacific Ocean. Smithsonian *Contributions to Zoology* 158.

DAWSON, W.L. 1911. Another fortnight on the Farallones. *Condor* 13: 171-183.

DOUGHTY, R.W. 1971. San Francisco’s nineteenth-century egg basket: the Farallons. *Geographical Review* 61: 554-572.

ERICKSON, W.A. & HALVORSEN, W.L. 1990. Ecology and control of the roof rat (*Rattus rattus*) in Channel Islands National Park. Davis, CA: Unpubl. report, University of California, Coop. National Park Resources Study Unit, Tech. Report No. 38.

EVERETT, W.T., & ANDERSON, D.W. 1991. Status and conservation of the breeding seabirds on offshore Pacific islands of Baja California and the Gulf of California, in Seabird status and conservation: A supplement (J.P. Croxall, ed.), pp. 115-139. Int. Council Bird Preservation Tech. Pub. 11.

FAULKNER, K.R. & KESSLER, C.C. 2011. Live capture and removal of feral sheep from eastern Santa Cruz Island, California. Pp. 295-299. In Veitch, C.R., Clout, M.N., and Towns, D.R. (eds.). Island Invasives: eradication and management. IUCN. Gland, Switzerland.

FRY, D.M. 1994. Injury of seabirds from DDT and PCB residues in the Southern

California Bight ecosystem. Sacramento, CA: Unpubl. report, U.S. Fish and Wildlife Service.

HAMER, T., REED, M., COLCLAZIER, E., TURNER, K., AND DENIS, N. 2014. Nocturnal Surveys for Ashy Storm-Petrels (*Oceanodroma homochroa*) and Scripps’s Murrelet (*Synthliboramphus scrippsi*) at offshore oil production platforms, southern California. United States Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2014-013. 62 pp.

HARVEY, A.L., AUER, S.A., BARNES, K.W., MAZURKIEWICZ, D.M., CARTER, C.A., JACQUES, M.E., AND YAMAGIWA, A.A. 2013. Scripps’s Murrelet, Cassin’s Auklet, and Ashy Storm-Petrel colony monitoring and restoration activities on Santa Barbara Island, California in 2010-2011. Unpublished report prepared, California Institute of Environmental Studies. 81 p.

HARVEY, A.L., MAZURKIEWICZ, D.M., MCKOWN, M.W., CARTER, H.R., BARNES, K.W. & PARKER, M.W. 2016. First breeding record of the Ashy Storm-Petrel at Anacapa Island, California. *Marine Ornithology (in review).*

HOWELL, S.N.G. & WEBB, S. 1995. A guide to the birds of Mexico and northern central America. Oxford University Press Inc., New York.

HOWELL, S.N.G., MCGRATH, T., HUNEFELD, W.T., & FEENSTRA, J.S. 2009. Occurrence and identification o f the Leach’s Storm-Petrel (*Oceanodroma leucorchoa*) complex off southern California. *North American Birds* 63: 540-549.

HOWELL, S.N.G. 2012. Petrels, albatrosses and storm-petrels of North America. Princeton, NJ: Princeton University Press.

HUNT, G.L., JR., PITMAN, R.L., NAUGHTON, M., WINNETT, K., NEWMAN, A., KELLY, P.R. & BRIGGS, K.T. 1979. Distribution, status, reproductive biology and foraging habits of breeding seabirds. In Summary of marine mammals and seabird surveys of the Southern California Bight area, 1975-1978. Vol. 3. Investigator’s reports, Part 3: Seabirds of the Southern California Bight, Book 2. Irvine, CA: Unpublished report, University of California.

HUNT, G.L., JR., PITMAN, & JONES H.L. 1980. Distribution and abundance of seabirds breeding on the California Channel Islands. In D.M. Power (ed.). The California islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara, California.

INGERSOLL, M. 1886. Nesting habits and egg of Ashy Petrel (*Cymochorea homochroa*). *Ornithologist and Oologist* 11:21.

IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland. 112 p.

INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE (IUCN). 2016. The IUCN Red List of Threatened Species. Version 2015.4. <[www.iucnredlist.org](http://www.iucnredlist.org)>. Downloaded on 25 January 2016.

JANIKSKEE, B. 2010. Creature feature: the common raven is an uncommonly intelligent bird. [http://www.nationalparkstraveler.com/2010/06/creature-feature-common-raven-uncommonly-intelligent-bird5933. Accessed January 26](http://www.nationalparkstraveler.com/2010/06/creature-feature-common-raven-uncommonly-intelligent-bird5933.%20Accessed%20January%2026), 2016.

JAMES-VEITCH, E.A.T.C. 1970. The Ashy Petrel, *Oceanodroma homochroa*, at its breeding grounds on the Farallon Islands. Doctoral dissertation, Loma Linda University, Los Angeles, California.

KIFF, L.F. 1994. Eggshell thinning in birds of the California Channel Islands. Sacramento, CA: Unpublished report, U.S. Fish and Wildlife Service.

LOOMIS, L.M. 1918. A review of the albatrosses, petrels, and diving petrels. *Proceedings of the California Academy of Sciences* (4th series) 2 (part 2, no. 12): 1–187.

MARZLUFF, J.M. & ANGELL, T. 2005. In the company of Crows and Ravens. Yale University Press, New Haven Connecticut.

MARZLUFF, J.M. & NEATHERLIN, E. 2006. Corvid response to human settlements and campgrounds: causes, consequences, and challenges for conservation. *Biological Conservation* 130: 301-314.

MASON, J.W., MCCHESNEY, G.J., MCIVER, W.R., CARTER, H.R., TAKEKAWA, J.Y., GOLIGHTLY, R.T., ACKERMAN, J.T., ORTHMEYER, D.L., PERRY, W.M., YEE, J.L., PIERSON, M.O. & MCCRARY, M.D. 2007. At-sea distribution and abundance of seabirds off southern California: a 20-year comparison. *Studies in Avian Biology* No. 33.

MATO, Y., TOMOHIKO, I., TAKADA, H., KANEHIRO, H., OHTAKE, C. & KAMINUMA, T. 2001. Plastic resin pellets as transport medium for toxic chemicals in the marine environment. *Environmental Science and Technology* 35: 318-324.

MCCHESNEY, G.J. 1988. Mark-recapture population estimates and diet of Ashy and Leach’s storm-petrels on Southeast Farallon Island, California 1987. B.A. thesis, University of California, Santa Cruz.

MCCHESNEY, G.J., CARTER, H.R. & PARKER, M.W. 2000. Nesting of Ashy Storm-Petrels and Cassin’s Auklets in Monterey County, California. *Western Birds* 31: 178-183.

MCIVER, W.R. 2002. Breeding phenology and reproductive success of Ashy Storm-Petrels (*Oceanodroma homochroa*) at Santa Cruz Island, California, 1995-98. Arcata, CA: M.Sc. thesis, Humboldt State University. 70 p.

MCIVER, W.R. & CARTER, H.R. 2006. Nest surveys and monitoring of Ashy Storm-Petrels at Santa Cruz Island, California: 2005 progress report. Unpublished report, Carter Biological Consulting, Victoria, British Columbia. 6 p.

MCIVER, W.R., CARTER, H.R., GOLIGHTLY, R.T., MCCHESNEY, G.J., WELSH, D. & HARVEY, A.L. 2009a. Reproductive performance of Ashy Storm-Petrels (*Oceanodroma homochroa*) at Santa Cruz Island, California, in 1995-2007. In Damiani, C.C. & Garcelon, D.K. (eds.). Proceedings of the 7th California Islands Symposium. Arcata, CA: Institute for Wildlife Studies. pp. 269-281.

MCIVER, W.R., HARVEY, A.L., & CARTER, H.R. 2009b. Monitoring and restoration of Ashy Storm-Petrels at Santa Cruz Island, California, in 2008. Unpublished report, U.S. Fish and Wildlife Service, Arcata, California; Channel Islands National Park, Ventura, California; and Carter Biological Consulting, Victoria, British Columbia. 30 p.

MCIVER, W.R., HARVEY, A.L., CARTER, H.R., & HALPIN, L.R. 2011. Monitoring and restoration of Ashy Storm-Petrels at Santa Cruz Island, California, in 2010. Unpublished report, U.S. Fish and Wildlife Service, Arcata, California; Channel Islands National Park, Ventura, California; Carter Biological Consulting, Victoria, British Columbia; and Simon Fraser University, Burnaby, British Columbia. 45p. + appendices.

MCIVER, W.R., HARVEY, A.L., & CARTER, H.R. 2013. Monitoring and restoration of Ashy Storm-Petrels at Santa Cruz Island, California, in 2011. Unpublished report, U.S. Fish and Wildlife Service, Arcata, California; California Institute of Environmental Studies, Davis, California; and Carter Biological Consulting, Victoria, British Columbia. 58 p.

MCIVER, W.R., HARVEY, A.L., & CARTER, H.R. 2014. Monitoring and restoration of Ashy Storm-Petrels at Santa Cruz Island, California, in 2012. Unpublished report, U.S. Fish and Wildlife Service, Arcata, California; California Institute of Environmental Studies, Davis, California; and Carter Biological Consulting, Victoria, British Columbia. 50 p.

MCIVER, W.R., MAZURKIEWICZ, D.M., & HOWARD, J.A. 2015. Monitoring and restoration of Ashy Storm-Petrels at Santa Cruz Island, California, in 2013. Unpublished report,

U.S. Fish and Wildlife Service, Arcata, California; Montrose Settlements Restoration Program, Channel Islands National Park, Ventura California; and California Institute of Environmental Studies, Davis, California. 49 p.

MCIVER, W.R., CARTER, H.R., HARVEY, A.L., MAZURKIEWICZ, D.M. & MASON, J.W. 2016. Use of artificial nest structures and vocalization broadcasting to restore Ashy Storm-Petrels *Oceanodroma homochroa* at Orizaba Rock, Santa Cruz Island, California. *Marine Ornithology (in review).*

MILLS, K.L. 2016. Seabirds as part of migratory owl diet on Southeast Farallon Island, California. *Marine Ornithology*, in press.

MILLS, K.L., PYLE, P. SYDEMAN, W.J., & RAUZON, M.J. 2002. Direct and indirect effects of house mice on declining populations of a small seabird, the ashy storm-petrel (*Oceanodrama homochroa*) on Southeast Farallon Island, California. *In* Turning the tide: the eradication of invasive species. IUCN, Gland, Switzerland.

MONTROSE SETTLEMENTS RESTORATION PROGRAM (MSRP). 2005. Final restoration plan and programmatic environmental impact statement, and environmental impact report. Unpublished report, Montrose Settlements Restoration Program, National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, National Park Service, California Department of Fish and Game, California Department of Parks and Recreation, and California State Lands Commission.

NATIONAL AUDUBON SOCIETY. 2006. America’s top ten most endangered birds: A March 2006 report from the National Audubon Society. Washington, D.C. 16 pp.

NUR, N., & SYDEMAN, W.J. 1999. Demographic processes and population dynamic models of seabirds: Implications for conservation and restoration. *Current Ornithology* 15: 149-188.

NUR, N., BRADLEY, R., SALAS, L., & JAHNCKE, J. 2013. Modeling the impacts of house mouse eradication on Ashy Storm-Petrels on Southeast Farallon Island. Unpublished report to the U.S. Fish and Wildlife Service. PRBO Conservation Science, Petaluma, California. PRBO Contribution Number 1880.

NUR, N., BRADLEY, R., SALAS, L., & JAHNCKE, J. In prep. Evaluating population impacts of reduced predation by owls on storm petrels as a consequence of proposed island mouse eradication.

PARKER, M.W., CARTER, H.R., & WHITWORTH, D.W. 2013. Preliminary assessment of burrow and crevice breeding habitats for storm-petrels and alcids on rocks near Trinidad, California, in 2012. Unpublished report, California Institute of Environmental Studies, Davis, California. 100p.

PENNIMAN, T.M., COULTER, M.C., SPEAR, L.B., & BOEKELHEIDE, R.J. 1990. Western Gull. In Ainley, D.G. & Boekelheide, R.J. (eds.). Seabirds of the Farallon Islands: ecology, dynamics, and structure of an upwelling-system community. Stanford, CA: Stanford University Press. pp.218-244.

REMSEN, J.V. 1978. Bird species of special concern in California: An annotated list of declining or vulnerable bird species. Nongame Wildlife Investigation, Wildlife Management Branch Administrative Report 78-1. California Department of Fish and Game, Sacramento, CA. 67 p.

ROEMMICH, D., & MCGOWAN. 1995. Climatic Warming and the decline of zooplankton in the California Current. *Science* 267: 1324-1326.

SAN FRANCISCO CALL. 1895. First cargo of Guano. October 11, 1895. Page 3. Accessed on 26 January 2016 at: http://chroniclingamerica.loc.gov/lccn/sn85066387/1895-10-11/ed-1/seq-3/.

SCHUYLER, P. 1993. Control of feral sheep (*Ovis aries*) on Santa Cruz Island, California. Pages 443-452 *in* Hochberg, F.G. (ed.). The third California Islands symposium: recent advances in research on the California Islands. Santa Barbara Museum of Natural History, Santa Barbara, California.

SEMARNAT. 2010. Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para inclusion, exclusion o cambio-Lista de species en riesgo.

SCHUITEMAN, M.A. 2006. Intra- and inter-annual breeding season diet of Leach’s storm-petrel (*Oceanodroma leucorhoa*) at a colony in southern Oregon. M.S., University of Oregon, Oregon Institute of Marine Biology, Charleston, Oregon. 56 p.

SOWLS, A.L., DEGRANGE, A.R., NELSON, J.W., & LESTER, G.S. 1980. Catalog of California seabird colonies. United States Department of Interior, Fish and Wildlife Service, Biological Services Program. FWS/OBS 37/80. 317 p.

SPEAR, L.B., AINLEY, D.G., HARESTY, B.D., HOWELL, S.N.G. & WEBB, S.W. 2004. Reducing biases affecting at-sea surveys of seabirds: use of multiple observer teams. *Marine Ornithology* 32: 147-157.

SPEAR, L.B. & AINLEY, D.G. 2007. Storm-petrels of the eastern Pacific Ocean: species assembly and diversity along marine habitat gradients. *Ornithological Monographs* No. 62.

STALLCUP, R.W. 1976. Pelagic birds of Monterey Bay, California. *Western Birds* 7: 113-136.

SYDEMAN, W.J., NUR, N., MCLAREN, E.B. & MCCHESNEY, G.J. 1998. Status and trends of the Ashy Storm-Petrel on Southeast Farallon Island, California, based upon capture-recapture analyses. *Condor* 100:438-447.

THOMSEN, S.K. & PLUMB, S. 2014. Factors influencing depredation of Scripps’s Murrelets by Barn Owls on Santa Barbara Island: Summary Results from the 2012 field season. Unpublished report prepared for: Montrose Settlements Restoration Program. 15 p.

U.S. FISH & WILDLIFE SERVICE (USFWS). 2002. Birds of conservation concern 2002. Arlington, VA: U.S. Fish and Wildlife Service, Division of Migratory Bird Management.

U.S. FISH & WILDLIFE SERVICE. 2005. Regional Seabird Conservation Plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, OR.

U.S. FISH & WILDLIFE SERVICE (USFWS). 2009. Endangered and threatened wildlife and plants; 12-month finding on a petition to list the Ashy Storm-Petrel as threatened or endangered. Notice of 12–month petition finding. *Federal Register* 74: 41832-41860.

U.S. FISH & WILDLIFE SERVICE (USFWS). 2013. Endangered and threatened wildlife and plants; 12-Month finding on a petition to list Ashy Storm-Petrel as an endangered or threatened species. Notice of 12–month petition finding. *Federal Register* 78: 62523-62529.

U.S. Navy. 2015. Explosive safety risk assessment for San Miguel & Prince Island. Naval Base Ventura County. 165 p.

WHITE, P. 1995. The Farallon Islands: sentinels of the Golden Gate. San Francisco, CA: Scottwall Associates.

WHITWORTH, D.L., CARTER, H.R., YOUNG, R.J., MCCHESNEY, G.J., HESTER, M. & ALLEN S. 2002. Status and distribution of the Ashy Storm-Petrel (*Oceanodroma hochroa*) at Point Reyes National Seashore, California, in 2001. Unpublished report, Humboldt State University, Department of Wildlife, Arcata, California. 15 p.

WHITWORTH, D.L., HARVEY, A.L. & CARTER, H.R. 2011. Cassin’s Auklets, Xantus’s Murrelet and other crevice-nesting seabirds at Santa Barbara Island, California: 2009-2010 Surveys. Unpublished report, California Institute of Environmental Studies, Davis, California; Channel Islands National Park, Ventura, California; and Carter Biological Consulting, Victoria, British Columbia. 84 p.

WHITWORTH, D.L., CARTER, H.R. & GRESS, F. 2013. Recovery of a threatened seabird after eradication of an introduced predator: eight years of progress for Scripps's Murrelet at Anacapa Island, California. *Biological Conservation* 162:52-59.

WHITWORTH, D.L., HARVEY, A.L., CARTER, H.R., YOUNG, R.J., KOEPKE, J.S., & MAZURKIEWICZ, D.M. 2105. Breeding of Cassin’s Auklet *Ptychoramphus aleuticus* at Anacapa Island, California, after eradication of Black Rats *Rattus rattus*. Marine Ornithology 43: 19-24.

WOLF, S., ROTH, J.E., SYDEMAN, W.J. & MARTIN, P.L. 2000. Population size, phenology and productivity of seabirds on Santa Barbara Island, 1999. Channel Islands National Park Technical Report CHIS 00-02. 68 p.

WOLF, S. 2007. Petition to list the Ashy Storm-Petrel (*Oceanodroma homochroa*) as a threatened or endangered species under the Endangered Species Act. Center for Biological Diversity, Fallbrook, California. 51 p.