# **SPECIES REPORT FOR ASHY STORM-PETREL** *(Oceanodroma homochroa)*

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U.S. Fish and Wildlife Service (Service)
Bay-Delta Fish and Wildlife Office, Sacramento, California

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## EXECUTIVE SUMMARY

The ashy storm-petrel (*Oceanodroma homochroa*) is a small seabird whose known at-sea distribution ranges from about the California-Oregon Border to Islas San Benitos, Mexico. The 32 known breeding sites of the ashy storm-petrel stretch from Point Cabrillo, Mendocino County, California to Islas Todos Santos Island, Ensenada, Mexico. More than 90 percent of the population breeds in two population centers at Southeast (SE) Farallon Island and in the California Channel Islands. Anacapa, San Miguel, Santa Cruz, Santa Rosa, San Clemente, San Nicholas, Santa Barbara, and Santa Catalina Islands comprise the Channel Islands. Ashy storm-petrels occur at their breeding colonies nearly year-round and occur in greater numbers from February through October. The ashy storm-petrel feeds at night on euphausiids, other krill, decapods, larval lanternfish, fish eggs, young squid, and spiny lobster.

### Previous Federal Actions

The purpose of this species report is to provide the best available scientific and commercial information about the species so that we can evaluate whether or not the species warrants protection under the Endangered Species Act of 1973 (Act or ESA). On August 9, 2009, the Service announced its 12-month finding that found, after reviewing the best available scientific and commercial information, listing the ashy storm-petrel was not warranted. The Center for Biological Diversity challenged this decision in the District Court of the Northern District of California on October 25, 2010. This challenge was resolved by a September 16, 2011, Stipulation of Dismissal, based on the approval of two settlements in which the Service agreed to submit a proposed rule or a not-warranted finding regarding the ashy storm-petrel to the **Federal Register** by the end of Fiscal Year (September 30) 2013.

## I. SPECIES DESCRIPTION

The ashy storm-petrel is a dark smoke-gray, small seabird with long slender wings, a long forked tail, and webbed feet (Ainley 1995, p. 2). On average, individuals weigh about 1.3 ounces (~38 g), are eight inches (20 cm) in length, and have a wingspan of about 18 inches (46 cm). The ashy storm-petrel has a relatively short neck, large puffy head, small bill, and pointed wings usually somewhat crooked at the wrist. Upper tail covert feathers are typically a contrasting paler gray with flight feathers slightly darker with a pale dusky-gray ulnar band (Howell. 2012, p. 419). The bill, legs, and feet are black (Howell 2012, p. 420). The ashy storm-petrel generally can be distinguished from other storm-petrels by size, tail shape, and plumage color differences (Ainley 1995). At sea, where size, tail-shape and plumage differences are are difficult to discern, the ashy storm-petrel is best separated from other all-dark storm-petrels by a distinctive wing action in flight (Ainley 1980, p. 838).

## II. TAXONOMY

The ashy storm-petrel is a seabird species belonging to the order Procellariiformes, family Hydrobatidae. This order is distinguished by sheathed nostrils in horny tubes arising from the base of the bill (Warham 1990, p. 1–186). Storm-petrels, like many members of this family, have a distinct musky odor (Ainley 1995, p. 1). The ashy storm-petrel is one of five storm-petrel species (including fork-tailed (*Oceanodroma furcata*), Leach's, black (*O. melania*), and least (*O. microsoma*) storm-petrels) that nest on islands along the west coast of North America (Harrison 1983, pp. 272–278). Research by Nur *et al.* (1999, Ch. 2–9) indicates that there are no genetic differences between ashy storm-petrel populations on the Farallon and Channel Islands, and no recognized subspecies within *Oceanodroma homochroa* (Coues 1864, p. 72–96; American Ornithologists' Union 1957, p. 23).

## III. LIFE HISTORY

Reproductive Habitat and Biology

Research on reproduction and biology of ashy storm-petrels comes primarily from SE Farallon Island where approximately 58 percent of the breeding population nests (Table 1). Like other procellariids, storm-petrels are long lived (Warham 1996, p. 20). Studies on SE Farallon Island showed an observed maximum longevity of 35 years for ashy storm-petrel (Bradley and Warzybok 2003, p. 122; Nur *et al*. 2013, p. 20). In the closely related Leach's storm-petrel, the oldest known banded bird was greater than 36 years of age (Huntington *et al*. 1996), and mean age of first breeding at 5.9 years ± 1.3 years (Huntington *et al.* 1996, p. 19). Sydeman *et al.* (1998b, p. 7) concluded that 90 percent of adult ashy storm-petrels were capable of breeding at 6 years of age.

Ashy storm-petrels have been confirmed to breed at 32 locations (on islands and offshore rocks) from Mendocino County, California, south to the Todos Santos Islands, west of Ensenada, Baja California, Mexico (Carter *et al.* 1992, pp. 77–81; Ainley 1995, pp. 2, 8, 9; Carter *et al.* 2006, p. 6; Carter *et al.* 2008a, p. 118; Carter, pers. comm. 2012; Harvey, pers. comm. 2012). Greater than 90 percent of the species breeds in two population centers at SE Farallon Island and the following California Channel Islands: San Miquel, Santa Cruz, Anacapa, Santa Barbara, Santa Catalina, and San Clemente (Table 1).

The breeding season is protracted, and breeding activities (courtship, egg-laying, chick-rearing) at nesting locations occur from February through January of the following year (Ainley *et al.* 1974, p. 301, Ainley 1995, p. 5, James-Veitch 1970, p. 71). Although ashy storm-petrels occur at their breeding colonies nearly year-round, they occur in greater numbers from February through October (Ainley 1995, p. 5). Like other procellariids, ashy storm-petrels are highly philopatric; birds usually return to the same breeding site or colony from which they were raised as chicks (James-Veitch 1970, p. 81; Warham 1990, p. 12). At SE Farallon Island, Ainley *et al.* (1974, p. 301) reported that immature (nonbreeding) ashy storm-petrels visited the island from April through early July.

The egg-laying period extends from late April to October, peaking in June and July (James-Veitch 1970, p. 243; Ainley *et al.* 1990, p. 148; McIver 2002, p. 17). Clutch size is one egg per year, and parents take turns incubating the egg (James-Veitch 1970, p. 244; Ainley 1995, p. 6). The egg incubation period averages 44.8 days in length, but ranges from 42 to 59 days (Ainley *et al.* 1990, p. 150). Less than about 4 percent of all eggs laid are replacement (or re-nesting) eggs, laid after the failure of a first egg (Ainley *et al.* 1990, p. 148; McIver 2002, p. 18). Hatchlings are semi-precocial (James-Veitch 1970, p. 128); they have precocial characteristics at hatching (open eyes, downy, capacity to leave the nest), but remain at the nest and are cared for by parents until close to adult size (Sibley 2001, p. 573). Once hatched, the nestling is brooded (attended by adult and kept warm) for between 3.5 and 7 days (Ainley *et al.* 1990, p. 152). The nestling is fed irregularly (once every 1 to 3 nights on average) during brief nocturnal visits by its parents from feeding areas at sea (James-Veitch 1970, pp. 180–208). Fledging (day when young leave the nest) occurs after an average of 84.4 +/– 6.5 days after hatching, but ranges from 72 to 119 days (Ainley *et al.* 1990, p. 152). From the time the egg is laid to fledging averages about 130 days, or approximately 4 months (Ainley *et al.* 1990, pp. 150–152). Fledging occurs at night from late August to January, and once they leave the nest, fledglings are independent of their parents (Ainley *et al.* 1974, p. 303; McIver 2002, p. 36). Peak fledging occurs in early to mid-October (McIver 2002, p. 18). Throughout the fledging period, the number of adults visiting the colony declines (Ainley *et al.* 1974, p. 301).

Ashy storm-petrels do not excavate burrows; rather, they nest in crevices in talus slopes, rock walls, sea caves, cliffs, and driftwood (James-Veitch 1970, pp. 87–88; Ainley *et al.* 1990, p. 147; McIver 2002, p. 1). Crevice nesting by ashy storm-petrels is believed to be an adaptation to avoid predation. Mammalian and avian predators are known to prey on ashy storm-petrels and their eggs (Ainley *et al.* 1990, p. 146; McIver 2002, pp. 40–41; McIver and Carter 2006, p. 3), and nesting in crevices and burrows on remote headlands, offshore rocks, and islands generally reduces this predation by mammalian predators (Warham 1990, p. 13).

*Ashy storm-petrel habitat-SE Farallon Island*

*SE Farallon Island rock wall*

*Ashy storm-petrel nesting crevice*


*Dry Sandy Beach Cave-Santa Cruz Island*

## Movement

Ashy storm-petrels are known to regularly forage up to 220 miles (mi) (354 kilometers (km)) from their breeding grounds, although one individual has been located 466 mi (750 km) from its capture site (Adams and Takekawa 2008, p. 13). Ashy storm-petrels are not as migratory as other storm-petrel species. They forage primarily in the California Current, from northern California to central Baja California, Mexico, in areas of upwelling, seaward of the continental shelf, near islands and the coast (Ainley *et al.* 1974, p. 300; Briggs *et al.* 1987, p. 23; Mason *et al.* 2007, p. 60). The California Current flows along the west coast of North America, and extends to about 190 mi (300 km) offshore from southern British Columbia, Canada, to Baja California, Mexico. It comprises a southward surface current, a northward (poleward) undercurrent, and surface countercurrents (Dailey *et al.* 1993, pp. 8–10; Miller *et al.* 1999, p. 1), and is characterized by the upwelling of cool, nutrient-rich waters, which results in increased productivity of phytoplankton and zooplankton in the region (Hickey 1993, pp. 19–70). Upwelling involves wind-driven movement of dense, cooler, and usually nutrient-rich water towards the ocean surface, which replaces the warmer and usually nutrient-depleted surface water (Smith 1983, pp. 1–2). Coastal upwelling replenishes nutrients in the euphotic zone (where photosynthesis occurs), resulting in increased productivity in organisms higher in the food web such as seabirds (Batchelder *et al.* 2002, p. 37).

## Food Habits

Ashy storm-petrels leave and return to their nesting colonies only at night making them nocturnal in that aspect of their behavior. However, while at sea, they feed and can be observed at any time of the day. They are surface-feeders, picking prey from the surface of the water (Ainley 1995, p. 3). Their nocturnal (nighttime) activity to and from the nest is believed to be an adaptation to avoid predation by diurnal (daytime) predators, such as western gulls (*Larus occidentalis*), peregrine falcons (*Falco peregrinus*), and common ravens (*Corvus corax*) (Ainley 1995, p. 5; McIver and Carter 2006, p. 3). However, nocturnal activity at colony sites leaves ashy storm-petrels susceptible to predation at night by burrowing owls (*Athene cunicularia*) and barn owls (*Tyto alba*) (Ainley 1995, p. 5; McIver 2002, p. 30).

The diet of ashy storm-petrels has not been extensively studied, but likely includes euphausiid species including *T. spinifera*, other krill (small crustaceans), decapods, larval lanternfish (family Myctophidae), fish eggs, young squid, and spiny lobster (Warham 1990, p. 186; McChesney 1999, pers. comm.; Adams and Takekawa 2008, p. 14). Ashy storm-petrel pick their food from the water surface while sitting on the water or hovering above, as when preying on *Thysanoessa spinifera*. Ashy storm-petrels are also known to scavenge the nets of fishing boats (Ainley 1995, p. 3). It is likely that they also consume plastic particles, as has been documented in storm-petrel species that have been examined for plastic (Spear *et al.* 1995, pp. 129–131; Blight and Burger 1997, pp. 323–324; Shuiteman 2006, p. 23).

## IV. DISTRIBUTION AND LAND OWNERSHIP

Historical Range

The best available current information does not show any differences between the current and historical range of the ashy storm-petrel. Historical observations and sightings of ashy storm-petrel throughout its range can be found in California Bird Species of Special Concern (Carter *et al.* 2008, pp. 118–119).

Current Range

The known range of the ashy-storm petrel has expanded slightly in recent years, with the confirmation of breeding at new locations at the northern end of the breeding range. Ashy storm-petrels may have been present at these locations historically, but adequate surveys had not been done to determine presence. Therefore we do not consider this finding to indicate an expansion of the historical range. Four new breeding sites were confirmed in 2012. These locations, all in Mendocino County, include Stillwell Point Rock, Caskett Rock, Wharf Rock, and Franklin Smith Rock (Carter 2012a, pers. comm.). In 2011, ashy storm-petrels were confirmed breeding at West Anacapa Island in the Channel Islands for the first time (Harvey 2012, no pagination), although breeding was suspected prior to this, based on mist-net captures of ashy storm-petrels at Anacapa in summer 1994 (Carter *et al*. 2008, p. 119).). Black rats (*Rattus rattus*), which were introduced to Anacapa Island in the mid- to late $19^{th}$ Century, were eradicated from the island in 2001-2002 (Howald *et al*. 2009, p. 35), which may have facilitated additional nesting. While ashy storm-petrels may have previously nested in cliff areas inaccessible to rats while rats inhabitated the three Anacapa islets (Carter *et al*. 2008, p. 119), rat eradication may have made it possible for ashy storm-petrels to nest in other areas formerly unsuitable due to rat presence.

Ashy storm-petrels have been confirmed to breed at 32 locations (on islands and offshore rocks) from Mendocino County, California, south to the Todos Santos Islands, west of Ensenada, Baja California, Mexico (Table 1, Carter *et al.* 1992, pp. 77–81; Ainley 1995, pp. 2, 8, 9; Carter *et al.* 2006, p. 6; Carter *et al.* 2008a, p. 118). Adams and Takekawa 2008 (p. 13) radio marked ashy storm-petrels and located individuals up to 75 mi (120 km) out to sea from breeding sites. Previously published at-sea observations by Crossin (1974, p.176) of ashy storm-petrels as far north as latitude 47° N (approximately, as far north as Grays Harbor, Washington) and as far offshore as approximately 480 mi (773 km) and south near latitude 13° N (off Central America) have been disputed by Spear and Ainley (2007, p. 7), who stated that these observations likely represented misidentified dark-rumped Leach’s storm-petrels. Nevertheless, additional recent credible sightings indicate that the species has been observed as far north as latitude 47° N, and often off the coast of Oregon (Gillson 2011, no pagination). Observations in Oregon are of single or small numbers (<10) individuals and no large numbers of ashy storm-petrels or breeding colonies have been located in Oregon. At-sea observations of ashy storm-petrels south of Islas San Benitos, Mexico (latitude 28° N), are unusual; most observations of the species are off the coasts of California and Baja California, Mexico (Briggs *et al.* 1987, p. 23;

Ainley 1995, p. 2; Howell 2012, p. 418). Aerial and boat observations at sea confirm that the species is associated with pelagic (offshore) waters along the slope and just seaward of the Continental Shelf and the Monterey Submarine Canyon, and less often in neritic (nearshore) waters north of latitude 28° N (Briggs *et al.* 1987, p. 23; Mason *et al.* 2007, pp. 56–60; Adams and Takekawa 2008, pp. 12–13). Ashy storm-petrels are not known to be associated with the deeper and warmer oceanic waters west of the California Current, unlike the closely related Leach's storm-petrel (Ainley *et al.* 1974, pp. 299–300).

Although sightings of ashy storm peterel have occurred outside of the accepted range, the very few reports indicate thatthe at-sea distribution primarily falls within the mapped area below (Map 1). Thus, the Service considers the at-sea geographic distribution (marine range) of the ashy storm-petrel to include waters off the western coast of North America from latitude 42° N (approximately the California-Oregon State line) south to latitude 28° N (approximately Islas San Benitos, Mexico), and approximately 75 mi (120 km) out to sea from mainland and island coasts.

Map 1: Ashy storm-petrel range map

Table 1: Estimates of Numbers of Breeding Ashy Storm-Petrels at 32 known and 5 potential locations in California (United States) and Baja California (Mexico).

| Known Breeding Occurrence | Ownership/Management | Most Recent Estimate of Breeding Birds | Source of Most Recent Estimate | Median or Actual Estimate of Breeding Birds | Estimated Percent of Population | Nesting | Notes (number of nests or captured birds) | Source of Notes |
|---|---|---|---|---|---|---|---|---|
| Caspar, near Point Cabrillo, Mendocino County | BLM | No Estimate | | | | confirmed | An egg was found on "the rocky sea coast" here on June 26, 1926. No other confirmations have been made. The area has been visited several times since then, but not searched thoroughly. | Smith 1926, from Carter 2008a |
| Stillwell Point Rock, Schoolhouse Creek to Albion River | BLM | 20–30: estimated from number of nests found and knowledge of the species. | Carter 2012a, pers. comm. | 25 | 0.24% | confirmed | One nest found. August 2012. | Carter 2012a, pers. comm. |
| Caskett Rock, Elk | BLM | 10–20: estimated from number of nests found and knowledge of the species. | Carter 2012a, pers. comm. | 15 | 0.15% | confirmed | Two nests found. August 2012. | Carter 2012a, pers. comm. |
| Wharf Rocks, Elk | BLM | 10–20: estimated from number of nests found and knowledge of the species. | Carter 2012a, pers. comm. | 15 | 0.15% | confirmed | One nest found. August 2012. | Carter 2012a, pers. comm. |
| Franklin Smith Rock, South of Elk, Mendocino County | BLM | 40–60=estimated from number of nests found and knowledge of the species. | Carter 2012a, pers. comm. | 50 | 0.49% | confirmed | One nest found. August 2012. | Carter 2012a, pers. comm. |
| Bird Rock, Point Reyes National Seashore | NPS | 24–56: estimated from number of nests found, birds captured, and knowledge of the species. | Carter *et al.* 2012, p. 1 | 40 | 0.00% | confirmed | Five active nests found. One nest found with egg fragments. 2012. | Carter *et al.* 2012, p. 1 |
| Chimney Rock, Point Reyes National Seashore | NPS | No estimate | | | 0.00% | unconfirmed | Five mist net captures in 2001, odor detected and wings and feathers outside of two crevices. No nests found. | Whitworth *et al.* 2002, p. 4 |
| Stormy Stack, Point Reyes National Seashore | NPS | 40–80: estimated from number of nests found, birds captured, and knowledge of the species. | Carter 2012, pers. comm. | 60 | 0.59% | confirmed | Four nests found in 2001. | Whitworth *et al.* 2002, p. 4 |
| Southeast Farallon Island | FWS | lower bound 3790, upper bound 8778: 1992 estimate of 2660 breeding birds was multiplied by 116.8% increase in population. 2.168 X 2660 = 5768. The population more than doubled between 1992 and the 2009–2012 time period. | Nur *et al.* 2012, p. 17 | 5768 | 56.47% | confirmed | A special section on this Island will be included in the species report. | See species report |

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|---|---|---|---|---|---|---|---|---|
| Bench Mark-227x, Monterey County | BLM | 6–20: estimated from number of nests found, potential nest sites found, number of mist net captures, and other likely unsurveyed habitat. | McChesney *et al.* 2000, p. 181 | 13 | 0.13% | confirmed | 10–30 estimated breeding pairs on Bench Mark-227x, Castle Rocks, and Hurricane Point Rocks collectively. Breakdown to 6–20 birds per island reflects this. 2 nests in September 1997. | McChesney *et al.* 2000, p. 181 |
| Castle Rocks and Mainland, Monterey County | BLM | 6–20=estimated from number of nests found, potential nest sites found, number of mist net captures, and other likely unsurveyed habitat. | McChesney *et al.* 2000, p. 180, 181 | 13 | 0.13% | confirmed | One adult in incubating posture. Presumably sitting on an egg, one bird captured. September 1997. | McChesney *et al.* 2000, pp. 180, 181 |
| Hurricane Point Rocks, Monterey County | BLM | 6–20: estimated from number of nests found, potential nest sites found, number of mist net captures, and other likely unsurveyed habitat. | McChesney *et al.* 2000, p. 181 | 13 | 0.13% | confirmed | One nest found, 12 mist netted. September 1997. | McChesney *et al.* 2000, p. 181 |
| Castle Rock, San Miguel Island vicinity | USN=Ownership NPS=Management MOU with NPS (Channel Islands National Park, off San Miguel Island) | 341: Based on count of 455 crevice sites. 75% L correction factor to account for burrow occupancy. 1991. | Carter *et al.* 1992, pp. I–78 | 341 | 3.34% | confirmed | Did not land during prime nesting season. Late October, one nest found, one capture, 1991. October 21–22 1991 crevice counts. | Carter *et al.* 1992, pp. I–78 |
| San Miguel Island proper (Cuyler Harbor to Harris Point) | USN=Ownership NPS=Management MOU with NPS (Channel Islands National Park) | No Estimate | Hunt *et al.* 1979, p. III-29. | | 0.00% | unconfirmed | 1976: Strong ASP odor at burrow on Hare Rock, adjacent to Cuyler Harbor. Three birds with brood patches captured near Harris Point. | Hunt *et al.* 1979, p. III-29 |
| Prince Island, San Miguel Island vicinity | USN=Ownership NPS=Management | 1154: Estimated using CAPTURE and JOLLY programs based on number of birds captured. Mean of all models was taken. | Carter *et al.* 1992, pp. I–79 | 1154 | 11.30% | confirmed | 1991: 309 in mist netted nine nights of netting in two locations, 10 nests found | Carter *et al.* 1992, pp. I–79 |
| Shipwreck Cave, Santa Cruz Island | TNC/NPS | 20-30: estimated from number of nests found and knowledge of the species. | Carter 2012a, pers. comm. | 25 | 0.24% | confirmed | Eight nests found in August 1997. | Carter 2012a, pers. comm. |
| Dry Sandy Beach Cave, Santa Cruz Island | TNC/NPS | 58: Number of nests found doubled to get breeding individuals. Complete search. | McIver *et al.* 2011, p. 19 | 58 | 0.57% | confirmed | 2011: 29 nests found, complete coverage. Only one visit in 2012 with incomplete coverage. No solid data for 2012. | McIver *et al.* 2011, p. 19 |
| Del Mar Rock (Rock 17), Santa Cruz Island vicinity | NPS | 10: estimated from number of nests found and knowledge of the species. | Carter 2012, pers. comm. estimate | 10 | 0.10% | confirmed | One nest found. 1991. | Carter *et al.* 1992, p. II-303 |
| Cave of the Bird's Eggs, Santa Cruz Island | TNC/NPS | 54: Number of nests found doubled to get breeding individuals. Complete search. | Harvey 2012, pers. comm. | 54 | 0.53% | confirmed | 27 nests found, complete coverage. 2012. | Harvey 2012, pers. comm. |

| Known Breeding Occurrence | Ownership/Management | Most Recent Estimate of Breeding Birds | Source of Most Recent Estimate | Median or Actual Estimate of Breeding Birds | Estimated Percent of Population | Nesting | Notes (number of nests or captured birds) | Source of Notes |
|---|---|---|---|---|---|---|---|---|
| Diablo Rocks, Santa Cruz Island vicinity | NPS | 20: estimated from number of nests found and knowledge of the species habitat. | Hunt *et al.* 1979. p. III-33 | 20 | 0.20% | confirmed | Four nests found in July of 1976. | Hunt et al. 1979. p. III-33 |
| Orizaba Rock, Santa Cruz Island vicinity | NPS | 70: Number of nests found doubled to get breeding individuals. Complete search. | Harvey 2012, pers. comm. | 70 | 0.69% | confirmed | 35 nests. 2012. | Harvey 2012, pers. comm. |
| Bat Cave, Santa Cruz Island | NPS | 166: Number of nests found doubled to get breeding individuals. Complete search. | Harvey 2012, pers. comm. | 146 | 1.43% | confirmed | 83 nests. 2012. | Harvey 2012, pers. comm. |
| Cavern Point Cove Caves, Santa Cruz Island | NPS | 10: Number of nests found doubled to get breeding individuals. Complete search. | Harvey 2012, pers. comm. | 10 | 0.10% | confirmed | Five nests at cave #5, zero nests at cave #4. 2012. | Harvey 2012, pers. comm. |
| Scorpion Rocks, Santa Cruz Island vicinity | NPS | 166: actual count of mist netted birds. | Carter *et al.* 2007, p. 26 | 166 | 1.63% | confirmed | 166 petrels captured in 2006. 63 birds captured in 1991 with estimates of 140 and 303. | Carter *et al.* 2007, p. 26 |
| Willows Anchorage Rocks, Santa Cruz Island | NPS | 111: applied rough L correction factor of 75% to total crevice sites. | Carter et al. 1992, p. I-80 | 111 | 1.09% | confirmed | 51 birds captured. 1991. | Carter *et al.* 1992, pp. I–80 |
| Gull Island, Santa Cruz Island vicinity | NPS | 2: based on single nest found on April 12, 1977. | Hunt *et al.* 1979, p. III-33 | 2 | 0.02% | confirmed | Single nest found on April 12, 1977. | Hunt *et al.* 1979, p. III-33 |
| Santa Cruz Island proper, non cave sites | TNC/NPS | North Side has habitat. Could easily be 100's in cliffs on Island; climbing gear would be needed to survey this area. | Carter 2012, pers. comm. |  | 0.00% | unconfirmed |  |  |
| Anacapa Island | NPS | 100–200: estimated from number of nests found, birds captured, and knowledge of the species. | Carter 2012, pers. comm. | 150 | 1.47% | confirmed | 50 birds captured April 1994. One nest found 2011. | Carter 1994, pers. comm.; Harvey *et al.* 2012, p. 1 |
| Santa Barbara Island | NPS | 874: Estimated using CAPTURE and JOLLY programs based on number of birds captured. | Carter *et al.* 1992, p. 87 | 874 | 8.56% | confirmed | 1991: 393 netted on Sutil and Santa Barbara , One nest found. 1994: 51 mist netted 1995: 91 mist netted 1996: 161 mist netted 1999: 75 mist netted | Carter et al. 1992, p. 87; CNIP 1994, pp. 2–14; Wolf et al.1999, p. 10 |
| Sutil Island, Santa Barbara Island vicinity | NPS | 586: Estimated using CAPTURE and JOLLY programs based on number of birds captured. | Carter *et al.* 1992, p. 81 | 586 | 5.74% | confirmed | Breeding confirmed in 1976. 393 on Sutil and Santa Barbara in 1991. | Hunt *et al.* 1979, p. III-34/ Carter *et al.* 1992, p. 81 |
| Shag Rock, Santa Barbara Island Vicinity | NPS | 2–10: estimated from number of nests found and knowledge of the species. | Carter 2012a, pers. comm. | 6 | 0.06% | confirmed | One adult in nest (without egg) found in May 1996. | Carter 2012a, pers. comm. |
| Ship Rock, Santa Catalina Island | BLM | 0–10: estimated from number of nests found, birds captured and knowledge of the species. | Carter 2012, pers. comm. | 5 | 0.05% | confirmed | One egg in 1937 was collected. One visit recently, did not find anything. Found smell on nearby rocks near Silver Canyon. | Carter *et al.* 2008, p. 119 |

| Known Breeding Occurrence | Ownership/Management | Most Recent Estimate of Breeding Birds | Source of Most Recent Estimate | Median or Actual Estimate of Breeding Birds | Estimated Percent of Population | Nesting | Notes (number of nests or captured birds) | Source of Notes |
|---|---|---|---|---|---|---|---|---|
| Santa Catalina Island | Santa Catalina Island Company *et al.*; Catalina Consevancy | 0–50: estimated from number of nests found, birds captured, and knowledge of the species. | Carter 2012, pers comm. | | 0.00% | unconfirmed | No nests found. Found smell on nearby rocks near silver canyon | Carter 2008, p. 120 |
| Seal Cove Rocks, San Clemente Island | USN, BLM | 10–100=(estimate includes San Clemente proper) estimated from number of nests found, birds captured, and knowledge of the species. | Carter 2012, pers. comm. | 55 | 0.54% | confirmed | 31 birds captured, 84% with brood patches between 1994–1996. One nest found in 1994 with bird found in incubating posture. Bird was not flushed, but assumed to be sitting on egg. Only confirmed nesting. | Carter *et al.* 2009, p. 30 |
| San Clemente proper, Mosquito Cove | USN=Naval Oceans Systems Facility | 0–50=estimated from number of nests found, birds captured, and knowledge of the species. | Carter 2012, pers. comm. | | 0.00% | unconfirmed | 1994: Eight birds captured with brood patches at Mosquito Cove. One Bird at Seal Cove Rocks area. | Carter *et al.* 2009, p. 25 |
| Islas Los Coronados, Mexico | MX | 300–400=estimated from number of nests found and knowledge of the species. | Carter 2012, pers. comm. | 350 | 3.43% | confirmed | 2005: 40–58 nests. 40 confirmed. Only one Island out of four was searched and it was the smallest one. The other islands do have habitat. | Carter *et al.* 2006a, pp. 73-75 |
| Islas Todos Santos, Mexico | MX | 10=estimated from number of nests found and knowledge of the species. | Carter 2012, pers. comm. | 10 | 0.10% | confirmed | One nest in 2005 | Carter *et al.* 2006b, p. 12 |
| Total | | | | 10215 | | | | |
| Channel Islands percent estimate | | | | | 37.62% | | | |

## V. CURRENT CONDITIONS

Population Estimates

Obtaining direct population counts of ashy storm-petrels is difficult because the species often nests in deep inaccessible crevices (Carter *et al.* 1992, p. 77; Sydeman *et al.* 1998a, p. 438). Techniques for estimating population size at breeding locations have included counting crevices and applying correction factors to account for burrow occupancy, mark and recapture using mist nests, and direct observation of nest sites. Table 1 provides various estimates of numbers of breeding ashy storm-petrels at 32 locations in California and Baja California, Mexico.

Large numbers of ashy storm-petrels are known to congregate in the waters of Monterey Bay, California, in the fall to feed, approximately 3 to 10 mi (5 to 16 km) offshore from the town of Moss Landing. Shearwater Journeys, a birdwatching concessionaire in Monterey, California, observed large flocks (estimated 7,000 to 10,000 birds) of ashy storm-petrels in September 2008 on Monterey Bay (Shearwater Journeys 2008, pg. 2). Ainley *et al.* 1974b (p. 300) reported congregations of up to 7,000 ashy storm-petrels in the vicinity of Monterey Bay. Both of these estimates used nonstandardized visual estimates, not scientifically rigorous survey methods, but include observations by very experienced seabird biologists and observers.

Previous estimates of the number of breeding ashy storm-petrels in California have ranged from 5,187 (Sowls *et al.* 1980, p. 25) to 7,209 (Carter *et al.* 1992, p. I-87). Ainley 1995 (p. 1) estimated the total population of breeding birds at approximately 10,000 individuals. Sowls 1980 (p. 24) estimated the total number of breeding and non-breeding birds to not exceed 10,000. Additional colony sites and larger ashy storm-petrel numbers have been found at several locations in the Channel Islands and along the mainland coast of California in Mendocino County since the time of previous estimates (Carter *et al.* 2008a, p. 119; Carter 2012a, pers. comm.).

The current total global (restricted to California and Mexico) population size of breeding ashy storm-petrels at all known locations is estimated at between 10,000 and 11,000 individuals (Table 1). Nur *et al.* (1999, Ch. 3, p. 4) estimated that 53.5 percent of the SE Farallon Island population were breeders. Using this value to extrapolate from estimated number of breeding birds to total population size throughout the range, we estimate a total current global population of breeding and non-breeding individuals between about 18,700 and 20,600 birds. These estimates account only for known population occurrences. Unconfirmed and potentially unknown locations are not included in the estimate, however, the existence of sizeable unknown populations (on the scale of SE Farallon or Channel Islands) is unlikely, given the considerable survey efforts that have occurred (Sowls *et al.* 1980, pp. 24–25; Carter *et al*. 1992).

Population Trends and Productivity

Population size and productivity (nesting success) are two measures of population status, along with trends in those measures over time. Because over 90 percent of the estimated breeding population is restricted to SE Farallon Island and the Channel Islands (Table 1), and most colony data are derived from those two locations, we will focus on those locations for population trends and productivity estimates. Research on productivity has been conducted only at SE Farallon Island (James-Veitch 1970, pp. 1–366; Ainley *et al.* 1990, pp. 128–162; Sydeman *et al.* 1998a, pp. 1–74; PRBO Conservation Science 2011, p. 9) and Santa Cruz Island (McIver 2002, pp. 1–70; McIver and Carter 2006, pp. 1–6; Carter *et al.* 2007, pp. 1–32; McIver *et al.* 2008, pp. 1–23; McIver *et al.* 2009a, pp. 1–30).

There are two different methods to collect population trend data: data collected at nesting colonies and data collected at sea. At-sea density data is collected by observing birds from a moving vessel. At-sea data are typically collected along transects, with the same or similar transects followed year after year. These data are useful for determining where seabirds forage, congregate, and the extent of the range. If sampling is properly designed for the purpose, these data can also be used to estimate population size and trend. Ashy storm-petrel spatial distribution on the ocean varies greatly from year to year as well as within a year, and is largely driven by upwelling areas and food resources. Ashy storm-petrels generally occur at relatively low densities at sea (Ainley and Hyrenbach 2010, Table 5), but sometimes aggregate in large groups, such as discussed above for Monterey Bay. Such a species distributed with low density and high patchiness typically requires a rigorous and relatively high-effort sampling design to obtain accurate, unbiased estimates of population size and trend. Some of the trend results from at-sea studies do not agree with the results from colony data for ashy storm-petrels. The existing at-sea studies do not appear to have been designed to estimate ashy storm-petrel population size and trend. For this reason, some caution is called for in interpreting their results. With insufficient sampling, results could be due to survey methods rather than population change, such as if survey transects overlap ashy storm-petrel patches in some years but not others. One at-sea study recognized that observed changes may reflect survey differences in survey methods and coverage over time, and not actual population changes (Mason *et al*. 2007, p. 94).

The other type of data collection is from ashy storm-petrel breeding colonies and uses mist nets or other methods to count the birds at the colonies. Data using the same collection methods are compared among years. For ashy storm-petrels, this data may be more reliable than at-sea data because the counts are conducted at sites where the species consistently concentrates (to breed), thus there is less variability in estimates of population size compared to variability in estimates based on densities at-sea. However, data collected at breeding colonies may not account for nonbreeding birds that do not visit the colony (Ainley 1995, p. 8), and estimates of total population size would need to account for those birds (Sydeman 1998b, p. 444), as we have done above to estimate total population size. Each of the following studies is labeled as based either on at-sea data (S) or colony data (C).

***Farallon Islands Population estimates and trends***

The Farallon Islands population comprises an estimated 58 percent of the total ashy storm-petrel population.

**(C) SE Farallon Island; 1971–1992; Sydeman *et al.* 1998a**
Sydeman *et al.* (1998b, pp. 1–74) conducted a population viability analysis (PVA) of ashy storm-petrels at SE Farallon Island, quantitatively examining the effects of predation on ashy storm-petrel populations. Sydeman *et al*. (1998b, pp. 1–2) estimated a 2.87 percent per year decline in the population of ashy storm-petrels from 1972 to 1992, and hypothesized that removal of western gulls would produce a stable population. They also stated that, given then current population parameters and predation rates, the population of ashy storm-petrels on SE Farallon Island faces a 46 percent probability of "quasi-extinction" (which they defined as the population reaching 500 or fewer breeding individuals) within 50 years (Sydeman *et al*. 1998b, p. 22). This study relied significantly on the population growth estimates from Sydeman *et al.* 1998a; limitations of that study are noted above. Also, this study based some population parameters on data from other storm-petrel species, as data were not available for ashy storm-petrels (Sydeman *et al.* 1998b, pp. 6-8).

**(C) SE Farallon Island; 1971–1992; Sydeman *et al.* 1998b**
Sydeman *et al.* 1998b, (pp. 438–442) re-analyzed data from SE Farallon Island from the years 1971 and 1972 (Ainley and Lewis 1974, p. 435), and included data from 1992, to estimate 6,461 total and 3,402 breeding ashy storm-petrels in 1971–1972, and 4,284 total and 1,990 breeding ashy storm-petrels in 1992. Capture-recapture analysis for 1971-1972 and 1992 was input into the JOLLY program to estimate breeding and total population size each year (Sydeman *et al.* 1998b, p. 441). Based on comparison of these data sets, Sydeman *et al.* (1998a, p. 442) suggested declines of 34 percent and 42 percent in the total and breeding populations of ashy storm-petrels, respectively, at SE Farallon Island, between 1971-1972 and 1992. Sydeman *et al.* (1998a, pp. 445–446) reported that this decline occurred in prime ashy storm-petrel nesting habitat, and suggested that it was due in part to an increase in the predation rate on ashy storm-petrel adults and subadults by western gulls and burrowing owls. This study was limited to data from two points in time, with no data on population size and variability during the intervening two decades. The authors noted that oceanographic conditions varied between the 1971-1972 and 1992 periods, and that reduced food availability in 1992 during a severe El Niño event may have influenced colony attendance and breeding effort (Sydeman *et al*. 1998a, pp. 445-446).

**(C) SE Farallon Island; 1969–1997; Sydeman *et al.* 2001** —Sydeman 2001 used nesting surveys conducted between 1971 and 1997 to determine trends in ashy storm-petrel reproduction. Reproductive performance (the number of offspring produced per breeding pair per year) increased slightly through the mid-1980s, then decreased sharply thereafter to the conclusion of the 1997 study, with decreased reproductive performance in the last decade of the study (Sydeman *et al*. 2001, p. 309). Reproductive performance was the result of two components, hatching success (percent of eggs that hatch) and fledging success (percent of hatched chicks that fledge). Sydeman *et al.* (2001, pp. 317, 320) found that hatching success in the 1990s was low and likely responsible for the lower ashy storm-petrel reproductive performance during that time period. While overall reproductive performance and hatching success appeared to increase, then decrease, during the study period, fledging success actually increased during the 1969–1997 time period (Sydeman *et al.*, pp. 319–320).

**(S) Point Pinos to Bodega Bay; 1980–1995; Spear and Ainley** (2007, p. 27) used models to examine the seasonal at-sea distribution and abundance of all storm-petrel species (including ashy storm-petrels) from 1980–1995 (Spear and Ainley 2007, p. 11), and estimated on average 4,207 (95 percent confidence interval: 4,500-9,070) and 7,287 (95 percent CI: 2,690-6,425) birds during autumn and spring, respectively off of Monterey to Sonoma Counties (Point Pinos to Bodega Bay up to 155 mi (250 km) offshore).

**(C) SE Farallon Island; 1999–2007; Warzybok and Bradley 2007—**Using mist net data from 1999 to 2007, Warzybok and Bradley (2007, p. 17) reported preliminary results from analyses of mark/recapture data that suggest increasing capture rates and survival of ashy storm-petrels from 1999 to 2007. Specifically, they reported that the mean standardized capture rate (number of birds caught per hour of effort) increased from approximately 13 birds per hour to 38 birds per hour between 1999 and 2005, but declined slightly in 2006. The mean capture rate for 2007 was 39 birds per hour, but netting effort was low in 2007 (Warzybok and Bradley 2007, p. 7 and 17).

**(S) Bodega Bay to Cypress Point; 1985-1994, 1997–2006; Ainley and Hyrenbach 2010—** Using at-sea data collected along strip transects during annual fishery surveys from Bodega Bay to Cypress Point (south of Monterey Bay), this study estimated that mean ashy storm-petrel densities for 1997–2006 were 76 percent lower than mean densities for 1985–1994. The authors attributed this difference to factors explained by year, suggesting a long-term decline not explained by changes in ocean conditions. The authors suggest that changes in breeding habitat at SE Farallon Island were likely the main factors regulating the ashy storm-petrel population (p. 252). This study used data collected during May and June, which is the height of nesting season. Their estimate of 1985-1994 densities included data from 2 years of unusually high densities (1991 and 1992), when ashy storm-petrel abundances were about twice that of any other year in the study. These 2 years were during an El Niño event, which may have affected the ashy storm-petrel's at-sea distribution. The authors do not discuss the high densities in 1991 and 1992, or those two years' contribution to their finding of a decline. These ship-based transects were designed for rock fish recruitment assessment; timing and survey track lines of individual sweeps varied slightly from year to year, and sampling effort and number of days sampled per year also varied considerably (Ainley and Hyrenbach, pp. 243–250).

**(C) SE Farallon Island; 1992–2010; Bradley *et al.*** (2011) assessed the status of seabirds on Southeast Farallon Island for the 2011 breeding season using mist net capture data. This study used mist net captures to derive an index of the number of birds captured per unit effort (CPUE) during mist netting on SE Farallon Island. While CPUE varied considerably from year to year, Bradley *et al.* 2011 (p. 7) found that the mean CPUE for early July for 2002–2010 was double the mean early July CPUE from 1992–2001. This was a strongly significant result, suggesting higher colony attendance in the second decade of the study (Bradley *et al.* 2011, pp. 7, 24). While the number of ashy storm-petrels on SE Farallon Island appears to have increased in recent years (Table 1, Figure 4), the effect of year-to-year variation on capture rates described the data better than any trend over time (Bradley *et al.* 2011, p. 7, p. 10). Bradley *et al*. (2011, p. 9) suggested that adult survival could be the best way to measure ashy storm-petrel population trends.

**(C) SE Farallon Island; 1971–2011; Warzybok and Bradley 2011—**This study found ashy storm-petrels had lower productivity in 2011 than in 2010, but overall breeding performance was close to or slightly below the long-term mean (Warzybok and Bradley 2011, p. 5). However, in 2011, the mean number of birds captured was 34 birds per hour, the highest rate since 2007, and the second highest for the 1992-2011 period with comparable data (Bradley *et al*. 2011, p. 23). Nest site occupancy and total breeding sites were higher than in previous seasons (Warzybok and Bradley 2011, p. 9).

**(C) SE Farallon Island; 2000-2012; Nur *et al.* 2013 —**The purpose of the Nur *et al*. (2013) study was to evaluate the management benefits of house mouse eradication from the SE Farallon Islands, not to determine future trends in ashy storm-petrel populations on the Island or estimate time to extinction. In addition to analyzing impacts of owl predation on storm-petrel adult survivorship, the study analyzed recent trends in the ashy storm-petrel population index for the SE Farrallon Islands, which is based on mist-netting, and used recent estimated trends to model potential future storm-petrel population trends with and without a reduction in overwintering burrowing owls. However, the models used are not calculating absolute estimates of population viability or growth rates, but relative viabilities or population growth rates for the purpose of comparing several management options (Nur *et al.*2013, p.15–16); the latter is recommended as the more reliable interpretation and use for PVA models (Akçakaya and Raphael 1998, p. 891; Beissinger *et al.*1998, p. 832). The efficacy of PVAs for predicting long-term population trends and probability of extinction is widely debated in the literature (Fieberg and Ellner 2000, p. 2046; Coulson *et al.* 2001, p. 221; but see Brook *et al.* 2000, p. 836). PVAs are considered much more reliable for comparing the efficacy of management options, as relative results such as management choices are less sensitive to data gaps or assumptions inherent to any statistical model (Akçakaya and Raphael 1998, p. 891; Beissinger *et al.*1998, p. 833, Coulson *et al.* 2001, p. 221). We also note that this study was limited to the SE Farallon Island population, and not to the entire range of the species.

The Nur *et al.* model uses data from a small number of years to predict future population trends which limits its use in determining the current and future status of the species as a whole. Only the most recent 6 years of ashy storm-petrel population index data was incorporated into the model. Only the most recent 3 years of data were used to obtain an average burrowing owl population size, which the model then used to predict future population trends of ashy storm-petrels. This small subset of data used makes the model's predictions very sensitive to any variations in burrowing owl numbers in the future. A 6 year timeframe is likely too short to produce a significant result with these methods (Nur *et al.* 2013, p. 25). Natural variations and fluctuations in environmental conditions or population parameters are not evaluated in determistic models of the type used in this study. These models indicate that reducing burrowing owls on SE Farallon Island will likely benefit the ashy storm-petrel population on the island. However, because there is no clear long term trend in ashy storm-petrel populations, it is unknown what future population trend trajectory will accurately reflect the effect that burrowing owls will have in the future.

Ashy storm-petrel population trends were examined for the period 2000–2012. Using the best fit model, a change point in trend occurred between 2006 and 2007. Thus, subsequent analysis of ashy storm-petrel trends were split into two different trend sets: one from 2000–2006 and one from 2007–2011. This report found a significant average increase in the ashy storm-petrel population index of 22.1 percent per year from 2000–2006, and a mean non-significant decrease in the ashy storm-petrel population index on SE Farallon Island of 7.19 percent per year from 2007 to 2012 (Nur *et al*. 2013, p. 25). However, this negative trend was not statistically significant and the 7.19 percent value is dependent on the authors' selection of one model as best explaining the ASSP population index trends, using a model-selection approach based on AIC (Akaike Information Criterion) values. However, the selection of that model was not well supported, at least for the purposes of trend analysis, and selecting another model would have yielded a different trend estimate.  Models that differ by less than 2 AIC units are generally considered to be competitive and have substantial support in their ability to explain the data (Anderson and Burnham 2001). The model selected by Nur *et al.* (2013) differed from two competing models by less than 0.1 AIC units and from six competing models by less than 2 AIC units (Nur *et al.* 2013, p. 40). Therefore, several models other than the one they selected have strong support for explaining recent ashy storm-petrel population patterns, and if the trend analysis were based on one of those models, the trend estimate would be different. Nur *et al.* (2013) did not discuss this issue or report population trend estimates based on the competing models.

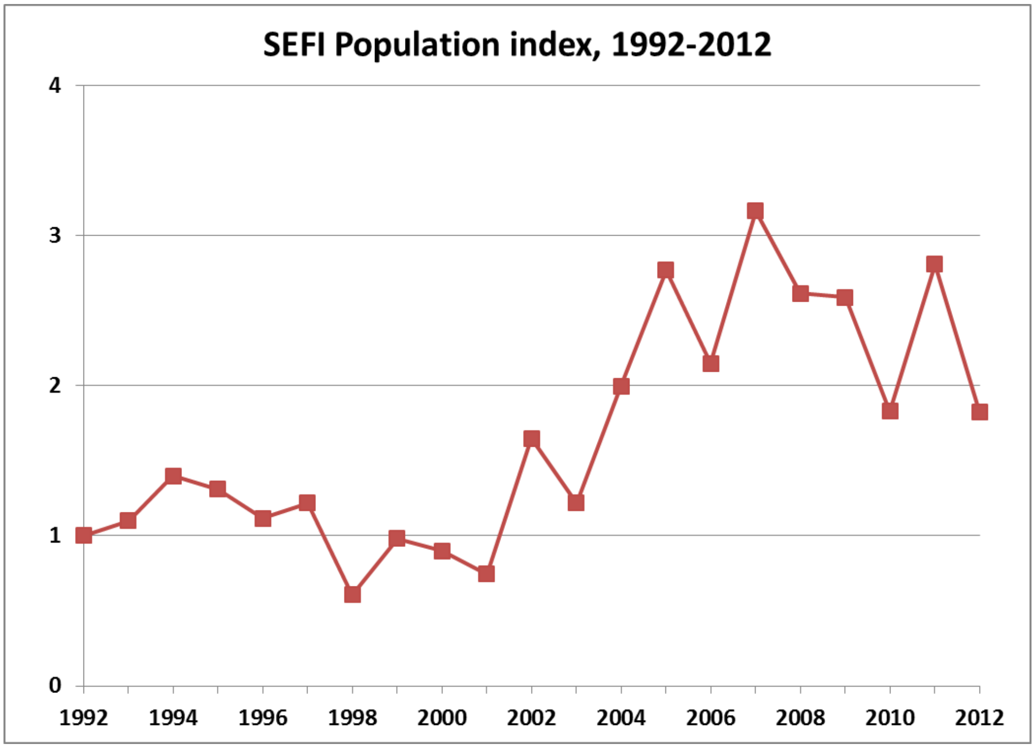
To model potential future ashy storm-petrel projections, the recent estimated trend decline of 7.19% was input into a model to determine what effect the reduction of 50 percent or 71.5 percent of the overwintering burrowing owl population on the island (i.e., due to mouse eradication) would have. Because of uncertainty in this trend estimate and its non-significance, this report also models two other population trend scenerios which the 2012 draft did not. These are a "moderate annual decline (3.4 percent)" (or plus one standard error of the mean) and a "near stable annual trend (0.6 percent increase)" (or plus two standard errors of the mean; near stable scenario). Each of these scenarios models future population trends with "no burrowing owl reduction, 50 percent reduction, and 71.5 percent reduction". The results indicate that a reduction of burrowing owl abundance on SE Farallon Island will decrease instances of burrowing owl predation of ashy storm-petrels on the island. The analysis is sensitive to the timeframes that the data are grouped into. For instance, while a limited group of data (2007-2012) results in a future downward trajectory, using a larger data set would likely result in a different outcome. A longer term data set of petrel and predator population dynamics would be needed to be confident in population trajectories.

Nur *et al*. 2013 (p. 26) used the last three years of ashy storm petrel capture data to estimate the current number of breeding birds on the island. They concluded with a 95 percent confidence interval that there are between 3790 and 8778 breeding birds on SE Farallon Island. This study estimated an average of 5768 breeding birds on the island in 2012. This is a 116.8 % increase from the number of breeding ashy storm-petrels on SE Farallon Island in 1992. Thus, despite projections of a potential decline since 2007, numbers of breeding individuals are estimated to have more than doubled since 1992.

***Summary of Farallon Island Population Trends***

We do not have any comparable colony size data for evaluating population trends before 1992, when standardized mist netting efforts began on SE Farallon Island. The best data available are based on the mist net population index there, and show up and down variation from 1992 to about 2001 (Figure 1, 2). Nur *et al.* 2013 (p. 25) found an average increase in the ashy storm-petrel population index of 22.1 percent per year from 2000–2006, and a mean decrease in the ashy storm-petrel population index on SE Farallon Island of 7.19 percent per year from 2007 to 2012. However, this recent negative trend was not statistically significant and the 7.19 percent value is dependent on the authors' selection of one model as best explaining the ASSP population index trends, using a model-selection approach based on AIC values. However, the selection of that model was not well supported, at least for the purposes of trend analysis, and selecting another model would have yielded a different trend estimate. We conclude that the population is currently experiencing fluctuations due to various factors, including avian predation. After assessing the best available scientific data, we have concluded that there is no consistent long term trend in the species' population nesting on SE Farallon Island.

**Figure 1:** Population Index from Mist Netting Analyses for Ashy Storm-petrels, 1992–2012, from SE Farallon Island (Bradley 2013, pers. comm.). The index is set at 1.0 for 1992 (see Methods section). Index values are presumed directly proportional to abundance of ashy storm-petrels on the island (Nur *et al.* 2013, p. 50). Vertical axis represents variations from the baseline year of 1992.



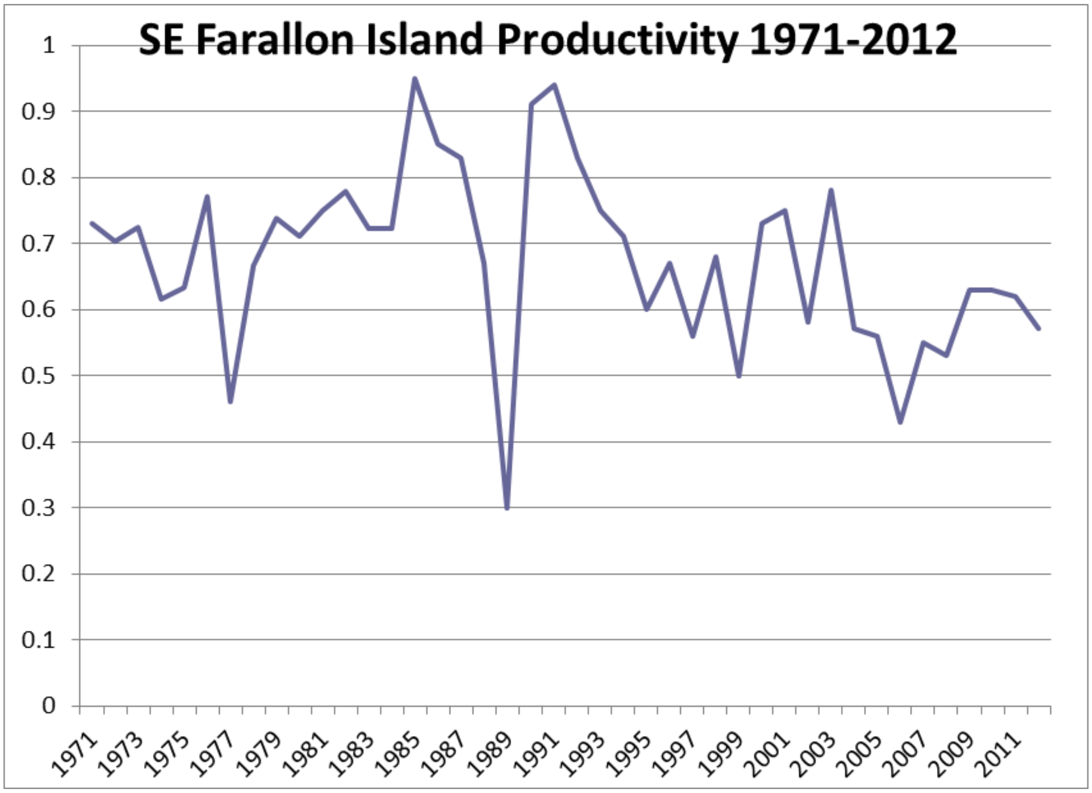

***Farallon Islands Population Productivity***

Productivity of ashy storm-petrels at SE Farallon Island declined from the late 1980s to the mid-1990s (Sydeman *et al.* 2001, p. 315; Center for Biological Diversity 2007, p. 8; Warzybok and Bradley 2007, p. 7). However, recent data indicate that this decline has not continued (Warzybok and Bradley 2011, p. 11, Figure 2). Warzybok and Bradley 2011, (p. 9) reported that occupancy of existing nest sites and total number of breeding sites were higher in 2011 than in previous years. Productivity increased from 2005 to 2008 and has since stabilized (Warzybok and Bradley (2011, p. 11). The productivity rate during 2009–2011 hovered just below the 42-year mean of 0.68 (Warzybok and Bradley 2011, p. 11). In 2012, productivity did drop to 0.57 (Bradley 2012b, pers. comm.).

As indicated in the above paragraph, and by Figure 2, productivity, when measured as chicks fledged per breeding pair, has varied widely on SE Farallon Island since 1971. The Service conducted a trend analysis (linear regression) to test whether there has been a trend in annual productivity on the island over the entire period for which data were available (1971-2012) (PRBO 2013a, unpublished data). That analysis suggests a slight decline in productivity over this period, representing an average decrease in productivity of about 0.0036 chicks fledged per breeding pair per year (95 percent confidence interval: -0.0069 to -0.0003; adjusted R-square of 0.08; $P$ = 0.035) (PRBO 2013a, unpublished data). Because the confidence interval almost includes zero, indicating a weak trend pattern, these results should be interpreted cautiously, and in conjunction with other data.

Productivity is one measure of population status. It is computed on a per-pair basis, and therefore does not take into account the number of birds breeding in a given year, which also affects total annual reproductive output and population trend. As discussed elsewhere here, survivorship is another key parameter affecting ashy storm-petrel population status and trends.

Figure 2: Ashy storm-petrel productivity (chicks fledged per breeding pair) at SE Farallon Island from 1971–2012; the vertical axis is chicks fledged per breeding pair.




### *El Niño and La Niña as related to productivity*

The California Current System, on which ashy storm-petrels rely for food, is affected by interannual (El Niño/La Niña) and interdecadal (Pacific Decadal Oscillation) climatic processes. The El Niño-Southern Oscillation (periodic increased sea-surface temperatures, reduced flow of eastern boundary currents, and reduced coastal upwelling) occurs in the Pacific Ocean roughly every 2 to 7 years (Norton and McLain 1994; pp. 16,019–16,030; Schwing *et al.* 2002, p. 461; National Oceanic and Atmospheric Association (NOAA) 2012, no pagination). La Niña events (sometimes called anti-El Niño or cold-water events) in the northeast Pacific Ocean tend to be the reverse of El Niño events; during La Niña events, strong winds that facilitate upwelling and a shallow thermocline (zone of rapid temperature change with increased depth that typically separates warm and cold water) result in colder, more nutrient-rich waters than usual

(Murphree and Reynolds 1995, p. 52; Oedekoven *et al.* 2001, p. 266). In addition to interannual climate events such as El Niño and La Niña, the mid-latitude Pacific Ocean experiences warm and cool phases that occur on decadal (10 year) time scales (Mantua 2000, p. 2). The Pacific Decadal Oscillation describes long-term climate variability in the Pacific Ocean, in which there are observed warm and cool phases, called regime shifts (Mantua *et al.* 1997, pp. 1069–1079). Because there are no officially recognized El Niño years (NOAA Earth System Research Library 2012, no pagination), we will refer to years with warm ocean conditions simply as warming events.

Since monitoring of ashy storm-petrels in 1971, warming events occurred in 1972–73, 1976–1977, 1982–83, 1991–1993, 1997–1998, 2002–2003, 2005–2006, 2009–2010 (Center for Ocean Atmospheric Prediction Studies 2012, no pagination; NOAA National Weather Service 2012, no pagination). Warming events usually start in October and end in September of the following year, although there is much variation (COAPS 2012, no pagination). Monitoring of ashy storm-petrels was initiated in 1971 (Figure 2). The symbol *n* refers to the number of birds that were analyzed for the study. During warming years, ashy storm-petrel productivity (chicks fledged per breeding pair) was 0.64 in 1972 ($n$ = 36) and 0.69 in 1973 ($n$ = 35); 0.81 in 1976 ($n$ = 37); 0.75 in 1982 ($n$ = 28) and 0.67 in 1983 ($n$ = 18) (Ainley and Boekelheide 1990, p. 392); 0.56 in 2005 and 0.48 in 2006 (Warzybok *et al.* 2006, p. 7). These results show that in all but 2 years (2005–2006), ashy storm-petrel productivity was at or near the 35-year mean of 0.68 during warming events.

Ainley (1990b, p. 371) reported that breeding by other seabirds at SE Farallon Island was poor to nonexistent during the warming events in 1973, 1976, 1978, 1982, and 1983. Similarly, a delay in the onset of spring upwelling in the northern California Current resulted in breeding failures of Cassin's auklets (*Ptychoramphus aleuticus*) at SE Farallon Island and Triangle Island, British Columbia, in 2005 (Warzybok *et al.* 2006, pp. 12–14). Upwelling of warmer, nutrient-depleted waters during warming events leads to breeding failures, mortality, and population declines throughout the food web (Barber and Chavez 1983, pp. 1203–1210). Like Cassin's auklets, ashy storm-petrels feed on krill; however, as noted earlier, ashy storm-petrels did not fail to breed on SE Farallon Island in 2005 when Cassin's Auklets suffered near reproductive failure. In 2006, when Cassin's auklets again suffered near reproductive failure at SE Farallon Island for the second straight year, likely as a result of warm-water conditions, reduced upwelling, and reduced availability of krill, or a delay in the onset of spring upwelling, ashy storm-petrels did breed but had lower productivity (Warzybok *et al.* 2006, p. 14). Unlike Cassin's auklets, ashy storm-petrels have more extended incubation and chick-rearing periods (per egg-laying effort), and feed over a wider geographic area; thus, they are likely more able to exploit other similar food resources when these resources are reduced or more patchily distributed.

Some species of seabirds have experienced breeding failures that can be linked to El Niño events, warmer water, or decreased food resources. However, productivity of the ashy storm-petrel over the past approximately 38.4 years does not show breeding failures in those same years. Ainley (1990b, pp. 357–359) reported that ashy storm-petrels showed the lowest interannual variability in productivity of any species breeding at SE Farallon

Island, for the years 1971–1983. Since regular annual monitoring of nesting activities began at SE Farallon Island (in 1971) and at Santa Cruz Island (in 1994), researchers have observed ashy storm-petrel populations breeding each year; no clear correlation between warm-water years and reduced reproductive success (productivity) was evident (Ainley and Boekelheide 1990, p. 392; McIver *et al.* 2009b, p. 277). The only responses to El Niño conditions were smaller numbers of ashy storm-petrels breeding and delayed egg laying (later in the season than in other years); timing of breeding was later in 1998, an El Niño year (Ainley and Boekelheide 1990, p. 392; Ainley *et al.* 1990, pp. 149–150). Catch per Unit Effort (CPUE) was also lower during 1998 (Bradley *et al.* 2011, p. 7), but again, this was not reflected in all El Niño years. See ***Farallon Islands Population estimates and trends*** above.

### *Channel Island Population Estimates and Trends*

The Channel Islands population comprises an estimated 36 percent of the total ashy storm-petrel population. We currently have no published studies of population trends on the Channel Islands. The best available scientific and commercial information we have consists of data collected using varying methods and incomplete analyses. As a result, these data are interpreted with caution, and are described below.

**(C) Santa Barbara Island and Anacapa Islands; 1999-2011; Harvey 2012—**Harvey 2012 provided a preliminary comparison of raw capture rates for 1999 vs. 2010-2011 based on mist netting data. As noted by Harvey (2012), their data have not yet been standardized (for moon phase, weather, net type, location, etc.), which should be done prior to publishing or other rigorous comparisons of changes over time. Due to relatively high variability in mist-net captures between geographic locations, nights, etc., capture efforts in 1999 and 2009-2011 may not have been adequate for comparing average annual capture rates between years. Comparisons have not yet been attempted between 2010-2011 and the extensive mist-net data gathered in 1991 (Carter *et al*. 1992) or limited mist-net data obtained in other years (e.g., 1994, 2004; Adams and Takekawa 2008; H.R. Carter, unpubl. data). The Service will consider any future complete analysis of these data in our ongoing review of the species status.

**(S) Cambria, San Luis Obispo County, California to the California-Mexican Border; 1975-1983, 1999-2002; Mason 2007—**Mason *et al.* (2007, p. 94) observed a 450 percent increase in ashy storm-petrel at-sea densities in the years 1999–2002 compared to 1975–1983, in the Southern California Bight (Mason *et al.* 2007, p. 94). However, during this interval, there was little change in ashy storm-petrel colony sizes in the Southern California Bight, suggesting that these increases may reflect differences in survey methods and coverage, and not actual population changes (Mason *et al.* 2007, p. 94).

### *Channel Islands Population Productivity*

Hatching and breeding (combined hatching and fledging) success of ashy storm-petrels on Santa Cruz Island has improved in recent years (2005–2008) in comparison to 1995–

1998 (McIver *et al.* 2009b, p. 275). Also, breeding (combined hatching and fledging) success from 2005–2011 is higher than average breeding success from 1995–1998 (Table 2), mainly reflecting (greater) hatching success (McIver *et al.* 2012a, p. 29). Reduced egg breakage due to reduced levels of organochlorines may be partly responsible for the improvement in reproductive success (McIver *et al.* 2009b, p. 275, McIver *et al.* 2012a, p. 29).

As done for Farallon Islands population productivity, the Service conducted a trend analysis (linear regression) to test whether there has been a trend in annual productivity in the Channel Islands, based on available productivity data from Santa Cruz Island from 2005-2011. That analysis suggests an increase in natural productivity (excluding artificial nest sites) over this period for the monitored population, representing an average annual increase in productivity of about 0.0261 chicks fledged per breeding pair (95 percent confidence interval: 0.0053 to 0.0468; adjusted R-square of 0.61; $P$ = 0.023) (Table 2). While this shows an increase in productivity over this period, the data represent a relatively small number of years, and are not indicative of longer trends. Therefore, these results should be interpreted cautiously, and in conjunction with other data. Productivity is one measure of population status. It is computed on a per-pair basis, and therefore does not take into account the number of birds breeding in a given year, which also affects total annual reproductive output and population trend. As discussed elsewhere here, survivorship is another key parameter affecting ashy storm-petrel population status and trends.

**Figure 3:** Channel Islands Productivity Trends: Chicks fledged per pair in 2005-2011; the vertical axis is chicks fledged per pair.

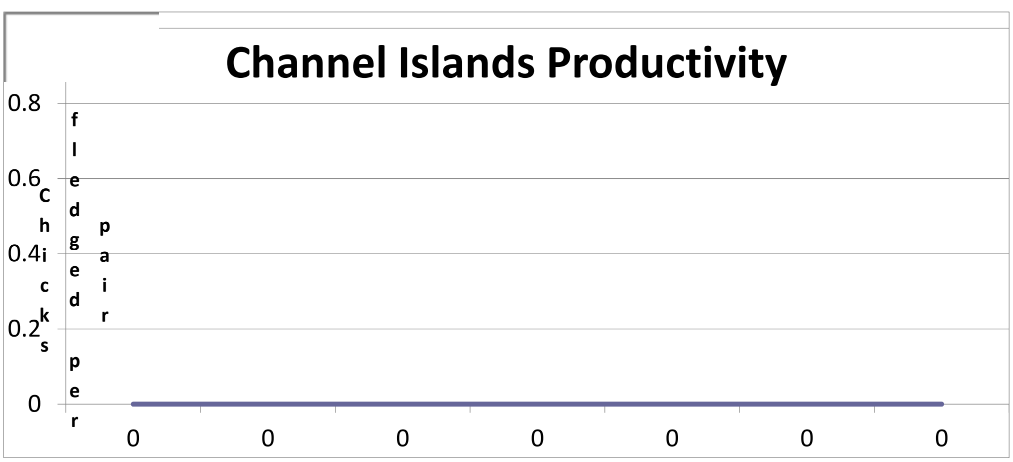



**Table 2:** Annual Breeding Success of Ashy Storm-petrels at Five Locations (Bat Cave, Sandy Beech Cave, Cave of Birds Eggs, Orizaba Rock, on Santa Cruz Island, 1995–2012.

| Location | Year (s) | Chicks Fledged per Pair | Artificial and Natural Site Productivity | Source |
|---|---|---|---|---|
| Santa Cruz Island | 1995 | 0.54 (n=124) | | McIver *et al.* 2007, p. 273 |
| Santa Cruz Island | 1996 | 0.45 (n=173) | | McIver *et al.* 2007, p. 273 |
| Santa Cruz Island | 1997 | 0.65 (n=134) | | McIver *et al.* 2007, p. 273 |
| Santa Cruz Island | 1998 | 0.65 (n=46) | | McIver *et al.* 2007, p. 273 |
| Santa Cruz Island | 2005 | 0.58 (n=76) | | McIver *et al.* 2007, p. 273 |
| Santa Cruz Island | 2006 | 0.68 (n=57) | | McIver *et al.* 2007, p. 273 |
| Santa Cruz Island | 2007 | 0.65 (n=80) | | McIver *et al.* 2007, p. 273 |
| Santa Cruz Island | 2008 | 0.70 (n=80) | .69 (n=84) | McIver *et al.* 2009a, p. 24 |
| Santa Cruz Island | 2009 | 0.69 (n=131) | .69 (n=137) | McIver *et al.* 2010, p. 26 |
| Santa Cruz Island | 2010 | 0.68 (n=120) | .66 (n=126) | McIver *et al.* 2011, p. 15 |
| Santa Cruz Island | 2011 | 0.81 (n=103) | .79 (n=110) | McIver *et al.* 2012, p. 17 |
| Santa Cruz Island | 1995-1998 | 0.55 (n=477) | | McIver *et al.* 2009b, Table 4 |
| Santa Cruz Island | 2005-2011 | 0.65 (n=293) | | McIver *et al.* 2009b, Table 4 |

## VI. THREATS TO ASHY STORM-PETREL

We used the guidelines developed by NatureServe (Masters *et al.* 2009) to define terms and to structure our threats assessment for the ashy storm-petrel. The threats assessment is in the format of a five factor analysis. In the following discussion of current and future threats to the ashy storm-petrel, we will consider how threats categorized under each of the five factors below are affecting the species. At the conclusion of each section, we will indicate the timing, scope, and severity of the potential threat. The scope of the threat was derived from the overall percentage of the species that is potentially impacted by the threat and can be found in Table 3. This number is based on the most recent estimates of breeding population at nesting colonies. We stress that these are estimates and not the exact number of birds at each location. However, this is the best scientific data available to us at this time.

## Definition of Terms

### *Breeding Occurrences*

Breeding occurrences are the islands or rock formations where ashy storm-petrels are known to breed, based on observations of eggs at these locations. However, at Seal Cove Rocks, San Clemente Island, an ashy storm-petrel was observed in breeding posture, which served to confirm breeding. To limit disturbance, the bird was not flushed and, therefore, no egg was observed. Potential occurrences (locations where there is some evidence of nesting, but no eggs have been observed) are listed in Table 1, but will not be included in the threats analysis because we do not have data to verify or quantify these locations.

### *Scope*

Scope is the percentage of the species' occurrences or population affected by a particular threat. For instance, burrowing owls are only known to be a threat on the Farallon Islands. The ashy storm-petrel population that resides on the Farallon Islands is 56.47 percent of the total population, between 31 and 70 percent of the species' total population; therefore, according to the NatureServe categories, the scope is "large."

### *Threats*

Threats are the activities or processes that have caused, are causing, or may cause in the future the destruction and/or degradation and/or impairment of ashy storm-petrel or its habitat. Threats are primarily related to human activities, but can be natural events. Impacts of human activities may be direct, such as destruction of habitat, or indirect, such as introduction of invasive species. Threats may be observed, inferred, or projected to occur in the near term. Overlaying threats, such as human population growth, will not be included in this analysis.

### *Past Threats*

Past threats are not used in the scope or severity calculations. Effects of past threats (if not continuing) are taken into consideration when determining long-term and/or short-term trends.

## Classification of Threats

For each threat that is identified, the scope, severity, and timing are determined. Although the average lifespan of ashy storm-petrel is unknown, reproduction is known to commence by age 6 (Sydeman *et al.* 1998b, p. 7). Assuming the average age of first breeding is 5.5 years and adult survivorship is 0.88 (Nur *et al*. 2013, pp. 15-16 and 22), then an ashy storm-petrel generation time would be 12.8 years, based on a published method of calculating generation time for birds (Saether *et al*. 2005, pp. 1-4). Using a standard 3-generation timeframe to assess risk (following the NatureServe approach), we calculated this to be approximately 38.4 years (13-year generation time multiplied by 3 generations). However, the long-term threat of sea level rise due to climate change will be assessed for 2030, 2050, and 2100 due to the temporal scope of existing climate model predictions.

*Scope of the Threat*

Scope is the proportion of the ashy storm-petrel breeding occurrences that can reasonably be expected to be affected by a threat within three generations, given continuation of current circumstances and trends. Current circumstances and trends include both existing and potential new threats.

Scope Categories:

**Pervasive—**affects all or most (71–100 percent) of the total population or occurrences

**Large—**affects much (31–70 percent) of the total population or occurrences

**Restricted—**affects some (11–30 percent) of the total population or occurrences

**Small—**affects a small (1–10 percent) proportion of the total population or occurrences

**Negligible—**affects a negligible (less than 1 percent) proportion of the total population or occurrences

*Severity of the Threat*

Within the scope of the threat, the severity is the level of damage to ashy storm-petrel populations or breeding occurrences that can reasonably be expected from the threat within three generations, given continuation of current circumstances and trends. For instance, sea level rise is expected to affect 2.94 percent of the ashy storm-petrel population. The severity will be derived based only on the effect to this 2.94 percent of the population. Severity is measured as the degree of declines in ashy storm-petrel populations or the degree of degradation or decline in the integrity of ashy storm-petrel habitat.

Severity categories:

**Extreme—**likely to destroy or eliminate the habitat or reduce the species' population by 71–100 percent

**Serious—**likely to destroy or eliminate the habitat or reduce the species' population by 31–70 percent

**Moderate—**likely to destroy or eliminate the habitat or reduce the species' population by 11–30 percent

**Slight—**likely to destroy or eliminate the habitat or reduce the species' population by 1–10 percent

**Negligible—**likely to destroy or eliminate the habitat or reduce the species' population by less than 1 percent

*Timing of the Threat*

Although timing (immediacy) is recorded for threats, it is not used in the calculation of threat impact. Additionally, threat impact is not calculated for threats where timing values are long-term future or past/historical.

Timing Categories:

**Ongoing**—continuing (a threat now).

**Near-term future**—only in the future (could happen in the short-term (<3 generations)), or now suspended, but could come back in the short-term.

**Long-term future**—only in the future (could happen in the long-term (>3 generations)) or now suspended but could come back in the long-term.

**Past/Historical**—only in the past and unlikely to return, or no direct effect.

The following table presents information on threats. Immediately below the table, we describe these threats in detail and explain our rationale for each of the scope and severity conclusions.

**Table 3:** Potential threats to ashy storm-petrel

| Factor—Threat | Areas Present | Scope (percent Population Affected) | Scope | Severity (Percent reduced within the scope) | Severity (Population or Habitat) | Timing |
|---|---|---|---|---|---|---|
| A—Climate Change: Warming: Increased El Niño years and decreased ocean productivity | everywhere | 100% | pervasive | 1–10% | slight | ongoing |
| A—Climate Change: Ocean acidification | everywhere | 100% | pervasive | 1–10% | slight | ongoing |
| A—Climate Change: Sea level rise | nests below 167 cm (5.48 ft) (NAS 2012) above mean sea level at Santa Cruz Island, Shipwreck Cave, Dry Sandy Beach Cave, Del Mar Rock, Cave of Bird Eggs, Bat Cave, Cavern Point Caves, Ship Rock, Santa Catalina Island | 2.94% | small | 31–70% | serious | ongoing |

| | | | | | | |
|---|---|---|---|---|---|---|
| A—Human presence | Everywhere except SE Farallon Island | 42.28% | large | <1% | negligible | ongoing |
| A—Introduced New Zealand spinach | SE Farallon Island | 56.47% | large | 1–10% | slight | ongoing |
| A—Military Activities | San Clemente Island, Seal Cove Rocks | 0.52% | negligible | 1–10% | slight | ongoing |
| B—Scientific purposes | Everywhere nests are accessible | 100% | pervasive | <1% | negligible | ongoing |
| B—Recreational purposes | all locations, except for SE Farallon | 42.28% | large | <1% | negligible | ongoing |
| C—Burrowing Owl predation | SE Farallon | 56.47% | large | 1–30% | slight/moderate | ongoing |
| C—Western Gull predation | SE Farallon | 56.47% | large | 1–30% | Slight/moderate | ongoing |
| C—Mouse predation | Santa Cruz Island, Farallon Island | 60.61% | large | <1% | negligible | ongoing |
| C—Raven predation | Orizaba Rock | 0.67% | negligible | 11–30% | moderate | ongoing |
| C—Barn Owl predation | everywhere | 100% | pervasive | 1–10% | slight | ongoing |
| C—Island spotted skunk predation | Santa Cruz sea caves | 2.79% | small | 11–30% | moderate | near term future |
| C—Disease | mainland Santa Catalina and San Clemente Islands | unknown | unknown | <1% | negligible | N/A |
| E—Artificial light: Squid fishing | everywhere squid fishing is permitted | 100% | pervasive | 1–10% | slight | ongoing |
| E-Artificial light: Oil platforms | all Channel Island breeding locations | 37.62% | large | 1–10% | slight | ongoing |
| E—Oil spill: Offshore energy platforms | all Channel Island breeding locations | 37.62% | large | 1–10% | slight | near term future/ long term future |

| | | | | | | |
|---|---|---|---|---|---|---|
| E—Oil spill: Vessels | everywhere | 100% | pervasive | 1–10% | slight | near term future/ long term future |
| E—Organochlorine contaminants | everywhere | 100% | pervasive | 1–10% | slight | ongoing |
| E—Ingestion of plastics | everywhere | 100% | pervasive | 1–10% | slight | ongoing |

**Factor A: The Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range**

Climate change

Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (for example, temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see IPCC 2007a, p. 30; and Solomon *et al*. 2007, pp. 35–54, 82–85). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007a, pp. 5–6 and figures SPM.3 and SPM.4; Solomon *et al*. 2007, pp. 21–35). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011, p. 4), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (for example, Meehl *et al*. 2007, entire; Ganguly *et al*. 2009, pp. 11555, 15558; Prinn *et al*. 2011, pp. 527, 529). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2007a, pp. 44–45; Meehl *et al*. 2007, pp. 760–764 and 797–811; Ganguly *et al*. 2009, pp. 15555–15558; Prinn *et al*. 2011, pp. 527, 529). (See IPCC 2007b, p. 8, for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation. Also see IPCC 2011(entire) for a summary of observations and projections of extreme climate events.)

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). Identifying likely effects often involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007a, p. 89; see also Glick *et al.* 2011, pp. 19–22). There is no single method for conducting such analyses that applies to all situations (Glick *et al.* 2011, p. 3). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Global climate projections are informative, and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (for example, IPCC 2007a, pp. 8–12). Therefore, we use “downscaled” projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick *et al*. 2011, pp. 58–61, for a discussion of downscaling). With regard to our analysis for the ashy storm-petrel, downscaled projections are available. We describe the effects of ocean acidification, ocean warming, and sea level rise below.

*Ocean Acidification*

The ocean is becoming increasingly acidic, a process known as ocean acidification. This has implications for all organisms in the ocean food web. While the diet of ashy storm-petrels has not been extensively studied, based on the diets of other storm-petrel species they likely feed on euphausiids, other krill, juvenile lanternfish, fish eggs, and other small fish that occur at the surface of the ocean. These prey items have the potential to be negatively affected by ocean acidification.

Human industrial and land-use activities have resulted in increased atmospheric concentrations of carbon dioxide (Feely *et al.* 2004, p. 362). For at least the previous 650,000 years, and likely the last 20 million years (Anarctic Climate Ecosystems 2008, p. 4), atmospheric carbon concentrations ranged between 180 and 300 parts per million (ppm) (Siegenthaler *et al.* 2005, p. 1316). Since the industrial revolution, atmospheric carbon concentrations have been rising, and are now at 395 ppm (Scripps 2013, no pagination). Much of this carbon dioxide is absorbed by the oceans (Caldiera and Wickett 2003, p. 365; Sabine *et al.* 2004, p. 370).

The chemical processes that cause ocean acidification are well known. Increases in carbon dioxide in the atmosphere cause corresponding increases in carbon dioxide levels in the ocean. When carbon dioxide dissolves in water, carbonic acid is formed, most of which quickly dissociates into a hydrogen ion and a bicarbonate ion; the hydrogen ion can further react with a carbonate ion to form bicarbonate (Fabry *et al.* 2008, p. 415). The effects of increased carbon dioxide absorption by the oceans include an increase in the concentrations of carbonic acid, bicarbonate, and hydrogen ions; a decrease in the concentration of carbonate; and a reduction in pH level of the seawater (Caldiera and Wickett 2003, p. 365; Royal Society *et al.* 2005, p. 16; Fabry *et al.* 2008, p. 415). Generally, oceanic surface waters are saturated with calcium carbonate and deeper waters are undersaturated. The depth where waters transition from saturated to unsaturated is called the saturation horizon (Hardt and Safina 2008, p. 2). Once formed, calcium carbonate will dissolve back into the water unless the surrounding seawater contains sufficiently high concentrations of carbonate ions (Royal Society *et al.* 2005, p. 10).

Inorganic carbon in the ocean is largely responsible for the pH (the measure of acidity) of seawater. Pure water has a pH of 7, solutions below pH 7 are acidic, and solutions above pH 7 are alkaline (basic) (Hardt and Safina 2008, p. 1). Oceans are slightly alkaline, with a pH of 8.1 (at latitude 30°N, approximately; Caldiera and Wickett 2005, p. 5). Measurements of surface ocean pH in 2005 were 0.1 unit lower (more acidic) than preindustrial values (prior to the 1850s), and could become 0.3 to 0.4 units lower by the end of the 21st century (Caldiera and Wickett 2005, p. 5). A recent study by Sunda and Cai (2012) suggests that input of nutrients from land runoff can further increase acidification in some coastal waters.

Marine organisms that produce shells, such as corals, mollusks, echinoderms, and crustaceans (including krill), require carbonate ions to produce their calcium carbonate shells and skeletons (Orr *et al.* 2005, p. 681; Fabry *et al.* 2008, p. 415). A reduction in carbonate ions causes all forms of calcium carbonate to dissolve at shallower depths, and reduces the rate at which marine organisms can produce calcium carbonate (Hardt and Safina 2008, p. 2). This reaction of excess carbon dioxide with seawater reduces the availability of carbonate ions necessary for shell and skeleton formation for these organisms (Fabry *et al.* 2008, p. 415).

The ecological effects of changing ocean carbonate chemistry are uncertain due to the complexities of marine ecosystems, and research to date has focused on the impact of acidification on calcifying organisms (Antarctic Climate & Ecosystems Cooperative Research Centre 2008, p. 7). Although the chemical processes associated with ocean acidification and the biological processes involving the transport of carbon in the oceans have been studied and described in detail, little research has been conducted to assess the response of many zooplankton populations to ocean acidification (Fabry *et al.* 2008, p. 426).

The major planktonic calcium carbonate producers in the ocean are coccolithophores (single-celled phytoplankton), foraminifera (amoeboid protists), and pteropods (marine mollusks) (Fabry *et al.* 2008, p. 417). Marine organisms act as "biological pumps," transferring carbon dioxide and nutrients from the ocean surface to the deeper ocean and ocean bottom (Zondervan *et al.* 2001, p. 507; Chen *et al.* 2004, p.18).

Yamada and Ikeda (1999, pp. 62–67) tested the acute (lethal) effects of lowered pH levels upon *Euphausia pacifica*, a species of krill that occurs in the northern Pacific Ocean and is a known prey item of ashy storm-petrels. Observing 5 juveniles and 20 nauplii (the free-swimming first stage of the larva), Yamada and Ikeda (1999, p. 65) found increased mortality with increased exposure time and decreased pH (less than 6.9). Based on this data, they suggested that the ability to tolerate lowered pH may be highly variable between and possibly within species, as in the case of nauplii and juveniles of *Euphausia pacifica* (Yamada and Ikeda 1999, p. 66). Yamada and Ikeda (1999, p. 66) also suggested that studies on pH levels that induce chronic (sublethal) effects would provide a more appropriate estimate of the long-term consequences to a given zooplankton population, because zooplankton may survive exposure to lower pH levels but be unable to produce normal offspring. Watson *et al.* (2012, p. 1) showed that skeletal calcium carbonate decreased with latitude, decreasing seawater temperature, and decreasing seawater carbonate saturation state in a number of species, including echinoids, bivalves and gastropods.

The timing of ocean acidification is "ongoing" and the scope is "pervasive," having the potential to affect the entire range of ashy storm-petrel. Our review of the available information did not reveal any diet studies or measurements of chick growth and weight that indicate that ashy storm-petrels are eating fewer euphausiids or are providing less food to their chicks. Although the processes and potential effects of ocean acidification on biological food webs have been described, and experimental research on *Euphausia pacifica* has tested lethal effects of exposure to low pH, we are not aware of any information that demonstrates a direct link between ocean acidification and reduced abundance and survival of prey items on which ashy storm-petrels depend. Therefore, we conclude that the severity of ocean acidification is "slight" (likely to destroy or eliminate the habitat or reduce the ashy storm-petrel population by 1–10 percent).

*Ocean warming*

Behrenfeld *et al.* (2006, pp. 752–755) described significant global declines in net primary production between 1999–2004, attributed to reduced nutrient enhancement due to warmer ocean surface temperatures during that period. Some species of seabirds have experienced breeding failures in certain years, which can be linked to warmer water or lower primary productivity. Warming oceans have the potential to negatively affect ashy storm-petrel by limiting food resources available to the species.

Roemmich and McGowan (1995, pp. 1324–1326) described 43 years (1951–1993) of observations off the southern California coast. They reported that zooplankton decreased by 80 percent, and that surface temperatures along transects off Point Conception and Orange County warmed by an average of 2.2 degrees Fahrenheit (°F (1.2 degrees Celsius (°C)) and 2.3 °F (1.6 °C), respectively, during this period. They suggested that the zooplankton decline was directly related to, and caused by, the observed warming of the ocean (Roemmich and McGowan 1995, p. 1325).

Warming events as they may affect ashy storm-petrel productivity has been discussed above under "El Niño and La Niña as related to productivity". As discussed in detail there, eight warming events have occurred since ashy storm-petrel monitoring began on SE Farallon Island in 1971. Monitoring results show that in all but 2 years (2005–2006), ashy storm-petrel productivity was at or near the 35-year mean during warming events. Although many seabird species exhibit breeding failures in years that exhibit oceanic warming events, productivity of the ashy storm-petrel over the past approximately 38.4 years does not show a pattern of breeding failures in those same years.

The timing of oceanic warming is "ongoing" and the scope is "pervasive," having the potential to affect the entire range of ashy storm-petrel. However, ashy storm-petrel productivity was at or near the 42-year mean of 0.68 during all but two warming years since 1971, an indication that the ashy storm-petrel is less affected by changes in ocean productivity than other species. Therefore, we conclude that the severity of oceanic warming into the near future is "slight" (likely to destroy or eliminate the habitat or reduce the ashy storm-petrel population by 1–10 percent).

*Sea Level Rise*

Sea level rise has the potential to decrease nesting habitat availability due to flooding. We evaluated different projections of sea level rise to estimate future climate effects on ashy storm-petrel nesting habitat. The National Academy of Sciences (NAS) projected that sea levels along the California coast south of Cape Mendocino will rise 4–30 centimeters (cm) (2–12 inches (in)) by 2030, 12–61 cm (5–24 in) by 2050, and 42–167 cm (16–66 in) by 2100 (NAS 2012, p. 131) compared to 2000 sea levels. Research indicates that the coastal land area south of Cape Mendocino is sinking at an average rate of about 1 millimeter (mm) (.04 in) per year, although Global Positioning System (GPS)-measured rates vary widely (-3.7–0.6 mm per year) (NAS 2012, p. 93). The NAS committee used output from global ocean models under an IPCC (2007) mid-range greenhouse gas emission scenario (NAS 2012, p. 5). However, carbon dioxide emissions from fossil fuels for the past decade have been at the high end of IPCC scenarios owing to rapid economic growth in developing countries (Le Qu´er´e *et al.* 2009). We consider the maximum values of sea level rise to be both feasible and possible. Because modeling of climate change to the year 2100 is routine in literature, and the IPCC predictions are the most widely accepted version of the best available scientific data about future sea level conditions, we consider the effects of sea level rise on the ashy storm-petrel through the end of the 21st century. Because emissions for the last decade have been on the high end of the IPCC scenarios, a maximum rise of 5.48 feet (ft) (167 cm) by 2100 is appropriate for analyzing the impact of sea level rise on storm-petrel colonies.

Future sea levels along the coast of California will likely depend upon many factors, including future changes in global temperatures, lag time between atmospheric changes and oceanic reactions, thermal expansion of ocean water, effects of atmospheric temperature changes on Antarctica, melting of Greenland ice and other glaciers, and local subsidence and uplift of coastal areas (California Coastal Commission 2001, p. 12). Gradual sea level rise progressively worsens the impact of high tides (through erosion and submersion), surge, and waves resulting from storms (Cayan *et al.* 2008, pp. S57–S58). Areas with steep sea walls (southern California) with limited beach habitat are expected to have the most severe losses (Galbraith *et al.* 2002, pp. 173–183). In addition to the rising height of the seas, timing and duration of extreme water heights in the San Francisco Bay vicinity are expected to increase from the current 9 hours per decade to hundreds of hours by 2050 and several thousand hours per decade by 2100 (NAS 2012, p. 131). These increased extreme water height events will impact coastal rocks and islands throughout the range of the ashy storm-petrel.

We reviewed topographic maps and information provided in Sowls *et al.* (1980), Bunnell (1988), and Carter *et al.* (1992; 2006a; 2006b) to estimate the elevations of known ashy storm-petrel nesting habitat at 26 (out of 32) known breeding locations for which we have elevation data. We do not have elevation data for six of the occurrence locations. This information is presented in Table 4.

**Table 4**. Estimated range of elevation above sea level (ASL) in feet (ft) and meters (m) of known nesting habitat of ashy storm-petrels.

| Location Number | Breeding Location Name | Elevation (ASL) |
|---|---|---|
| 1 | Bird Rock near Greenwood, Mendocino County | 10–40 ft (3–12 m) |
| 2 | Caspar, near Point Cabrillo, Mendocino County | 10–40 ft (3–12 m) |
| 3 | Bird Rock, Marin County | 10–40 ft (3–12 m) |
| 4 | Stormy Stack, Marin County | 10–50 ft (3–15 m) |
| 5 | SE Farallon Island | 10–330 ft (3–100 m) |
| 6 | Castle/Hurricane Colony Complex, Monterey County | 10–100 ft (3–30 m) |
| 7 | Castle Rock, Santa Barbara County | 20–80 ft (6–24 m) |
| 8 | Prince Island | 20–300 ft (6–91 m) |
| 9 | Shipwreck Cave, Santa Cruz Island | 5–15 ft (1.5–5 m) |

| | | |
|---|---|---|
| 10 | Dry Sandy Beach Cave, Santa Cruz Island | 5–15 ft (1.5–5 m) |
| 11 | Del Mar Rock, Santa Cruz Island | 5–20 ft (1.5–6 m) |
| 12 | Cave of the Birds Eggs, Santa Cruz Island | 5–10 ft (1.5–3 m) |
| 13 | Diablo Rocks, Santa Cruz Island | 10–40 ft (3–12 m) |
| 14 | Orizaba Rock, Santa Cruz Island | 10–30 ft (3–9 m) |
| 15 | Bat Cave, Santa Cruz Island | 5–20 ft (1.5–6 m) |
| 16 | Cavern Point Cove Caves, Santa Cruz Island | 0–10 ft (0–3 m) |
| 17 | Scorpion Rocks, Santa Cruz Island | 10–40 ft (3–12 m) |
| 18 | Willow Anchorage Rocks, Santa Cruz Island | 10–40 ft (3–12 m) |
| 19 | Gull Island, Santa Cruz Island | 10–100 ft (3–30m) |
| 20 | Santa Barbara Island | 10–600 ft (3–183 m) |
| 21 | Sutil Island | 10–250 ft (3–76 m) |
| 22 | Shag Rock | 10–50 ft (3–15 m) |
| 23 | Ship Rock, Santa Catalina Island | 5-20 ft (1.5–6 m) |
| 24 | Seal Cove Area, San Clemente Island | 10-50 ft (3–15 m) |
| 25 | Islas Los Coronados, Mexico | 10-100 ft (3–30 m) |
| 26 | Islas Todos Santos, Mexico | 10-100 ft (3–30 m) |

The nesting habitat at the majority of ashy storm-petrel breeding locations will likely not be directly affected by the sea level rise projected for California by 2100 (Table 4). A portion of nesting habitat at Cavern Point Cove Caves, Santa Cruz Island, would likely be submerged if projected sea level rises of 61 cm (24 in) by 2050 occur; much of the nesting habitat at this location would likely be submerged if the sea level rises 167 cm (66 in) by 2100.

On Santa Cruz Island in November 2008, McIver *et al.* (2009a, p. 6) reported ocean water flooding in a sea cave that probably killed one ashy storm-petrel chick. While some active nests in caves may fail due to flooding in the future, we anticipate that the more pervasive effect of sea level rise will be the loss of potential nesting habitat as former nesting areas become inundated. As the ocean level rises gradually over years, some areas currently dry and available to nesting birds will become submerged and unsuitable, reducing the area of available nesting habitat. It is likely that sea level rise coupled with more frequent high water events caused by storms will impact a portion of the nests that occur between 1.5–3 m (5–10 ft) above sea level by 2100. This includes Shipwreck Cave, Dry Sandy Beach Cave, Del Mar Rock, Cave of the Birds Eggs, and Bat Cave on Santa Cruz Island, Ship Rock near Santa Catalina Island, and, as already mentioned, Cavern Point Cove Caves 0–1.5 m (0–5 ft). The combined population of these sites is approximately 2.94 percent of the total ashy storm-petrel population.

Winter storm surges periodically wash through all of the sea caves at Santa Cruz Island, but these storm events likely do not negatively affect ashy storm-petrels; most ashy storm-petrels are not present at the colonies during winter months (Ainley 1995, p. 5) as peak fledging occurs in mid-October (see **Reproductive Habitat and Biology** section above). In fact, past winter storms have benefited ashy storm-petrels at Santa Cruz Island by creating nesting habitat; approximately 25 percent of ashy storm-petrel nest sites in Bat Cave occur among accumulated driftwood debris (both human-made and natural) that has washed into the cave during past winter storm events.

The timing of sea level rise is “ongoing” and the scope is “small,” having the potential to affect up to 2.94 percent of the ashy storm-petrel population. Under the maximum sea-level rise of 5.48 ft (1.67m) by 2100, the worst-case scenario would be for all of the potential nest sites below about 1.5-3m (5-10 feet) above sea level to be unavailable to nesting ashy storm-petrels. This represents between 31–70 percent of the current nest sites in most sea caves. Therefore, we conclude that the severity of sea level rise is “serious” (likely to destroy or eliminate the habitat or reduce the vulnerable 2.94 percent of the ashy storm-petrel population by 31–70 percent by the year 2100). Some storm-petrels could shift their nesting grounds to higher sites or nest elsewhere, ameliorating the effect of sea level rise.

Invasive Species

New Zealand spinach (spinach) *(Tetragonia tetragonoides)* occurs in proximity to ashy storm-petrel nest sites on SE Farallon Island. Based on population estimates for these areas presented in Table 1, 56.47 percent of ashy storm-petrels breed at this location. Spinach is highly invasive on the south side of the island, growing to nearly 100 percent ground cover in the summer on portions of Lighthouse Hill where ashy storm-petrels nest (McChesney 2013, pers. comm.). At certain times in the summer, spinach plants drape over the entrances of rock crevices, which could reduce access to nesting crevices for ashy storm-petrel adults nesting in areas that are prone to spinach draping over rock wall crevices (McChesney 2013, pers. comm.). Only a small portion of crevices are expected to be covered in spinach such that ashy storm-petrels cannot access them (McChesney 2013, pers. comm.). Cheeseweed *(Malva parviflora)* sometimes grows in high densities next to the rock wall surrounding the helicopter pad where ashy storm-petrels are known to nest, and could restrict access to nesting sites in this rock wall.

The timing of invasive species impacts is “ongoing” and the scope is “large,” potentially affecting 56.47 percent of the ashy storm-petrel population (the entire SE Farallon Island population). The best available information indicates that spinach and cheeseweed could restrict access to nest sites of a small number of breeding individuals. Therefore, we conclude that the severity of invasive spinach is “slight” (likely to destroy or eliminate the habit or reduce the 56.47 percent of the ashy storm-petrel population within the scope of this threat by 1–10 percent).

Human Activities

Most breeding locations occur on federally owned or managed lands that are generally inaccessible to the public. SE Farallon Island contains approximately 56.47 percent (Table 1) of the total ashy storm-petrel population. It has low human visitation by the Service’s refuge staff and researchers and is closed to the general public. The public is not allowed on any of the Farallon Islands because wildlife on the islands can be very sensitive to human disturbance. This closure is strictly enforced by island staff. Because research efforts will be discussed in Factor B below, we will exclude SE Farallon Island from the scope of human visitation, therefore limiting the scope to 42.28 percent of the population.

The U.S. National Park Service (NPS), Channel Islands National Park, has closed 98 percent of all ashy storm-petrel breeding locations in the Channel Islands to visitation, and has posted signs at several locations (see *National Park Service Organic Act* section below). Although there is direct evidence that tourists have occasionally visited sea caves at Santa Cruz Island where ashy storm-petrels nest (McIver *et al.* 2008, p. 5; McIver *et al.* 2009a, pp. 7–8), the available information does not indicate adverse impacts of tourism on ashy storm-petrels, such as degraded or modified nesting habitats, dead birds, or broken eggs. Due to lower hatching success observed at Cavern Point Cove Caves in comparison to other locations at Santa Cruz Island (McIver 2002, p. 24), we cannot discount the possibility that visitation by tourists may have resulted in disturbance and abandonment of some ashy storm-petrel nests at this location.

The timing of human visitation is “ongoing” and the scope of the impact of human visitation is “large,” affecting 42.28 percent of the known breeding population. Because most ashy storm-petrel breeding locations are generally inaccessible to tourists, we find it unlikely that human visitation has caused large-scale disturbance to ashy storm-petrels and subsequent abandonment of nesting efforts. Consequently, of the 42.28 percent of locations outside of SE Farallon Island, we conclude that the severity is “negligible” (likely to destroy or eliminate the habitat or reduce the species population by <1 percent).

Military Activities

Within the range of the ashy storm-petrel, military activities occur primarily within the Southern California Range Complex. San Clemente Island, one of the Channel Islands, is owned and managed by the Navy and is within the Southern California Range Complex. Ashy storm-petrels are confirmed to breed at Seal Cove Rocks (Carter *et al.* 2008a, p. 119), off San Clemente Island’s west side, and may breed on offshore rocks off China Point, and at or near Mosquito Cove (Hering 2008, p. 4). Surveys from 1994 estimated 5–50 breeding pairs, or 10–100 individuals, mainly at Seal Cove and Mosquito Cove (Carter *et al.* 2009, p. 2). Surveys in 2008 indicated continued attendance of the colony at Seal Cove, but did not provide definitive numbers of pairs or individuals (Carter *et al.* 2009, p. 2). Seal Cove Rocks is located outside of any current training areas (Hering 2008, p. 5). Mosquito Cove is also within the boundaries of the Shore Bombardment Area (SHOBA), but is located well outside the impact areas within a buffer area not directly subject to operations (Hering 2008, p. 5). Offshore rocks near China Point do occur within the SHOBA; however, these rocks are not targeted by bombardment activities, and ashy storm-petrels have not been confirmed to be breeding there (Hering 2008, p. 5). Both the offshore rocks at Seal Cove and China Point are part of the Coastal California National Monument. However, noise from military activities in the vicinity could potentially result in nest abandonment or limit movement of ashy storm-petrels and, therefore, we cannot conclude that the severity is “negligible.”

It is unknown if ashy storm-petrels were present on San Clemente Island prior to the establishment of Vandenburg Air Force base. As stated ealier, this analysis only evaluates present threats as historic threats have already been taken into consideration in the population trend analysis. Ashy storm-petrels have been mist netted on Destroyer Rock in the vicinity of Vandenburg Air Force Base (Department of the Air Force 2013, p. 2). However, to date, there is no confirmed breeding of ashy storm-petrels at this location (Department of the Air Force 2013, p. 3)

The timing of military activities is “ongoing” and the scope is “negligible,” potentially affecting a negligible (Seal Cove Rocks, 0.52 percent, or less than 1 percent) proportion of the total population or occurrences (Table 1). Because this 0.52 percent of the population is outside of any training activity areas, we conclude that the severity of the threat is “slight” (likely to destroy or eliminate the habitat or reduce the species’ population by 1–10 percent within the 0.52 percent scope) because although noise from military activities and bombing activities are disruptive, they are not expected to be driving population trends.

Conservation Measures to Reduce Habitat Destruction, Modification, or Curtailment of Habitat

*Farallon Island Invasive Species Removal (Plants)*

An invasive species eradication program was implemented by the Service in the 1980s in attempt to reduce or eliminate spinach and cheeseweed on SE Farallon Island. This involved a combination of herbicide spraying and mechanical removal of invasive weeds during various times of the year (McChesney 2013, pers. comm.). The herbicide treatment has been successful in eradicating the spinach and cheeseweed in some years. However, in other years the plants had already gone to seed before spraying applications began. Mechanical removal has proved to be difficult in rocky terrain. Although some limited success has been seen in some areas in some years from spraying and removal efforts, the overall spread of spinach and cheeseweed has not been curbed on SE Farallon Island. Spinach spraying efforts have been modified for 2013, and herbicide applicators plan to spray the spinach before it goes to seed in early spring with another application to follow in July (McChesney 2013, pers. comm.)

*Human visitation reduction*

On Santa Cruz Island, signs prohibiting tourists from entering sea caves have been installed at Bat Cave, Cavern Point Cove Caves, Cave of Birds Eggs, Dry Sandy Beach Cave (McIver 2012a, p. 12). Authorities for these closures can be found in ***National Park Service Organic Act*** Section under **Factor D.** These signs were installed using funds from the Montrose Settlement Restoration Program (MSRP) (McIver 2012a, p. 4).

Many conservation actions are funded by the MSRP. The MSRP was started to mitigate the Montrose Chemical Corporation manufacturing plants discharging of millions of pounds of dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs**)** into ocean waters off the southern California coast between the 1940s and 1970s. NOAA and other federal and state agencies reached a settlement with the responsible parties, establishing the MSRP in 2001 (MSRP 2013, no pagination). Several of the conservation measures identified in this report were funded through the MSRP.

Additional policies and laws limiting human visitation on the Channel Islands are in place and can be found on the Channel Islands National Park website (CINP 2013, no pagination).

## Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Commercial Purposes

The ashy storm-petrel is not a commercially exploited or utilized species. The best available scientific and commercial information does not indicate that overutilization for commercial purposes is now or will in the future be a threat to the ashy storm-petrel across all or any portion of its range. Therefore, a discussion of commercial purposes as a potential threat is not applicable to this analysis.

Recreational Purposes

Ashy storm-petrels are a species of interest during pelagic birdwatching trips off the coast of California. Ashy storm-petrels are generally wary of and avoid boats, including boats with birdwatchers, and it is highly unlikely that the birds are negatively affected by these recreational activities. Tourism at sea caves (see Factor A) located on Santa Cruz Island is a recreational activity that could affect ashy storm-petrels. However, as stated above, the best available scientific evidence does not suggest such recreational activities are impacting the species as a whole. SE Farallon Island contains approximately 56.47 percent (Table 1) of the total ashy storm-petrel population and has low human visitation by the Service’s refuge staff and researchers, but is closed to the general public; this closure is strictly enforced by island staff. Consequently, we consider only the recreational effects to the 42.28 percent of the population located outside of SE Farallon Island.

The timing of recreational activity effects is “ongoing.” Although 42.28 percent of the ashy storm-petrel population is subject to recreational activities, making this potential threat large, we conclude that the severity of this threat is “negligible” because the best available scientific evidence does not suggest that recreational activities are acting to reduce the ashy storm-petrel population (likely to destroy or eliminate the habitat or reduce the ashy storm-petrel species population by <1 percent of the 42.28 percent within the scope).

Scientific and Educational Purposes

In California, scientific research (monitoring of nesting success, mark and recapture using mist nets, radio telemetry) has been conducted on SE Farallon Island since the mid-1960s (Ainley *et al.* 1974, pp. 295–310; Ainley *et al.* 1990, pp. 128-162; Sydeman *et al.* 1998a, pp. 438–447), at Santa Cruz Island since the mid-1990s (McIver 2002, pp. 1–70; McIver and Carter 2006, pp. 1–6; Carter *et al.* 2007, pp. 4–20; McIver *et al.* 2008, pp. 1–22; McIver *et al.* 2009a, pp. 1–30), and periodically at various breeding locations throughout the range of the ashy storm-petrel (Carter 2008, pp. 118–119). The Service is aware of reduced hatching success at SE Farallon Island caused by handling of ashy storm-petrels by researchers (James-Veitch 1970, p. 246) and reduced hatching success at SE Farallon Island in 1977 when "researcher disturbance was great" (Ainley *et al.* 1990, p. 161). Researchers may cause adults to abandon nests (Spear and Ainley 2007, p. 4). However, researchers at both SE Farallon Island and Santa Cruz Island have implemented procedures to reduce disturbance to ashy storm-petrels during regular nest monitoring activities. These measures can be found below under **conservation measures**.

The Service is aware of 220 ashy storm-petrel eggs and 355 study skins (study skins, skeletons, round skins) that have been collected and salvaged from 1885–2004 for scientific archival purposes. In addition, for purposes of measuring eggshell thickness and organochlorine (chlorinated hydrocarbon) contamination, a total of 26 viable eggs were collected from SE Farallon Island and a total of 68 viable ashy storm-petrel eggs were collected from Santa Cruz Island between 1968 and 2008 (Coulter and Risebrough 1973, p. 254; Kiff 1994, p. 11), and in 2008 (McIver *et al.* 2009b, p. 8). The majority of ashy storm-petrel birds and eggs that are found in scientific collections were collected at SE Farallon Island in the first half of the 20$^{th}$ century. More ashy storm-petrel birds and eggs were collected in 1911 ($n$ = 120 specimens) than in any other year. Over a period of 124 years, an average of 2.6 ashy storm-petrel eggs per year and 2.9 birds per year have been collected over the geographic range of the species. Since 2008, only one skin has been collected and it was sent to California Academy of Sciences. No eggs have been collected since 2008 at any location (Bradley 2012a, pers. comm.; McIver 2012a, pers. comm.).

Although all ashy storm-petrel breeding locations could be subject to scientific take, many of the locations would require climbing gear to be accessed, and to date, this has not been proposed. Therefore, the scope of scientific take is less than the 100% scope listed below. However, we have no means to quantify or approximate how many nests are inassessable, and therefore use 100% scope for this threat.

Researchers on SE Farallon Island and Santa Cruz Island regularly monitor ashy storm-petrel nest sites. Other sites are visited less frequently, but are still subject to scientific research impacts. Measures have been taken to reduce the impacts of scientific take on both SE Farallon Island and Santa Cruz Island. The timing of scientific take is "ongoing." Although scientific take is "pervasive," potentially affecting 100 percent of the population, the best available scientific evidence shows the severity of this potential threat to be "negligible" (likely to destroy or eliminate the habitat or reduce the species' population by <1 percent of the individuals of the 100 percent within the scope) largely due to survey protocol actions that have been implemented in the past 30 years to alleviate disturbance to nesting ashy storm-petrels.

Conservation Measures to Reduce Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

*Survey monitoring restrictions*

At Santa Cruz Island, researchers reduce disturbance to adult storm-petrels by not handling adults in nest sites, carefully walking through the colony so as not to disturb habitat, and visiting the colonies only once every 3–5 weeks (McIver 2012a, pers. comm.). On the Farallon Islands, biologists use standard access points when climbing rock walls, and are careful not to dislodge rocks from walls where the ashy storm-petrels nest (Bradley 2012a, pers comm.). When checking nests, biologists are not authorized to move an adult to determine egg presence. If eggs are found or adults observed sitting on the nest for two consecutive nest checks, no nest visits are permitted for the next 8 nest check dates (nests checks are every 5 days) to allow for full incubation. When chicks are observed in the nest, no nest checks are permitted for the next 8 nest check dates to allow for undisturbed chick growth (Bradley 2012a, pers. comm.).

## Factor C: Disease or Predation

Disease

Disease has not been reported as a threat to ashy storm-petrels (Ainley 1995, p. 8). The best available scientific and commercial information indicates that disease is not a known threat to the ashy storm-petrel at the present time or will be in the future. Therefore, a discussion of disease as a potential threat is not applicable to this analysis.

Predation

All species are naturally subject to some level of predation. For this factor, we have concentrated on ashy storm-petrel predators that may be having disproportional effects on the ashy storm-petrel population. Native avian predators of the ashy storm-petrel include western gulls, burrowing owls, barn owls, and common ravens. Native mammalian predators of eggs and birds include island deer mice (*Peromyscus maniculatus*), island fox (*Urocyon littoralis santacruzae*), and island spotted skunks *(Spilogale gracilis amphiala)*. Nonnative house mice *(Mus musculus)* are known predators of ashy storm-petrel eggs and birds (Ainley *et al.* 1990, p. 156; McChesney and Tershey 1998, p. 341).

Besides direct mortality of ashy storm-petrel individuals, predation can affect incubation and chick-rearing. Because ashy storm-petrel breeding pairs share egg incubation duties, the death of one adult during this stage could result in incomplete incubation and failure of the egg to hatch. Similarly, the death of one adult of an ashy storm-petrel breeding pair during the chick-rearing stage (post-hatching) could result in the death of the chick (by starvation), especially if it is younger than about 50 days old (Mauck *et al.* 2004, p. 883).

*SE Farallon Island*

SE Farallon Island serves as breeding grounds for approximately 58 percent of the known ashy storm-petrel breeding population (Table 1). Avian predators are known to prey on adult ashy storm-petrels, which is a greater potential threat to the species than taking eggs or young. The take of adults has direct effects on adult survivorship on the island. The following are known predators of ashy storm petrel on SE Farallon Island:

***Burrowing Owl***

*SE Farallon Island*

Burrowing owls do not currently breed on SE Farallon Island, but are regular fall visitors, and several individuals (5–8) overwinter on the island (Nur *et al.* 2013, p. 47). In the fall, burrowing owls arrive at SE Farallon Island and feed upon nonnative house mice when mice are seasonally abundant (Nur 2013 *et al.*, p. 7). In late winter and early spring, the mouse population declines in numbers and burrowing owls switch from mice to prey upon storm-petrels, which are courting and prospecting for nesting sites at this time (Nur *et al.* 2013, p. 7). From January 2003 through August 2008, approximately 98 percent of ashy storm-petrel carcasses found on SE Farallon Island likely died due to avian predation, and this predation occurred between February and August (PRBO Conservation Science 2008, no pagination). Being one of the avian predators, burrowing owls were thought to have high risks of dying from starvation following the mouse population crash. To reduce this cause of mortality, Service staff from SE Farallon National Wildlife Refuge trapped and moved several burrowing owls to the mainland. Five burrowing owls were translocated to Don Edwards San Francisco Bay NWR between 2005 and 2007 (Service 2008, p. 53). As an added benefit, decreased owl predation on storm-petrels was anticipated as a result from owl translocations. At this time, no future translocations are planned because of migratory bird permitting restrictions; also to fully realize benefits to storm-petrels, translocation would need to be conducted in perpetuity, a large and costly undertaking.  At this time, the Service is developing a plan to eradicate the nonnative house mouse through rodenticide application and prevent future human introductions of mice, which is expected to reduce owl predation on Farallon storm-petrels (see **Conservation Efforts** below). It is unknown to what extent burrowing owl predation occurs elsewhere, but the best available science at this time does not suggest that it is a threat outside of SE Farallon Island.

Burrowing Owls have been known to frequent SE Farallon Island since at least the late 1880s. The only recorded breeding of burrowing owls on SE Farallon Island was in 1911 by W. L. Dawson (Desante and Ainley 1980, p. 30). Between one to three burrowing owls wintered on SE Farallon Island each year from the years 1968–1976 (Desante and

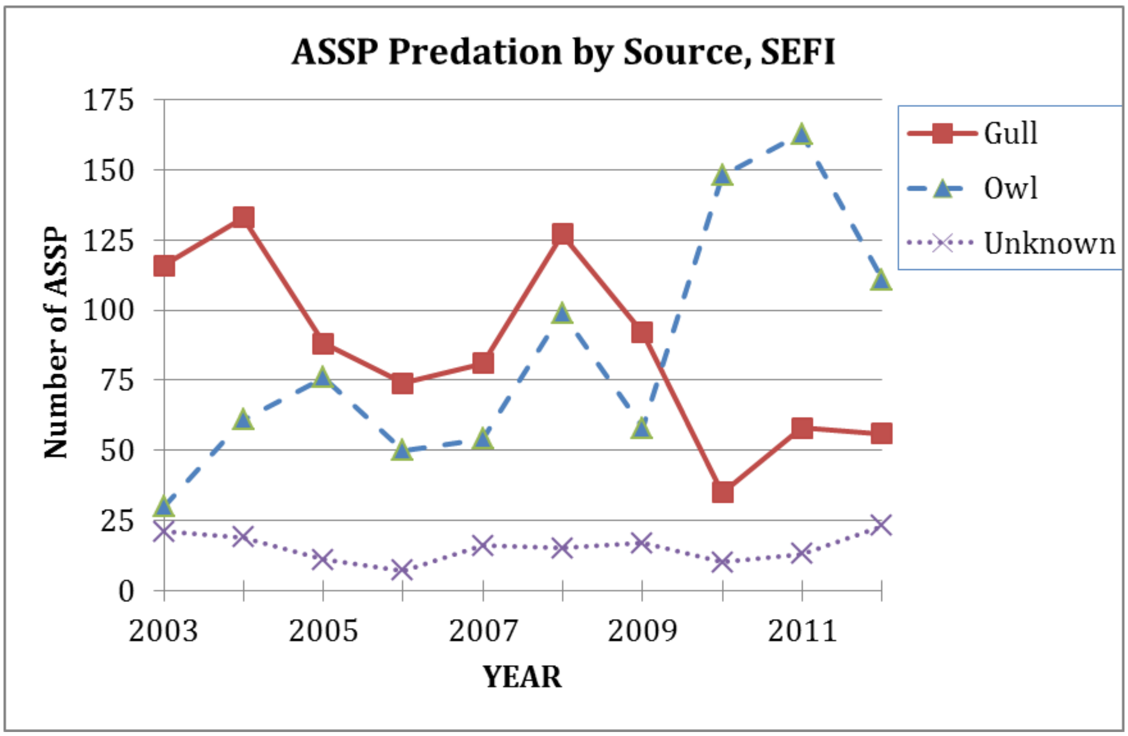
Ainley 1980, p. 30). The majority of individuals departed in March and April, although two burrowing owls stayed until May (Desante and Ainley 1980, p. 30).

The last 4 years (2009–2012) have had the highest abundance of burrowing owls on SE Farallon Island since recent systematic recording began in 2000 (Nur *et al.* 2013, p. 48). From 2003–2010, predation by burrowing owls accounted for 40 percent of ashy storm-petrel predation. Western gulls accounted for 52 percent, with the remaining predation from unknown predators (Bradley *et al.* 2011, p. 8). Therefore, the predation impact of less than ten burrowing owls on the island is comparable to the predation impact from thousands of western gulls. In recent years, burrowing owl predation has surpassed western gull predation (Figure 4; PRBO 2013c, unpublished data). In 2012, burrowing owls predated 111 ashy storm-petrels on the island, western gulls predated 56 ashy storm-petrels, while for 23 ashy storm-petrel carcasses, the cause of death was not determined (Figure 4; PRBO 2013c, unpublished data). These 23 individuals could have been predated by western gulls or burrowing owls or may have died from another cause (Bradley 2012d, pers. comm.).

Nur *et al.* 2013 found that greater monthly burrowing owl abundance resulted in greater predation on ashy storm-petrels. For 2009–2011, average burrowing owl maximum monthly abundance on SE Farallon Island from September to April was 6.29 individuals (Nur *et al.* 2013, p. 22). In a population modeling study, Nur *et al*. 2013 (p. 20) estimated a recent potential short-term ashy storm-petrel decline of 7.2 percent per year to continue if burrowing owls continue to frequent the Island at recent levels. Nur *et al.* derived this trend by using the same modeling technique as Nur *et al.* (1999a) and Sydeman *et al.* (1998b, p. 20). At that time, the authors calculated an ashy storm-petrel decline of 2.87 percent per year for 1972–1992 due largely to gull predation. Their model predicted this decline to continue into the future. As stated earlier, the Sydeman *et al.* 1998b (p. 20) prediction of a continued ashy storm-petrel decline did not turn out as predicted since the population increased at a rate of 22.1 percent per year from 2000-2007 (Nur *et al.* 2013, p. 25). However, since 2007, this increase appears to have stopped, and has become a potential short-term decline in recent years, quite possibly due to burrowing owl predation on ashy storm-petrel adults (Nur *et al.* 2013, p. 14). Results from Nur *et al.* (2013, p. 18) show that reducing the burrowing owl population will likely benefit the ashy storm-petrel population on the island.

In analyzing Nur *et al*. 2013 and burrowing owl predation on SE Farallon Island, we have considered the Service's recent issuance of the South Farallon Islands Invasive House Mouse Eradication Project: Draft Environmental Impact Statement (DEIS). As set forth in the Service's September 16, 2013, memo, we recognize that Nur *et al*. 2013, was not designed to examine population trends but to examine the recent impacts of burrowing owl predation on ashy storm-petrels and to project potential future population trajectories if the most recent conditions were to continue. Different purposes underlie the DEIS and this Species Report. Accordingly, we recognize that the use of population data from a longer time period than that used by Nur *et al*. 2013, or in the DEIS, is more appropriate here for the purpose of evaluating the conservation status and risk of extinction for the species.

The timing of burrowing owl predation is "ongoing" and the scope is "large," with all individuals on SE Farallon Island potentially at risk of predation. Burrowing owl predation on ashy storm-petrel adults on SE Farallon Island is likely having effects on the population as a whole within the scope of this threat. Using data collected on SE Farallon Island from 2003 through 2012, we made a rough estimate of the effects that burrowing owls could have on ashy storm-petrels in the near future. Our calculations showed that around 10 percent of the ashy storm-petrel population on SE Farallon Island could be eliminated over the next 38.4 years. However, because the ashy storm-petrel is sensitive to adult survival and it is likely that not all predated wings are found and included in our calculations, it is possible that losses could be higher. Because the best available information predicts a decrease that does not fit obviously into any category, we conclude that the severity of this threat is "slight/moderate" (likely to destroy or eliminate the habitat or reduce the species' population within the 56.47 percent scope by 1–30 percent).
**Figure 4:** Avian Predation on Ashy Storm-Petrel on SE Farallon Island from 2003-2012. Data provided by PRBO.




### *Western Gull—SE Farallon Island*

The Farallon Islands hosts the world's largest western gull breeding population, and the western gull is a resident native breeding species on the island. Historical distribution of western gull nesting areas has shifted and expanded since they were first mapped in 1959. The population stayed consistent between 22,000 and 25,500 breeding birds between 1959 and 1990 (Penniman *et al.* 1990, p. 223). However, the population has recently undergone a slight decline to around 17,500 western gulls. Furthermore, productivity for western gulls on the island has declined for the fourth straight year (Warzybok 2012, p. 7). It is unknown to what extent western gull predation occurs elsewhere, but the best available science at this time does not suggest that it is a threat outside of SE Farallon Island.

Ainley *et al.* (1974, p. 307) and Ainley *et al.* (1990, p. 157) estimated storm-petrel mortality rates based on presence of storm-petrel remains and on bands found in gull pellets collected in 1971 and 1972. Ainley *et al.* (1974, p. 307) and Ainley *et al.* (1990, p. 157) estimated that about 1 percent of the storm-petrel population (ashy and Leach's storm-petrels) on SE Farallon Island were depredated by western gulls in 1971 and 1972.

Sydeman *et al.* (1998b, pp. 1–74) collected wings of storm-petrel carcasses found on the southwestern slope of Lighthouse Hill from 1994–1996. In 2000, PRBO Conservation Science searched for and collected predated storm-petrel wings on Lighthouse Hill and other areas on SE Farallon Island, and categorized the wings by type of avian predation (such as gull or owl). In these studies, wings were collected during the course of frequent nest-monitoring activities. Sydeman *et al.* (1998b, pp. 21–22) estimated that 22 ashy storm-petrels were preyed upon by avian predators on Lighthouse Hill each year from 1994–1996. In addition, Sydeman *et al.* (1998b, p. 21) estimated a 2.5 percent annual mortality rate of breeding ashy storm-petrels at Lighthouse Hill due to avian predation from 1994–1996, based on an estimated breeding population of 651 ashy storm-petrels at Lighthouse Hill.

Western gulls predated over 75 ashy storm-petrels per year on SE Farallon Island from 2003–2009 (Figure 4). Western gull predation has recently decreased on the SE Farallon Island to less than 60 individuals per year from 2009–2012 as burrowing owl predation has increased (Figure 4).

The timing of western gull predation is "ongoing" and the scope is "large," with all individuals on SE Farallon Island potentially at risk of predation. Western gull predation on ashy storm-petrel adults on SE Farallon Island is likely having effects on the population as a whole within the scope of this threat. Using data collected on SE Farallon Island from 2003-2012, we made a rough estimate of the effects that western gulls could have on ashy storm-petrels in the near future. Our calculations showed that around 10 percent of the ashy storm-petrel population on SE Farallon Island could be eliminated over the next 38.4 years. However, because the ashy storm petrel is sensitive to adult survival and it is likely that not all predated wings are found and included in our calculations, it is possible that losses could be higher. Because the best available information predicts a decrease that does not fit obviously into any category, we conclude that the severity of this threat is "slight/moderate" (likely to destroy or eliminate the 56.47 percent scope by 1–30 percent).

***House Mouse Predation—SE Farallon Island***

Out of a total of 274 ashy storm-petrel eggs laid during 1972–1983, Ainley *et al.* (1990, p. 156) inferred predation by house mice of one ashy storm-petrel chick, based upon the remains of a partially eaten carcass. This is the only direct documentation of house mouse predation on ashy storm-petrel on SE Farallon Island. Although Ainley states that house mouse predation is likely affecting chick survival, because there is only one documented instance of house mouse predation on ashy storm-petrel, the best available science suggests that direct house mouse predation on ashy storm-petrel is negligible. Although the scope of house mouse predation is “large,” affecting 60.61 percent of the population (SE Farallon Island and Santa Cruz Island), the best available scientific information indicates that the severity of this threat is “negligible” (likely to destroy or eliminate the habitat or reduce the species population within the 60.61 percent scope by <1 percent).

*Channel Islands*

***Island Spotted Skunk***

The island spotted skunk (skunk) occurs only on Santa Rosa and Santa Cruz Islands (Crooks and Van Vuren 1994, p. 380). Because Santa Rosa Island is not known to support ashy storm-petrel breeding, the extent of this potential threat is limited to Santa Cruz Island, which harbors approximately 2.79 percent of the ashy storm-petrel population (Table 1). On Santa Cruz Island, the skunk population has increased recently from rare to abundant (Crooks and Van Vuren 1994, p. 380; Jones, *et al.* 2008, p. 76). Jones *et al.* (2008, pp. 81–84) reports that there are two explanations for this increase: competitive release (an increase in population due to reduced competition) due to decline of the native island fox, and recovery of vegetation due to removal of feral livestock. In a radio-telemetry study on Santa Cruz Island, Crooks and Van Vuren (1994, pp. 381–382) found that skunks utilized chaparral grasslands, open grasslands, and coastal sage scrub habitats; fed on deer mice, lizards, and insects; and were active only at night. Jones *et al.* (2008, p. 80) reported that skunks also utilized fennel-dominated riparian habitats.

Researchers reported that skunks killed at least 100 adult ashy storm-petrels at two locations on the northeast coast of Santa Cruz Island: 70 ashy storm-petrels at Bat Cave in 2005 and 32 at Cavern Point Cove Caves in 2008 (McIver and Carter 2006, p. 3; McIver *et al.* 2009a, p. 7). The mortality event at Bat Cave resulted in the temporary loss or abandonment of the largest ashy storm-petrel colony at Santa Cruz Island (average of 80 nests per year in 1995–97 (McIver 2002, p. 24)) and the colony with the largest numbers of monitored ashy storm-petrel nests (McIver and Carter 2006, p. 4). Ashy storm-petrel nests were documented in Bat Cave in 2006 (19 nests), 2007 (28 nests), and 2008 (40 nests); no further evidence of skunks in the cave has been observed since 2005 (Carter *et al.* 2007, p. 7; McIver *et al.* 2008, p. 4; McIver *et al.* 2009a, p. 6). The population has since fully recovered and Bat Cave had 83 nests in 2012 (Harvey 2013, pers. com.).

The second mortality event at Cavern Point Cove Caves, located approximately 0.6 mi (1 km) east of Bat Cave, resulted in the deaths of at least 32 adult ashy storm-petrels and complete reproductive failure (predation of virtually all nests) (McIver *et al.* 2009a, p. 7). Researchers removed skunks from both locations after the predation events (see the **Conservation Efforts** section below).

Recent research shows that skunk population numbers at Santa Cruz Island have likely increased to carrying capacity (maximum population that island resources can support), possibly in response to reduced numbers of island foxes (Jones *et al.* 2008, pp. 81–84). Given the additional skunk predation incident in 2008 and known increases in skunk population numbers on the island, ashy storm-petrels nesting in sea caves on Santa Cruz Island may be vulnerable to episodic predation by skunks (McIver *et al.* 2009a, p. 14). The skunk diet is largely comprised of invertebrates and vertebrates other than birds. For example, during 1992, avian remains in spotted skunk scat occurred only in 4 percent of samples. Samples in 2003 and 2004 contained no avian remains (Jones *et al.* 2008, pp. 81–84).

Like other sea caves in which ashy storm-petrels nest at Santa Cruz Island, Bat Cave and Cavern Point Cove Caves occur at the base of sheer cliffs and coastal bluffs (McIver 2002, p. 8). The coastal slopes above the sea caves at Santa Cruz Island comprise coastal bluff scrub habitat (Junak *et al.* 1995, p. 14), likely utilized by skunks. Skunks may have fallen or jumped off nearby bluffs or cliffs and swam into the caves (Carter and McIver 2006, p. 4) or climbed down to them, although the steep terrain likely restricts skunk movements. Like other procellariids, ashy storm-petrels have a strong and distinctive musky odor (James-Veitch 1970, p. 86), which can be detected at the entrances of the sea caves at Santa Cruz Island (McIver 2009, pers. obs.). In addition, ashy storm-petrels return to and depart from their nesting colonies at night; these nighttime activities include vocalizations and aerial displays, including circling flights at the sea cave entrances (James-Veitch 1970, p. 24). This puts them at greater risk of predation by island spotted skunks, which are also active at night.

Future skunk population numbers and trends at Santa Cruz Island are uncertain and may be directly related to the recovery status of the island fox (Jones *et al.* 2008, p. 83). A recovering population of island foxes may or may not be able to suppress the population of skunks to its former levels, which may result in a new equilibrium of fox and skunk population numbers at Santa Cruz Island (Jones *et al.* 2008, p. 83). It is unkown whether or not island foxes prey on ahsy storm-petrel, but we have no documentation that they do at this time. Skunk predation is unlikely to increase beyond levels observed in recent years; Jones *et al.* (2008, p. 83) suggest that skunks may have approached or even exceeded carrying capacity. This conclusion (Jones *et al.* 2008, p. 83) is supported by a trend toward smaller skunk body size and undiminished skunk home ranges in 2003–2004 compared to 1992. In addition, the proportion of juveniles among captured skunks decreased during the study, from 24 percent in September 2003 to 5 percent in September 2004 (Jones *et al.* 2008, p. 83). More recently, Coonan 2012 (p. 27) showed that although skunk numbers have been fairly stable over the last 3 years (approximately 3000 skunks), total captures and total individual skunks on the island are starting to decline.

The timing of skunk predation is “near-term future” and the scope is “small,” affecting

2.79 percent of the population. We do not have any probability values of how many, if any, skunk predation events will occur on in Santa Cruz Island caves in the future. Skunk traps have been deployed during the ashy storm-petrel breeding season every year since 2009 in Bat Cave, Cave of Birds' Eggs, and Cavern Pont Cove Caves (McIver 2012a, p. 12). There is a potential for skunks to occur where traps are not currently being deployed. Steps have been taken to eliminate skunks from caves and the skunk population seems to be on the decline. Because skunk predation events have resulted in complete reproductive failure at certain caves, and the potential threat of skunk predation persists, the best available scientific information indicates the severity of the threat is "moderate" (likely to destroy or eliminate 11–30 percent (approximately the population of one cave) of the population within the 2.79 percent scope of this threat).

***Barn Owl***

Barn owls have a worldwide distribution and occur throughout the range of the ashy storm-petrel (Rudolph 1970, p. 8; Marti 1992, p. 1). Barn owls hunt mostly at night, but occasionally during the day (Marti 1992, p. 3). Most hunting is done in low flight in open habitats (Bunn *et al.* 1982, p. 11), but some hunting occurs from perches (Taylor 1994, p. 58). McIver (2002, p. 46) reports that nest-site searching behaviors of adult ashy storm-petrel adults and the mobility of older chicks increase the susceptibility of ashy storm-petrels to predation by barn owls. Barn owls are only known to be a problem for ashy storm-petrels at Santa Cruz Island, where researchers have observed barn owl predation; however, this could be an issue throughout the ashy storm-petrel's range. In a study at five breeding locations on Santa Cruz Island, McIver (2002, p. 69) documented 83 ashy storm-petrels (76 adults and 7 chicks) killed by barn owls from 1995 to 1997. Approximately 97.6 percent of these were at two locations (75 birds at Bat Cave and 6 at Orizaba Rock) (McIver 2002, p. 69). More recent data reported that 13 ashy storm-petrels were killed by barn owls on Santa Cruz Island from 2005 to 2008 (McIver and Carter 2006, pp. 3–4; McIver *et al.* 2008, pp. 4–6; McIver *et al.* 2009a, pp. 5–10). At Santa Cruz Island, the mortality rate of ashy storm-petrel adults due to barn owl predation was approximately 5.4 percent during the 1995–97 period ($n$ = 350 estimated number of adults with nests) and 0.8 percent during 2005–2008 ($n$ = 304 estimated number of adults with nests) (McIver and Carter, unpubl. data). Our analysis indicates that mortality of ashy storm-petrels due to barn owls was heavy during the 1995–1997 period (McIver 2002, p. 30), but is currently (2005–2009) much reduced (McIver *et al.* 2012a, p. 33). The reason for this decline is unknown, but reductions at Bat Cave could be largely due to lack of ashy storm-petrels at that location after a skunk predation event in 2005 (McIver 2012a, p. 34). This decline may have also been due to an increase in bald eagles (*Haliaeetus leucocephalus*) nesting on the island. Bald eagles are known predators of barn owls.

Timing of barn owl predation is "ongoing." Although barn owl predation can be an issue, it appears that this threat has been reduced in recent years. The best available scientific evidence indicates barn owl predation is "pervasive," potentially affecting the species throughout 100 percent of the species' range, and that the severity of this potential threat is “slight” (likely to destroy or eliminate the habitat or reduce the species population by 1–10 percent within the 100% scope) because data show that predation from 2005-2008 was at lower levels than barn owl predation from 1995-1997 and because all species are naturally subject to some level of predation.

***Common Raven***

Common ravens are widespread and likely predate ashy storm-petrels throughout the range. We are aware of only one location where raven predation is known to rise to be a potential threat to ashy storm-petrel. This location is at Orizaba rock adjacent to Santa Cruz Island. After a decline in ashy storm-petrel abundance from 2000-2006, social attraction (recorded playback of ashy storm-petrel mating calls) and artificial nest boxes were used to attract birds to Orizaba Rock adjacent to Santa Cruz Island and promote breeding on Orizaba Rock from 2008–2011 (McIver *et al.* 2012, no pagination). Dismantling of artificial nests by ravens to gain access to nesting adults or offspring has been documented on Orizaba Rock, where less than 1 (0.067) percent of ashy storm-petrels nest. By 2010, breeding bird abundance was similar to that of the 1990s (McIver *et al.* 2012, no pagination). However, raven predation has recently commenced again (McIver 2011, p. 21; McIver 2012b, no pagination). Dismantling of nests has been an ongoing issue at the site and numerous attempts to raven proof the nests have not been fully successful (see the **“**Conservation Efforts” section below); raven predation is not known to be an issue at other locations.

The timing of raven predation is “ongoing.” The scope of raven predation is “negligible,” affecting less than 1 percent of the population (0.67). The severity of the threat is “moderate” (likely to destroy or eliminate 11–30 percent of the population that is within the 0.67 percent scope) because ravens are liklely influencing ashy storm-petrel population trends on Orizaba Rock.

Conservation Measures to Reduce Disease or Predation

Predation

***Burrowing Owl Translocations***

Service staff from SE Farallon National Wildlife Refuge have trapped and moved several burrowing owls to the mainland.  Five burrowing owls were translocated to Don Edwards San Francisco Bay NWR between 2005 and 2007 (Service 2008, p. 53). At this time, no future translocations are planned because of migratory bird permitting restrictions.

***SE Farallon Island Mouse Eradication Plan***

The Service has released for public comment the DEIS for the South Farallon Islands Invasive House Mouse Eradication Project to eradicate house mice on SE Farallon. Currently, there is no timeline for when or if this eradication will occur. If eradication does occur, it is expected to reduce burrowing owl predation on ashy-storm petrel adults because burrowing owls subsist on house mice for a portion of the year. In the fall, burrowing owls at SE Farallon Island feed upon nonnative house mice when mice are seasonally abundant (Nur *et al*. 2013, p. 7). In late winter and early spring, after the mouse population at SE Farallon Island declines in numbers, burrowing owls prey upon storm-petrels, which are courting and prospecting for nesting sites (Nur *et al*. 2013, p. 7). As discussed above, experts hypothesize that by eliminating house mice, burrowing owl abundance will be reduced, which in turn will have a positive effect on ashy storm-petrel population trends (Nur *et al*. 2013, p. 7). We anticipate that eradication of house mice on SE Farallon Island could potentially shift the impact of burrowing owl predation on ashy storm-petrel to a lower severity level. In addition to likely being beneficial to ashy storm-petrels that breed on the island, the eradication of house mice on SE Farallon Island would likely benefit the entire SE Farallon Island ecosystem. Because the potential for this action to be conducted in the future is uncertain, the possible effects of this eradication have not been included in our threats analysis and listing determination. Those findings are based on the current status of the species and only approved or currently implemented actions or actions reasonably certain to occur in the future are taken into consideration when evaluating species status.

***Island Spotted Skunk Removal***

Efforts to remove skunks from cave locations on Santa Cruz Island have been successful to date. One skunk was live trapped and removed from Bat Cave in June 2005, and another was presumed to have died or left the cave by the next year (McIver and Carter 2006, p. 3; Carter *et al.* 2007, p. 7). A skunk was live trapped and removed from Cavern Point Cove Caves in early July 2008, marked, and released on the island approximately 2.5 mi (4 km) SE from the capture location (McIver *et al.* 2009a, p. 7). Live traps were deployed in Bat Cave and Cavern Point Cove Caves to capture and remove skunks and prevent further storm-petrel deaths; these were monitored regularly for the remainder of the 2008 breeding season (McIver *et al.* 2009a, p. 7).
A second spotted skunk was caught in a live trap at Cavern Point Cove Caves in September 2008, but died. Skunk traps continue to be deployed at Bat Cave and Cavern Point Cove Caves; no skunks or evidence of skunk predation have been observed in the caves since the 2005 and 2008 events (McIver *et al.* 2011, pp. 16–17, McIver *et al.* 2012a, p. 18). Skunk traps have been deployed during the ashy storm-petrel breeding season every year since 2009 in Bat Cave, Cave of Birds' Eggs, and Cavern Pont Cove Caves (McIver 2012a, p. 12). The traps were deployed by the Service using Montrose Settlement Restoration Program (MSRP) funds (McIver 2012a, p. 4). There are no plans to remove the traps at this time. The deployment of these traps largely alleviates the threat of skunk predation in these caves.

***Artificial Nest Sites at Orizaba Rock, Santa Cruz Island***

On Santa Cruz Island, nest site enhancement on Orizaba Rock in the form of artificial nesting site construction has been shown to help the ashy storm-petrel population. From 2008 to 2011, social attraction and artificial nests were deployed at Orizaba Rock to enhance visiting and breeding of ashy storm-petrels on the rock (McIver 2012b, no pagination). This effort conducted by the Service was funded by MSRP (McIver 2012a, p. 4).

Although most social attraction equipment was removed from the rock in 2012, artificial nests remain on the rock. Dismantling of artificial nests by ravens has been documented on the rock (McIver 2011, p. 21; McIver 2012b, no pagination). Nests have been modified several times in an attempt to raven-proof them, but ravens have been able to access the artificial nesting boxes by removing or dismantling them. Raven predation still remains a problem on Orizaba Rock (McIver 2012a, p. 23; McIver 2012b, no pagination).

**Factor D: Inadequacy of Existing Regulatory Mechanisms**

We consider relevant Federal, State, and tribal laws and regulations when evaluating the status of the species. Regulatory mechanisms, if they exist, may preclude the need for listing if we determine that such mechanisms adequately address the threats to the species such that listing is not warranted. Only existing ordinances, regulations, laws, etc. that have a direct connection to a threat are applicable. We do not evaluate the lack of a regulatory mechanism that may address a particular threat if that regulatory mechanism does not exist. For instance, we do not have a regulatory mechanism that directly regulates the potential threat of sea level rise. So, even though the Clean Air Act could regulate greenhouse gas emissions, this is not a mechanism we can use to directly address sea level rise.

In addition to our analysis of existing regulations under Factor D of Section 4(a)(1), we have considered throughout this Species Report any efforts undertaken to protect the ashy storm-petrel.  Section 4(b)(1)(A) of the Act requires the Service to take into account "those efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species…"  While these efforts may not constitute regulatory mechanisms, they may provide a conservation benefit to the species and are considered accordingly.

Federal Protections

*Migratory Bird Treaty Act*

The Migratory Bird Treaty Act of 1918 (MBTA) states that it is unlawful "to pursue, hunt, take, capture, kill, or attempt to take, capture or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird, any part, nest, or eggs of any such bird, or any product, whether or not manufactured" (16 U.S.C. 703 (a)). The MBTA provides penalties for anyone convicted of violating its provisions (16 U.S.C. 707). The ashy storm-petrel is included in the list of migratory birds protected by the MBTA (50 C.F.R. 10.13).  The provisions of the MBTA thus prohibit hunting, capturing, or killing or attempting to take, capture, or kill, or possess ashy storm-petrels. There are likely to be instances where permits under the MBTA are not obtained and some mortality may occur. However, our analysis did not reveal information that would suggest a level of mortality that would be a significant threat to the species. Overall the MBTA provides protections for the ashy storm-petrel that would otherwise not exist.

On January 10, 2001, President Clinton issued Executive Order 13186, pertaining to responsibilities of Federal agencies to protect migratory birds, and directing executive departments and agencies to further implement the MBTA (66 FR 3853; January 17, 2001). Executive Order 13186 directs each Federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations to develop and implement (within 2 years) a memorandum of understanding (MOU) with the Service that promotes the conservation of migratory bird populations. The Department of Defense (DOD) entered into a MOU with the Service on August 30, 2006 (71 FR 51580), which emphasizes a general collaborative approach to conservation of migratory birds. Conservation measures include minimizing disturbance to breeding, migration, and wintering habitats. While this MOU is non-binding and does not authorize the take of migratory birds, it does provide an additional opportunity for the Service to continue to reduce the threat of habitat loss to the ashy storm-petrel on lands owned and managed by the DOD, including San Clemente Island. Currently, approximately 0.5 percent of the entire ashy storm-petrel population breeds on DOD lands (Table 1). We are not aware that any other Federal agency has entered into a similar MOU with the Service.

*National Environmental Policy Act*

The National Environmental Policy Act of 1970 (NEPA) (42 U.S.C. 4371 *et seq.*) requires that all activities undertaken, authorized, or funded by Federal agencies be analyzed for potential impacts to the human environment prior to implementation. However, NEPA does not require adverse impacts be fully mitigated, and some impacts could still occur. Additionally, NEPA is only required for projects with a Federal nexus, and, therefore, actions that do not require a Federal permit or that occur on private land are not required to comply with this law.

*National Wildlife Refuge System Administration Act of l966 and the National Wildlife Refuge Improvement Act of 1997*

The National Wildlife Refuge System Administration Act of 1966 authorized the Secretary of the Interior to permit the use of refuges whenever it is determined that such a use is compatible with the purposes for which the area was established (Service 2012b, no pagination). The National Wildlife Refuge Improvement Act of 1997 amended the 1966 Act to specifically state that the mission of the National Wildlife Refuge System is wildlife conservation. It identified a number of wildlife-dependent recreational uses that will be given priority consideration, mandated a long-term refuge planning process, and clarified the process for determining the compatibility of refuge uses (Service 2012c, no pagination). It also mandated that all Service refuges have a Comprehensive Conservation Plan by 2012 (Service 2009, p. 1). The National Wildlife Refuge System is managed by the Service primarily for the benefit of fish, wildlife, and plant resources and their habitats (Service 2009, p. 2).

The Farallon National Wildlife Refuge (Refuge), which was established in 1909, is located approximately 28 mi (45 km) west of San Francisco, and is composed of several islands, including SE Farallon Island. More ashy storm-petrels (about 58 percent) breed at SE Farallon Island than at any other single location (Table 1; Carter *et al.* 1992, p. I-78). On September 24, 2009, the Service published a final Comprehensive Conservation Plan (CCP) and Environmental Assessment to guide natural resources at the Refuge for the next 15 years (Service 2009, p. 1). As stated earlier, ashy storm-petrels at SE Farallon Island are susceptible to predation by western gulls (which breed at the island) and burrowing owls (which do not breed at the island but are regular fall migrants and overwinter at the island). Managers and researchers at the Refuge are concerned about high levels of avian predation upon, and reduced survivorship of, ashy storm-petrels at SE Farallon Island. Consequently, the Refuge proposed the following management actions to occur within 5 years of the publication (Service 2009, p. 86):

- Develop and implement a plan to eradicate the nonnative house mouse through rodenticide application, and prevent future human introductions of mice.
- Monitor and reduce predation on sensitive seabird populations by western gulls; study extent of problem and methods to lower predation rate. Monitor gull nests for seabird remains. Conduct experimental take of no more than 10 specialist gulls (individuals known to predate seabirds in large numbers) annually through a Migratory Bird Treaty Act permit to determine efficacy.
- Until mice are eradicated, translocate individual specialist owls that overwinter on SE Farallon Island.

The management actions in this plan were the basis for the mouse eradication program that is currently in the planning phase and talked about in **Factor C**. Management actions that have occurred to date are the actions associated with monitoring and the development of the plan to eradicate non-native house mice. These management actions, once implemented, may be successful in reducing predation of ashy storm-petrels by western gulls and burrowing owls at SE Farallon Island, which, in turn, may result in an increase in productivity and survivorship of ashy storm-petrels. The proposed management actions in the Refuge's CCP, including the mouse eradication plan, will likely benefit ashy storm-petrels at SE Farallon Island, where an estimated 58 percent of all breeding ashy storm-petrels occur because they will result in a reduction or elimination of known predators of the species.

*National Park Service Organic Act*

On August 25, 1916, the National Park Service Organic Act (16 U.S.C. l *et seq.*) established the National Park Service (NPS), whose purpose "is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 U.S.C. 1; NPS 2012, no pagination). On

March 5, 1980, Congress established as the Channel Islands National Park (Park) the islands of San Miguel, Santa Rosa, Santa Cruz, Anacapa, Santa Barbara, and the submerged lands and waters within 1 nautical mi (1.8 km) of each island (16 U.S.C 410ff). In 2007, in accordance with 36 CFR, Parts 1–7, the Park prohibited access by visitors on: 1) Offshore rocks and islets in the Park; 2) Bat Cave and Cavern Point Cove Caves, Santa Cruz Island; and 3) shorelines and cliffs at Santa Barbara Island, to protect wildlife and natural resources, including ashy storm-petrels (NPS 2007, p. 2). The majority of Santa Cruz Island was acquired by The Nature Conservancy and is currently off limits to the public without a permit. Thus, visitor access is prohibited at 18 ashy storm-petrel breeding locations (locations #14–32, Table 1) managed by the NPS, which constitutes approximately 98 percent of the breeding locations in the Channel Islands and approximately 36 percent of the known ashy storm-petrel breeding locations rangewide (Table 1).

*Antiquities Act –California Coastal National Monument*

Under the authority of the Antiquities Act of 1906 (16 U.S.C 431), the California Coastal National Monument (CCNM) was established by Presidential Proclamation number 7264 on January 11, 2000 (64 FR 2821)**.** This Presidential Proclamation defined the CCNM as all unappropriated or unreserved lands and interest in lands owned or controlled by the United States in the form of islands, rocks, exposed reefs, and pinnacles above mean high tide within 12 nautical miles (22 km) of the shoreline of the State of California. The CCNM is comprised of more than 20,000 small islands, rocks, exposed reefs, and pinnacles within the corridor extending 12 nautical miles (22 km) from the shoreline between Mexico and Oregon. The proclamation directed the Secretary of the Interior to manage the CCNM through the Bureau of Land Management (BLM). In 2005, the BLM approved a resource management plan for the CCNM which contains broad direction for the protection of the geologic formations and habitats for seabirds, and focuses on multiagency and other partnerships and involvement of local communities as the keys to management and protection. No motor vehicles or camping are permitted within the monument and pets must be on leash (CCNM p. 2-18). Livestock grazing and resource extraction are also prohibited, as is collection or take of any resources (CCNM, p. 2-6). Because motor vehicles, camping, and resource extraction can disturb ashy storm-petrels in nesting areas, these closures presumably benefit them. Ten ashy storm-petrel breeding locations (locations # 2–6, 11–13, 33, 35, Table 1), which comprise about 1.8 percent of the total known population of breeding ashy storm-petrels, are managed by the BLM.

*Sikes Act*

The Sikes Act of 1960 (16 U.S.C. 670 *et seq.*) authorizes the Secretary of Defense to develop cooperative plans for conservation and rehabilitation programs on military reservations and to establish outdoor recreation facilities, and provides for the Secretaries of Agriculture and the Interior to develop cooperative plans for conservation and rehabilitation programs on public lands under their jurisdiction. The Sikes Act Improvement Act of 1997 required DOD installations to prepare Integrated Natural Resources Management Plans (INRMPs). Consistent with the use of military installations to ensure the readiness of the Armed Forces, INRMPs provide for the conservation and rehabilitation of natural resources on military lands and incorporate, to the maximum extent practicable, ecosystem management principles and provide the landscape necessary to sustain military land uses. Although an INRMP is not technically a regulatory mechanism, because its implementation is subject to funding availability, it is an important guiding document that helps to integrate natural resource protection with military readiness and training. There is currently a draft INRMP for San Clemente Island Naval Auxiliary Landing Field. The INRMP is expected to be finalized in April of 2013.

***INRMP—Naval Auxiliary Landing Field San Clemente Island***

Objectives of the Naval Auxiliary Landing Field San Clemente Island INRMP are to:

• Avoid fixed high-intensity artificial light near ashy storm-petrel breeding sites;
• continue to conserve offshore rocks and other areas where ashy storm-petrels are known to breed;
• Seek opportunities to partner in regional efforts to assess ashy storm-petrel populations and occurrence in the Southern California Bight, as feasible;
• Increase protection of ashy storm-petrel breeding sites on San Clemente Island (not including offshore rocks) through control of nonnative predators;
• Evaluate oil spill response plans for San Clemente Island to assess how they address seabird nesting and modify, if necessary; and
• Continue to resolve baseline biological data gaps.

Additional protections by the Navy are discussed under the *Migratory Bird Treaty Act* section above. The U.S. Navy is currently targeting rats with rodenticide on the island (Booker 2012, pers. comm.), which may benefit the small numbers of ashy storm-petrels that may be nesting there.

Because ashy storm-petrels are attracted to lights, avoiding high intensity lighting near ashy storm-petrel breeding sites will likely reduce the inpact of lights on ashy storm-petrels.

*National Marine Sanctuaries Act*

The National Marine Sanctuaries Act of 1972 (NMSA) (16 U.S.C. 1431 *et seq.*) authorizes the Secretary of Commerce, and specifically NOAA, to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. Within the range of the ashy storm-petrel, the four national marine sanctuaries (NMS) that have been designated in California are: the Channel Islands NMS (CINMS) off the coast of southern California (1980), Gulf of the Farallones NMS (formerly Point-Reyes Farallon Islands NMS (1981)), Cordell Bank NMS off the coast of central California (1989), and the Monterey Bay NMS (1992). In 1989, Congress, in approving the designation of the Cordell Bank NMS, prohibited the exploration for, or the development or production of, oil, gas, or minerals in any area of the Cordell Bank NMS (Pub. L. 101-74, 103 Stat. 554), and NMFS revised its regulations governing prohibited activities in the sanctuary to so prohibit (54 FR 52342 (12/21/1989)). The Oceans Act of 1992 (Pub. L. 102-587, 106 Stat. 5039), which approved the designation of the Monterey Bay NMS, included similar language prohibiting the leasing, exploration of, producing, or developing oil and gas in the Monterey Bay NMS, and includes a requirement for the Secretary to evaluate the substantive progress made by the Sanctuary toward implementing a management plan and goals. In 2007, NOAA expanded the State "no-take" marine reserves and one of the limited take marine conservation areas in the CINMS to include Federal waters out to 6 nautical miles (11 km), which prohibited or limited removal of, and injury to, any CINMS resource, including ashy storm-petrels (NOAA 2007, 72 FR 29208,  29208–29235). Specifically, lobster harvest and recreational fishing for pelagic finfish (with hook and line only) are allowed within the marine conservation area, while all other extraction or injury to CINMS resources are prohibited (NOAA 2007, Id. At  29212). These Federal marine reserves were established in conjunction with State of California regulatory processes (see **State of California Protection** section below).

In December 2012, NOAA published its notice of intent to review the boundaries for the Gulf of the Farallones and Cordell Bank marine sanctuaries to evaluate and assess a proposed expansion of the sanctuaries (77 FR 75601 (December 21, 2012)).  The proposal would add about 2,770 square mi (7,174 square km) to the Gulf of the Farallones and Cordell Bank marine sanctuaries, adding a northern area from Bodega Bay, Sonoma County, to Alder Creek, Mendocino County, and west to the edge of the Continental Shelf, to protect the upwelling source waters of the sanctuaries (77 FR 75601). This would more than double the size of these sanctuaries, extending their northern edge from Bodega Bay up to Point Arena. Although the comment period has opened for these changes, we have no current timeline on when these changes are expected to take effect; NOAA's notice of intent anticipated a process of 18-24 months (NOAA 2012, no pagination; 77 FR 75602).

*Outer Continental Shelf Lands Act*

The Outer Continental Shelf Lands Act of 1953 (OCSLA) (43 U.S.C. 1331 *et seq.*) provides the Secretary of the Interior, on behalf of the Federal Government, with authority to manage the mineral resources, including oil and gas, on the outer continental shelf (OCS), and defines the OCS as all submerged lands lying seaward of the State and Federal boundary. The Federal Oil & Gas Royalty Management Act of 1982 (30 U.S.C. 1701 *et seq.*) mandates protection of the environment and conservation of Federal lands in the course of building oil and gas facilities. The Secretary of the Interior designated the Minerals Management Service (MMS) as the administrative agency responsible for the mineral leasing of submerged OCS lands and for the supervision of offshore operations after lease issuance.

On October 1, 2011, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), formerly the MMS, was replaced by the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement

(BSEE) as part of a major reorganization. Functions of the BOEM include offshore oil leasing, review of oil and gas exploration and development plans, and NEPA analysis. Functions of the BSEE include development and enforcement of safety and environmental regulations, permitting offshore exploration, and inspections of offshore drilling sites (BOEM 2012, no pagination). Within the range of the ashy storm-petrel, the BOEM and BSEE manage the offshore mineral resources of 49 active leases (43 producing and 6 non-producing), in coordination with other Federal, State, and local agencies, and in consultation with the public (Pereksta 2012, pers. comm.).

On August 27, 2012, the Secretary of the Interior gave final approval to the 2012–2017 OCS Oil and Gas Leasing Program. The program was effective on August 27, 2012, and will expire on August 26, 2017. The OCS Oil and Gas Leasing Program for 2012–2017 established a schedule that is used as a basis for considering where and when oil and gas leasing might be appropriate over a 5-year period. The coast of California, including the entire foraging range of the ashy storm-petrel, was not included in 15 potential lease sales, and is therefore unavailable for new exploration and development through the conclusion of this plan in 2017 (BOEM 2012b, no pagination; BOEM 2012c, no pagination). However, new oil resources could be accessed by drilling out from existing platform sites.

*Clean Air Act of 1970*

The Clean Air Act of 1970 (42 U.S.C. 7401 *et seq.*) provides the platform for the Environmental Protection Agency (EPA) to develop and enforce regulations to protect the general public from exposure to airborne contaminants known to be hazardous to human health. In 2007, the Supreme Court held that gases such as carbon dioxide fit within the Clean Air Act's definition of "air pollutant," and thus that EPA has the authority to regulate the emissions of such gases from new motor vehicles (*Massachusetts et al.* v. *EPA*, 549 U.S. 497, 532 (2007). This reduction in carbon emissions will reduce the potential threat of climate change to ashy storm-petrel.

*Oil Pollution Act of 1990 (OPA)*

The Oil Pollution Act of 1990 (33 U.S.C. 2701 *et. seq.*) amended the Clean Water Act and addressed the wide range of problems associated with preventing, responding to, and paying for oil pollution incidents in navigable waters of the United States. It created a comprehensive prevention, response, liability, and compensation regime to deal with vessel- and facility-caused oil pollution to U.S. navigable waters. The OPA increased Federal oversight of maritime oil transportation and provided environmental safeguards by: setting new requirements for vessel construction and crew licensing and manning, mandating contingency planning, enhancing Federal response capability, broadening enforcement authority, increasing penalties and potential liabilities, and creating new research and development programs. Various Federal agencies are responsible for implementing the OPA. EPA is responsible for nontransportation-related onshore facilities and incidents in the Inland Zone, the U.S. Coast Guard (USCG) is responsible for marine transportation-related facilities and incidents in the Coastal Zone, the Maritime Administration (MARAD; in the Department of Transportation) is responsible for promoting the U.S. merchant marine and shipbuilding industry, and the Department of Commerce (specifically, NOAA) is responsible for natural resource damage assessments relating to oil discharges. The OPA requires a phase-out of single-hull tankers (without double bottoms or double sides) from U.S. waters by 2015. Committee on Oil Pollution Act of 1990 *et al.* (1998, p. 147) reports that, although the mandatory phase-out schedule of section 4115 of the OPA banned all single-hull tankers from U.S. trade in 2010, it is probable that under the deep-water port and lightering (cargo transfer) zone exemption, large single-hull vessels up to 30 years of age will operate in the United States through 2015. The OPA imposes liability for removal costs and damages resulting from an incident in which oil is discharged into navigable waters or adjoining shorelines or the exclusive economic zone. In 2006, a damage assessment, restoration plan, and environmental assessment (Luckenbach 2006, pp. 1–165) was presented by Natural Resource Trustee Agencies (Service, NOAA, NPS, and California Department of Fish and Wildlife) for natural resources (including ashy storm-petrels) injured during multiple oil spills that occurred off the coast of San Francisco, California, from 1990 to December 2003.

Ashy storm-petrels have been shown to be susceptible to oil spills. Measures taken to reduce the probabilities of oil spills including mandating oil tankers to have double bottoms and double sides, increasing Federal oversight of maritime oil transportation, learning from past spill damage assessments, and imposing liability costs for oil discharged are expected to reduce the potential threat of oil spills to ashy storm-petrels.

State of California Protection

The California Department of Fish and Wildlife (CDFW; formerly California Department of Fish and Game) is the State agency responsible for managing California's fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. The ashy storm-petrel is designated as a Species of Special Concern by the CDFW (Carter *et al.* 2008, pp. 117–124). This status does not confer regulatory protection to the species, and applies to animals not listed under the Act or the California Endangered Species Act (CESA), but that nonetheless (1) are declining at a rate that could result in listing, or (2) historically occurred in low numbers and known threats to their persistence currently exist. In addition, this designation is intended to result in special consideration for these animals by the CDFW, land managers, consulting biologists, and others, and is intended to: focus attention on the species to achieve conservation and recovery of these animals before they meet CESA criteria for listing as threatened or endangered; stimulate collection of additional information on the biology, distribution, and status of poorly known at-risk species; and focus research and management attention on the species.

California Environmental Quality Act of 1970 (CEQA) does not regulate land use, but requires all local and State agencies to avoid or minimize environmental damage, where feasible, during the course of proposed projects. CEQA provides protection not only for State-listed or Federally listed species, but also for any species designated as Species of Special Concern by the CDFW.

In 1999, the California legislature approved and the governor signed the Marine Life Protection Act (MLPA; Stats. 1999, chapter 1015). The MLPA requires that the CDFW prepare and present to the California Fish and Game Commission (CFGC) a master plan that will guide the adoption and implementation of a Marine Life Protection Program, which includes a statewide network of marine protected areas (MPAs). In 2008, the CDFW published a revised draft plan for marine protected areas in California (CDFW 2008a, pp. 1–113). A California MPA update was released on January 9, 2013 to incorporate north coast Marine Protected Areas. There are various classifications used in California's MPA network. This includes three MPAs and two other designations:

• State Marine Reserve (SMR): Prohibits all take and consumptive use (commercial and recreational, living or geologic). Scientific research, and nonconsumptive uses are allowed.
• State Marine Park (SMP): Prohibits commercial take but may allow select recreational harvest to continue. Scientific research and nonconsumptive uses are allowed.
• State Marine Conservation Area (SMCA): May allow select recreational and commercial harvest to continue. Scientific research and nonconsumptive uses are allowed.
• State Marine Recreational Management Area (SMRMA): Provides subtidal protection equivalent to an MPA, while allowing legal waterfowl hunting. Scientific research and nonconsumptive uses are allowed.
• Special closures: Geographically specific area that prohibits human entry. Special closures are smaller in size than MPAs and are designed to protect breeding seabird and marine mammal populations from humans (CDFW 2013a, p. 1).

The statewide coastal network of MPAs includes 124 MPAs and 16 special closures covering approximately 852 square mi (2207 square km) of State waters and representing approximately 16 percent of all coastal State waters (CDFW 2013a, p. 1). A map of these areas can be found at http://www.dfg.ca.gov/mlpa/. There are several protections that this provides for ashy storm-petrel. For example, vessels are prohibited within a certain distance of the SE Farallon Island and speed is limited at further distances where a muffler or dry exhaust system is required for vessels to reduce noise (CDFW 2013b, pp. 52-59). This consequently also reduces the potential impacts of lights from boats within a certain distance to the Island. These prohibitions reduce potential disturbance to ashy storm-petrel. The Marine Life Protected Area plans also consolidate all limitations to these areas in one place.

On March 25, 2005, the CFGC adopted the Market Squid Fishery Management Plan (CDFW2005, pp. 1–558), which: (1) Limits the wattage of attracting lights (see Factor E below) to a maximum of 30,000 watts per boat; (2) requires that attracting lights be shielded to direct the light downward, or situated such that the illumination is completely submerged underwater; and (3) prohibits, at any time, the use of attracting lights for the purpose of taking of market squid in all waters of the Gulf of the Farallones NMS. In 1993, Assembly Bill (AB) 14 (Hauser) restricted vessels from the use of squid attracting lights in District 10 (ocean waters of San Mateo, San Francisco, Marin, and Sonoma

Counties) (CDFW 2005, p. I-54). No lights are permitted within 1 nautical mile of San Miguel, Anacapa, and Santa Barbara Islands, from February 1 to September 30 (CDFW 2005, p. 2-14). In addition, squid fishery activities are not permitted within 11 marine reserves and 2 marine conservation areas in southern California, which collectively contain seven ashy storm-petrel breeding locations. These regulatory measures collectively prohibit the use of bright lights for commercial fishing at a total of nine confirmed ashy storm-petrel breeding locations: Bird Rock, Stormy Stack, SE Farallon Island, San Miguel Island, Prince Island, Anacapa Island, Santa Barbara Island, Sutil Island, and Shag Rock, which constitute approximately 85.01 percent of the rangewide population. However, ashy storm-petrels are known to forage great distances from their breeding sites and, therefore, could still be affected by lights in other areas.

Mexican Federal Protection

The ashy storm-petrel is currently listed as endangered under Mexican Law, NOM–059–ECOL–2001 (SEMARNAT 2010, p. 39). Pursuant to this law, general criteria are to be followed in managing Mexican wildlife, including but not limited to preservation of biodiversity and natural species habitats and preservation of endemic, threatened, endangered, or specially protected species. These considerations apply to all of the ashy storm-petrels found in Mexico, which constitute approximately 3.43 percent of the rangewide population. Information is not available on the adequacy and effectiveness of threatened or endangered status for conservation of ashy storm-petrels in Mexico.

International Agreements

*International Conference on Marine Pollution: Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978*

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL Convention was adopted on November 2, 1973 at International Maritime Organization (IMO 2012, no pagination). MARPOL has been successful in reducing operational discharges of oil by 85 percent between 1973 and 1990 (Hamton *et al.* 2003, p. 30).

**Factor E: Other Natural or Manmade Factors Affecting the Continued Existence of the Species**

Artificial Light Pollution

Light-induced collisions and mortality of ashy storm-petrels at sea and on land have been reported by researchers. Carter *et al.* (2000, p. 443) reported two specimens of ashy storm-petrels (archived at the Santa Barbara Natural History Museum, Santa Barbara, California (SBNHM)) that were recovered dead on an offshore oil platform (Platform Honda) located approximately 5 mi (8 km) off the coast of southern California. Carter *et* *al.* (2000, p. 443) reported six ashy storm-petrel carcasses (also archived at SBNHM) that were recovered from six mainland locations (from Goleta to Point Mugu) with bright lights in southern California. The Service is aware of at least seven additional museum specimens of ashy storm-petrels that were collected at mainland locations in California with bright lights; all were collected during autumn months (Ornithological Information System (ORNIS) 2008, pp. 1–7). We are aware of, in total, 15 museum specimens of ashy storm-petrels collected at lighted offshore energy platforms (two specimens) or brightly lit coastal mainland locations (13 specimens) (Carter *et al.* 2000, p. 443; ORNIS 2008, pp. 1– 7).

Direct observations of ashy storm-petrels around bright lights during autumn months support Imber (1975, p. 304), who states that juvenile procellariids are likely more attracted to lights than adults. Similarly, most of the museum specimens from mainland locations and offshore platforms were collected in the Fall and may have been juvenile birds. In a study of migratory passerine birds in the Gulf of Mexico, Russell (2005, p. 4) reported that lighted offshore platforms attract birds, induce nocturnal circulations of platforms, and result in mortality of birds through collision.

In their study of four species of procellariids (Barau's petrel (*Pterodroma baraui*), Mascarene petrel (*Pseudobulweria aterrima*), Audubon's shearwater (*Puffinus lherminieri bailloni*), wedge-tailed shearwater (*Puffinus pacificus*)) on Réunion Island in the Indian Ocean, Le Corre *et al.* (2002, p. 93) reported that birds that collided with lights then fell to the ground with fatal injuries, were killed by predators, or died of starvation, and that 94 percent of these procellariids were juveniles. Le Corre *et al.* (2002, p. 97) found that the geographic distribution of the mortality to Barau's petrel (due to attraction to bright lights at night) depended on the location of urban and industrial areas in relation to the distribution of breeding colonies. At Réunion Island, light sources were urban, stationary, and functioned continuously at night (Le Corre *et al.* 2002, p. 96).

Ashy storm-petrels have also been observed flying at night around bright lights at various lighted locations adjacent to San Francisco Bay including Giant's Stadium on several occasions during autumn months over the past several years. Capitolo 2005 (pers. comm.); Capitolo 2008 (pers. comm.). LeValley 2008 (pers. comm.) described the storm-petrels as juveniles, based upon plumage characteristics, and observed that on at least two occasions the storm-petrels flew to and landed in the lights.

Light-induced collisions and mortality of storm-petrels also have been reported at breeding locations. James-Veitch (1970, p. 40) reported that ashy storm-petrels collided with a lamppost on SE Farallon Island. Wolf (CBD 2008, p. 8) observed storm-petrels flying around the lighthouse light at West San Benito Island, Mexico, a breeding location for Leach's and least storm-petrels. She also observed many hundreds of dead storm-petrels of unknown species that had accumulated below the window that enclosed the lighthouse light, after attraction to the light and apparent collision with the glass. The period over which the storm-petrels collided with and accumulated under the window is unknown; in addition, the actual number and identification to species level is undocumented.

Several researchers (Gross 1935, p. 387; James-Veitch 1970, p. 65; Ainley 1995, p. 5) have reported that aerial activities by storm-petrels at their nesting grounds decreased on bright moonlit nights. Watanuki (1986, pp. 14–22) showed that colony activity levels of Leach's storm-petrels were inversely correlated with light intensities and the corresponding risk of predation by slaty-backed gulls (*Larus schistisagus*). Oro *et al.* (2005, p. 425) reported that predation of European storm-petrels (*Hydrobates pelagicus*) by yellow-legged gulls (*L. michahellis*) was much higher at a cave that received stronger illumination from the city of Benidorm, Spain, located approximately 1.9 mi (3 km) from the storm-petrel colony. Data in Keitt (2004, p. 176) supported their hypothesis that a function of nocturnal activity patterns in the black-vented shearwater (*Puffinus opisthomelas*) was reduction in the likelihood of predation by western gulls. Since procellariids have been shown to use the cover of darkness as a defense against predation at their nesting colonies, it is paradoxical that procellariids, including storm-petrels, are also attracted to bright lights (Montevecchi 2006, p. 94). Imber (1975, p. 305) suggested that the attraction is an artifact of their visual cueing towards bioluminescent prey.

Evidence from several studies, anecdotal observations, and museum specimens indicate that ashy storm-petrels are attracted to lights, which puts them at risk of light-induced mortality (Reed *et al.* 1985, pp. 377–383; Le Corre *et al.* 2002, pp. 93–102). These museum collections and direct observations demonstrate that ashy storm-petrels are attracted to light that occurs far from ashy storm-petrel breeding locations. Mortality to breeding and nonbreeding ashy storm-petrels could occur through direct collision with lights, and ashy storm-petrels, exhausted after constant circling of lights, could be susceptible to predation by gulls, which are also known to concentrate around lighted boats, presumably to feed on squid (Shane 1995, p. 10; McIver 2009, pers. obs.). Distraction as a result of lighting can result in decreased foraging time and, consequently, decreased productivity for the ashy storm-petrel. Below we discuss artificial light pollution at breeding colonies and at sea in detail.

*Artificial Light Pollution—Market Squid Fishery and Tuna Aquaculture*

The California market squid is found from central Baja California, Mexico, to SE Alaska (Roper and Sweeney 1984, pp. 95–96). In California, a fishery for market squid consists of two geographically distinct components: a central California fishery off the coast of Monterey and a southern California fishery around the Channel Islands and along the mainland coast (Pomeroy and Fitzsimmons 2001, p. 3). Off the coast of Monterey, squid fishery activities occur in the southern part of Monterey Bay between Point Pinos and Fort Ord (Recksiek and Frey 1978, p. 9). The Service is not aware of any market squid fishery activities at Islas Los Coronados and Islas Todos Santos, which are known ashy storm-petrel breeding locations in Mexico.

Regulatory measures collectively prohibit the use of bright lights for commercial fishing from February 1st to September 30th within 1 nautical mile of nine confirmed ashy storm-petrel breeding locations: Bird Rock, Stormy Stack (District 10), SE Farallon Island, San Miguel Island, Prince Island, Anacapa Island, Santa Barbara Island, Sutil Island, and

Shag Rock (CDFW 2005, p. 2-14), which constitute approximately 85.01 percent of the rangewide population. Squid lights are also prohibited within 1 nautical mile of the Gulf of Farallons from February 1st to September 30th. However, because ashy storm-petrels are known to forage hundreds of miles from their breeding grounds, they are still susceptible to squid lights when foraging.

Market squid spawn in sandy substrates near islands and the coast (California Fish and Game Commission 2005, p. 37). Harvest involves luring the squid to the surface with high wattage lamps, encircling them with purse seine nets, pumping, and using nets to remove the squid from the water, and finally storing them in an on-vessel fish hold (Hastings and MacWilliams 1999, p. iv). Market squid fishery activities occur during squid mating and egg-laying: April through October in central California, and October through May in southern California (Pomeroy and Fitzsimmons 2001, pp. 2–3; California Fish and Game Commission 2005, p. 37). Market squid fishery activities coincide with the ashy storm-petrel's peak fledging period (early to mid-October) and pre-egg and early egg-laying (February through May) periods (Ainley 1995, p. 5; McIver 2002, p. 17). Newly fledged juveniles could be drawn to the nearby offshore lights and this distraction could alter their feeding habits.

Market squid fishing generally coincides with spawning events, and in central California squid spawning occurs from April to October (CDFW 2005, pp. 1–21). During autumn months (generally September and October), thousands of ashy storm-petrels congregate in the bay in deeper waters over the Monterey Submarine Canyon (Roberson 1985, p. 43). Depending on location, flocks generally occur 3 to 25 mi (5 to 40 km) from squid fishing areas. Shearwater Journeys, a birdwatching concessionaire in Monterey, California, observed large flocks (estimated 7,000 to 10,000 birds) of ashy storm-petrels in September 2008 on Monterey Bay (Shearwater Journeys 2008, *http://www.shearwaterjourneys.com/index.shtml*). Since storm-petrels are known to be attracted to boats and brightly lit facilities on the mainland, the ashy storm-petrels in these large flocks may be attracted to lights from boats in Monterey Bay during autumn nights. Assuming a total population of 19,657 ashy storm-petrels, and autumn flock sizes of 7,000 to 10, 000 in Monterey Bay, approximately 36–51 percent of the total population of ashy storm-petrels theoretically could be exposed to this potential threat. This estimate includes ashy storm-petrels that come from SE Farallon Island only at this time of year. However, market squid fishing in northern California including Monterey Bay largely occurs during daylight hours (CDFW 2008b, p. 20; Pacific Fishery Management Council 2008, p. 44) rather than at night, when ashy storm-petrels feed and would be susceptible to lights.

In California, market squid fishery activities are permitted at 21 ashy storm-petrel breeding locations. Although we are not aware whether market squid fishing occurs at ashy storm-petrel breeding locations in Mexico, we are aware of aquaculture activities associated with the harvest of northern bluefin tuna (*Thunnus orientalis*) at Islas Los Coronados and Islas Todos Santos, Mexico, which use bright lights to illuminate at-sea tuna pens (Zertuche-Gonzáles *et al.* 2008, p.14; McIver 2009, pers. obs.). Therefore, bright lights associated with commercial fishing activities (market squid fishery and tuna aquaculture) are permitted at 23 locations, which serve as breeding grounds for approximately 14.9 percent of all breeding ashy storm-petrels.

The timing of squid boat light impacts is “ongoing.” The entire ashy storm-petrel population is subject to squid boat light impacts while foraging, making this threat “pervasive” throughout the species’ range. Approximately 14.9 percent of all ashy storm-petrels at breeding locations may be exposed to lighting within 1 nautical mile of their breeding grounds. Ashy storm-petrels are attracted to commercial fishery lights near breeding locations. Mortality of ashy storm-petrels as a result of this attraction, although not quantified, likely occurs. The threat of fishery-related lighting is not expected to increase to any large degree in the near future due to implementation of regulations by the State of California limiting wattage of lighting and location of fishing activities. This is discussed further in the **Inadequacy of Existing Regulatory Mechanisms** section above. The best available scientific information indicates that the severity of this threat is “slight” (likely to destroy and eliminate the habitat or reduce the species population by 1–10 percent within the 100 percent scope of the range where the species is affected) because restrictions on lighting are in place, northern fishereries are primarily conducted during the day, there is limited documented mortality from this threat, and this threat does not appear to be driving population trends.

*At-sea Artificial Light Pollution—Offshore Energy Platforms*

Within the range of the ashy storm-petrel, the BOEM and BSEE manage the offshore mineral resources of 49 active leases (43 producing and six non-producing) located adjacent to or under 23 platforms (BOEM 2013, no pagination). The six non-producing leases have the potential to go into production using the existing platforms. All of the currently operational platforms occur within the at-sea range of foraging ashy storm-petrels (Briggs *et al.* 1987; p. 23 Mason *et al.* 2007, pp. 56–59; Adams and Takekawa 2008, pp. 12–13). Offshore oil production platforms in California have bright incandescent lights that serve as maritime navigational aids and illuminate working platforms and walkways at night.

Field demonstration tests with alternative and reduced lighting on an offshore oil platform in the North Sea reduced passerine bird occurrence by 50–90 percent (Marquenie and van de Laar 2004, p. 6; Marquenie *et al.* 2008, pp. 2–4). Our review of the available information did not find any similar tests on oil production platforms in southern California.

Oil production platforms are located within 150 mi (240 km) of all Channel Island ashy storm-petrel breeding locations, well within the species’ foraging distance from breeding colonies (220 mi (354 km)) (Adams and Takekawa 2008, p. 13). Accordingly, we conclude that about 37 percent of the total population of ashy storm-petrels (100 percent of the ashy storm-petrels that breed in the California Channel Islands) may be exposed to the effects of bright lighting from offshore energy platforms making the scope “large.” Timing of lighting from oil production platforms is “ongoing.” In summary, based on observations of ashy storm-petrels collected dead from an offshore oil platform and from brightly lit mainland locations, and recent observations of ashy storm-petrels attracted to bright lights at a variety of facilities, we have information that ashy storm-petrels are susceptible to bright lights on structures in their oceanic environment. This threat likely results in some (but unknown) level of mortality. The best available scientific information indicates that the severity of platform light effect is “slight” (likely to destroy or eliminate the habitat or reduce the species population by 1–10 percent within the 37 percent scope of the range where the species is affected) because restrictions on lighting are in place, there is limited documented mortality from this threat, and this threat does not appear to be driving population trends.

Oil Pollution—Offshore Energy Production Platforms

The largest oil spill from offshore oil operations in California was the 80,000-barrel (3,360,000-U.S. gallon) Santa Barbara spill from Platform A in 1969, which resulted in the deaths of thousands of birds (McCrary *et al.* 2003, p. 46). Since 1969, only one spill in California from offshore oil and gas operations,  the 163-barrel (7,000-gallon) Platform Irene pipeline spill, off Point Arguello in 1997, has resulted in documented seabird mortality (more than 700 birds) (McCrary *et al.* 2003, p. 46; Torch/Platform Irene Trustee Council 2007, p. 3). Oiled ashy storm-petrels were not documented during either of these spills. Applying information on estimated spill size and spill probability to potential impacts on seabirds is difficult because of many factors, including the type, rate, location, and volume of oil spilled, weather and oceanographic conditions, timing of the spill, distribution of seabird species nearby, and behavior of seabirds in reaction to oil slicks (Ford *et al.* 1987, p. 549; McCrary *et al.* 2003, p. 46). There will be no new leasing or exploration of coastal areas within the range of the ashy storm-petrel through 2017 (BOEM 2012c, no pagination) (see the **Inadequacy of Existing Regulatory Mechanisms** section above). However, new oil resources could be accessed and extracted by drilling out from existing platform sites.

The probability of one or more spills for the 50 to less than 1,000 barrels of oil (bbl) size range using oil spill data from all US Outer Continental Shelf (OCS) operations (1996 – 2010) is 99.7 % and 83.3 % using oil spill data from Pacific Outer Continental Shelf Region operations (1964 – 2011) (Pereksta 2013b, pers. comm.). The lower probability of spills using oil spill data from the Pacific OCS operations is reflective of the lower number of oil spills throughout production history (Pereksta 2013b, pers. comm.). Using oil spill data from all US OCS operations (1996 – 2010), there is a 40.2 percent probability that a spill equal to or greater than 1,000 bbl could occur as a result of ongoing operations in the POCSR and the probability of this size spill was not calculated using oil spill data from POCSR operations only due to the limited dataset (1 spill > 1,000 bbls occurred in 1969) (Pereksta 2013b, pers. comm.). This is a conservative estimate based on overall US OCS operations and this would be an unlikely event in the POCSR. If a spill was to occur, ashy storm-petrels would likely be attracted to the bright lights associated with the platforms and this could result in additional negative impact on the species. Results of oil spills can not be predicted and depend on environmental conditions present at the time of the spill including wind speed and direction and prevailing ocean currents.

In 2006, Esperanza Energy, LLC, announced plans to file applications with State and Federal agencies to build a floating Liquified Natural Gas receiving facility 15 mi (24 km) from the Port of Long Beach (Esperanza Energy 2006, no pagination; CEC 2011, no pagination). This project is currently on hold.

Based on information available to the Service regarding offshore oil production, we conclude that about 37.62 percent of the total population (entire Channel Islands population) of ashy storm-petrels could potentially be exposed to oil spills from offshore energy platforms. Therefore the scope is “large.” However, predicting the possible effects of an oil spill from an offshore energy production platform is difficult and would depend on the timing and amount of a spill, prevailing ocean currents and conditions, and locations of ashy storm-petrels at the time of the spill. The timing of an oil spill from energy platforms is “near term future/long term future.” The best available scientific information indicates that the severity of an oil spill resulting from offshore energy platforms is “slight” (likely to destroy or eliminate the habitat or reduce the species population by 1–10 percent within the 37.62 percent scope of the range where the species is affected) because oil spills of over 1, 000 bbls are rare, with the last one occurring in 1969, and impacts would likely be limited to one or two seasons.

Oil Pollution—Vessels

Hampton *et al.* (2003, p. 29) summarized previous reports and showed that, during the 20th century, hundreds of thousands to millions of seabirds, especially common murres (*Uria aalge*), were killed by oil pollution from oil tankers and other marine vessels in central California. Hampton *et al.* (2003, p. 30) estimate that approximately 20 tankers per week arrive at and depart ports in California, where large oil transfer facilities occur in San Francisco Bay and Long Beach Harbor (Los Angeles) (California Resources Agency 2008, p. 5F-6). Ports for nontanker marine vessels (for example, dredges, cargo vessels) occur at numerous locations along the California and northwestern Baja California coasts. Tankers traveling along the coast stay about 50 mi (80 km) offshore, in accordance with a voluntary agreement with State and Federal agencies (Hampton *et al.* 2003, p. 31). Hampton *et al.* (2003, p. 30) showed that oil spill accidents with nontanker vessels are the most common in California, and that small volumes of oil may kill large numbers of birds. In an examination of shipping practices, Hampton *et al.* (2003, pp. 30–32) suggested that the dumping of tanker washings could occur several times per week off the California coast, which could produce the equivalent of a small (approximately 10,000-U.S. gallon) oil spill, and that dumping of tanker washings could pose a greater threat to offshore (greater than 50 mi (80 km) out) seabird species, including ashy storm-petrels, than to species occurring closer inshore. MMS (2001, p. xix) reported a 90.5 percent probability of a 22,800-barrel (957,600 U.S. gallons) tanker spill in waters of the OCS during 2002–2030. Updated spill probability information, such as that for oil platforms or probabilities for the POCSR, is not available at this time.

Oiled ashy storm-petrels have been collected in California. Specifically, two ashy storm-petrels were collected between 1997 and 2003, in association with “mystery spills” attributed to the *S.S. Jacob Luckenbach*, which sank in the Gulf of the Farallones in 1953, and leaked oil on the ocean floor as it decayed (Luckenbach Trustee Council 2006, pp. i, 65). Major oiling events attributed to the *S.S. Luckenbach* occurred every few years from 1973 through 2002 (Luckenbach Trustee Council 2006, pp. i, 65) when the ship was sealed (see the **Conservation Efforts** section). Small seabirds (including ashy storm-petrels) may be more susceptible to mortality due to predation after oiling, and the degree of at-sea loss is likely higher with offshore species (Ford *et al.* 1987, pp. 549–550). Although specific mortality for ashy storm-petrels was not estimated during the *S.S. Luckenbach* spill event, it was presumed that the ratio of actual dead to recovered dead was similar to that of ancient murrelets (*Synthliboramphus antiquus*) and Cassin's auklets, and that total mortality for ashy storm-petrels was approximately 21 individuals (Luckenbach Trustee Council 2006, p. 65).

During autumn months (generally September and October), thousands of ashy storm-petrels congregate in the bay in deeper waters over the Monterey Submarine Canyon (Roberson 1985, p. 43). Shearwater Journeys, a birdwatching concessionaire in Monterey, California, observed large flocks (estimated 7,000 to 10,000 birds) of ashy storm-petrels in September 2008 on Monterey Bay (Shearwater Journeys 2008, *http://www.shearwaterjourneys.com/index.shtml*). Since storm-petrels are known to be attracted to boats and brightly lit facilities on the mainland, the ashy storm-petrels in these large flocks may be attracted to lights from boats in Monterey Bay during autumn nights. Assuming a total population of 19,657 ashy storm-petrels, and autumn flock sizes of 7,000 to 10,000 in Monterey Bay, approximately 36–51 percent of the total population of ashy storm-petrels theoretically could be exposed to an oil spill in the vincinity of Monterey Bay.

Based on information available to the Service regarding oil tanker traffic off the coast of California, ashy storm-petrels are exposed to the possibility of oil spills throughout their range and, therefore, the scope of oil spills is "pervasive." The timing of oil spills is "near term future/long term future." In addition, because oiled ashy storm-petrels have been recovered from vessel-related spills (the *S.S Luckenbach*), we know that the species is susceptible to oiling. Predicting the possible effects of an oil spill from tankers is difficult and would depend on the timing and amount of a spill, prevailing ocean currents and conditions, and locations of ashy storm-petrels at the time of the spill. Since thousands of ashy storm-petrels congregate in Monterey Bay every Fall, the species could be vulnerable to a tanker spill near Monterey Bay at that time of year. However, the Service has no information indicating that tanker spills in Monterey Bay are predictable or likely. We conclude that the best available scientific information indicates that the severity of oil spills is "slight" (likely to destroy or eliminate the habitat or reduce the entire species population by 1–10 percent) because even if a large spill were to occur, the impact would likely be similar to the impact of the Luckenbach spill that killed an estimated 21 ashy storm-petrels, well within the slight threshold of 10 percent of the population. A small spill would likely result in limited impact to the species.

Organochlorine Contaminants

From the late 1940s to the early 1970s, Los Angeles area industries discharged and dumped thousands of tons of DDT and PCBs into ocean waters off the southern California coast (Department of Commerce 2001, p. 51391). Almost all of the DDT originated from the Montrose Chemical Corporation's manufacturing plant in Torrance, California, and was discharged into Los Angeles County sewers that empty into the Pacific Ocean at White Point, on the Palos Verdes shelf (Department of Commerce 2001, p. 51391). In addition, large quantities of PCBs from numerous sources throughout the Los Angeles basin were released into ocean waters through the Los Angeles County sewer system (Department of Commerce 2001, p. 51391).

Most organochlorine pesticides are hydrophobic (they tend to repel and do not mix with water) and show a high affinity for lipids (fatty acids and their derivatives) (Portman and Bourne 1975, p. 294). Bioaccumulation is defined as an increase in the amount of a substance in an organism or part of an organism that occurs because the rate of intake exceeds the organism's ability to remove the pesticide from the body (Holland 1996, p. 1170). Biomagnification is the increasing concentration of a substance at successively higher levels of the food chain (Holland 1996, p. 1171). Storm-petrels feed on prey at the ocean's surface that contain high concentrations of lipids, such as euphausiids, larval fish, fish eggs, and squid (Watanuki 1985, p. 885; Warham 1990, p. 186); while the diet of ashy storm-petrels has not been well-studied, it likely includes similar high-lipid prey, which would make ashy storm-petrels susceptible to bioaccumulation and biomagnification.

Eggshell thinning caused by dichlorodiphenyldichloroethylene (DDE), a metabolite of DDT, results in crushed eggs during incubation, and thus breeding failure of many fish-eating birds (Fry 1995, p. 168). DDT-induced eggshell thinning caused reproductive failures of brown pelicans (*Pelecanus occidentalis*), bald eagles, and peregrine falcons in the California Channel Islands (Hickey and Anderson 1968, pp. 271–273; Risebrough *et al.* 1971, pp. 8–9; Gress *et al.* 1973, pp. 197–208). Concentrations of DDE in ashy storm-petrel eggs have been linked with eggshell thinning and lower hatching success (Carter *et al.* 2008c, p. 4).

Coulter and Risebrough (1973, pp. 254–255) first reported eggshell thinning in the ashy storm-petrel in the early 1970s. Ashy storm-petrel eggs were also collected for contaminant analyses and eggshell measurements in 1992 (Kiff 1994, p. 3), 1995–1997 (Welsh, unpubl. data), and 2008 (Cater *et al.* 2008, p. 2). Of the eggs collected in 1992, ashy storm-petrel eggs had the highest levels of total DDT and PCBs, relative to other seabird species; averages of total DDT and PCBs in ashy storm-petrel eggs were the highest of any of the 13 species examined, and almost twice the levels observed in the second most contaminated eggs (Fry 1994, p. 30). Kiff (1994, pp. 1–29) compared eggshell thicknesses of ashy storm-petrel eggs collected before 1947 (before contamination) to eggshell thickness of eggs collected in 1992 and reported that 27.8 percent of the ashy storm-petrel eggs collected from Santa Cruz Island ($n$ = 18) were 15 percent thinner than the pre-1947 average.

Based on findings from 12 ashy storm-petrel eggs collected in 2008, Carter *et al.* (2008,

p. 4) reported statistically significant declines ($p<0.0001$) in levels of DDE and PCBs in ashy storm-petrel eggs collected in 2008, compared to eggs collected in the 1990s. Organochlorine contaminant levels and reproductive success of ashy storm-petrels in southern California were not measured or monitored prior to the 1990s; however, Carter *et al.* (2008, p. 5) suggested that higher organochlorine concentrations may have contributed to the lower hatching success and lower population size of ashy storm-petrels in southern California during the 1980s than in the 1990s. During 1995–1997, a higher proportion of broken eggs were found than in 2005–2007 (McIver *et al.* 2009b, p. 275). McIver *et al.* 2009b (p. 275) reported that hatching success at Santa Cruz Island differed significantly among years, with lowest success in 1996 (53.5 percent, $n$ = 187) and highest success in 2006 (82.0 percent, $n$ = 61). They speculated that DDE-induced eggshell thinning likely contributed to lower hatching success at Santa Cruz Island from 1995–1997, which likely explained (in part) the relatively high proportion of broken eggs found at all Santa Cruz Island locations monitored (McIver *et al.* 2009 p. 275). Carter *et al.* (2008, p. 5) concluded that DDE and total PCBs decreased to much lower levels between 1992 and 2008, and that, from 1992–1997, relatively high contaminant levels and associated eggshell thinning and premature embryo deaths likely were significant contributing factors to the relatively low hatching success observed during this period. However, broken eggs continued to occur in 2005–2007, likely reflecting continued contaminant effects (McIver *et al.* 2009b, p. 275).

Based on information available to the Service, ashy storm-petrels have been exposed (likely through their food resources) to organochlorine contaminants throughout their foraging range. Organochlorines are "pervasive," but this exposure has likely been greater for ashy storm-petrels breeding in the Channel Islands and foraging in nearby waters because higher concentrations are found in these areas. We conclude that organochlorine contaminants are still present in ashy storm-petrels and, therefore, the timing of organochlorine impacts is "ongoing," but preliminary results indicate that current levels of contaminants are much reduced compared to levels observed in the 1990s. In addition, fewer numbers of broken eggs and higher hatching success of ashy storm-petrels at Santa Cruz Island may be explained, in part, by reduced organochlorine contamination. We expect legacy DDT in the ocean to continue to decline into the future. Therefore, the best available information indicates that, although organochlorine contaminants may have been a greater problem in the past, they currently represent a "slight" threat to the ashy storm-petrel (likely to destroy or eliminate the habitat or reduce the entire species population by 1–10 percent within the 100 percent scope).

Ingestion of Plastics

Ingestion of plastics by seabirds is well documented (Blight and Burger 1997, pp. 323–324; Spear *et al.* 1995, p. 123). Plankton-feeding seabirds, such as ashy storm-petrels, are more likely to confuse plastic pellets for their prey than are fish-eating seabirds; therefore, the plankton-feeding seabirds show a higher incidence of ingested plastics (Azzarello and Van Vleet 1987, p. 295). Two studies have documented the presence of plastic particles in storm-petrel species that forage in the California Current. Blight and Burger (1997, pp. 323–324) dissected seabirds caught as bycatch in the eastern North

Pacific, and they found plastic in all eight storm-petrel (Leach's and fork-tailed) carcasses they collected. The number of pieces of plastic in each bird was highest for the two species of storm-petrels and a Stejneger's petrel (*Pterodroma longirostris*). Shuiteman (2006, p. 23) found plastic particles in regurgitation samples of Leach's storm-petrels caught in mist nets on Saddle Rock, Oregon.

At-sea surveys for plastic particles off the coast of southern California (Moore *et al.* 2004, pp. 1–6) in 2000 and 2001 are the only research available to the Service that have attempted to quantify the amount of plastics in waters within or near the foraging range of ashy storm-petrels. Moore *et al.* (2004, pp. 2–3) reported densities of up to 7.25 plastic pieces less than about 0.2 inches (5 mm) in diameter per cubic meter of water sampled. As stated in the **Food Habits** section above, ashy storm-petrels, like other storm-petrel species, feed by picking prey from the surface of the ocean. Because plastic ingestion by storm-petrels has been well-documented, it follows that ashy storm-petrels also ingest plastic. However, the incidence of plastic ingestion by ashy storm-petrels has not been specifically evaluated (such as by necropsy or analysis of regurgitations). In addition, plastic ingestion has not been reported as a cause of death of ashy storm-petrel chicks or adults (Ainley *et al.* 1990, pp. 128–162; McIver 2002, pp. 17–49), and the degree to which the ingestion of plastic may affect ashy storm-petrels is not known (Ainley 1995, p. 9). Plastics pellets collected from beaches around the world have been shown to contain PCBs and organochlorine pesticides (Mato *et al.* 2001, no pagination; Colabuono *et al.* 2010, p. 1). When ashy storm-petrels eat plastic, these chemicals could be transferred to the birds and may have detrimental effects (see the **Organochlorine Contaminants** section above).

Based on information available to the Service regarding the presence and availability of plastic particles in the marine environment used by ashy storm-petrels and the propensity for storm-petrels to ingest plastic, we recognize that nearly all ashy storm-petrels have the opportunity to ingest plastic, making plastics "pervasive" throughout the range. However, no information is available on the rate of ingestion and the impacts to ashy storm-petrels from plastic ingestion. We also recognize that plastic particles will continue to be ubiquitous in the future in the waters of the California Current, where ashy storm-petrels feed, making the timing of impacts to be "ongoing." We conclude that plastics are a "slight" threat to ashy storm-petrel (likely to destroy or eliminate the habitat or reduce the species' population by 1–10 percent within the 100 percent scope) because the best available information does not show that consumption of plastic is resulting in high mortality or driving population trends.

## Cumulative Effects

A species may be affected by a combination of factors. Within the preceding review of the five listing factors, we identified multiple threats that may have interrelated impacts on the ashy storm-petrel or its habitat. In the northern portion of its range, the greatest threat to ashy storm-petrel populations is from avian predation (Factor C). On SE Farallon Island, burrowing owls and western gulls prey on ashy storm-petrels breeding on the island. Together, these two predators have been shown to have short-term population effects on the ashy storm-petrel population on the island. Invasive New Zealand spinach

(Factor A) restricts access to ashy storm-petrel nest sites for a portion of the population during the height of the breeding season, which likely results in some ashy storm-petrels remaining at the entrance of crevice breeding sites for a longer period of time. This longer entrance time further increases vulnerability of ashy storm-petrels to avian predation from burrowing owls and western gulls (Factor C). The best available current information does not show that these impacts are resulting in a long-term downward trend in the species population on the Farallon Islands.

Oceanic foraging habitat is expected to have declining resources into the future. A number of oceanic threats, including warming sea temperatures and ocean acidification (Factor A) that will affect food resources available to the ashy storm-petrel throughout its range are expected to increase in the future. As the abundance of plastics continues to increase into the future, ingestion of plastics (Factor E) by seabirds will increase in unison with the effects of climate change (Factor A). Less food in the ocean due to warming sea temperatures and ocean acidification (Factor A) combined with plastic in the ocean (Factor E) will result in less food available to ashy storm-petrel. Lights from offshore energy platforms and squid fishing vessels will continue to distract ashy storm-petrels within their vicinity and can result in direct collisions and mortality (Factor E); moreover, exhausted after circling lights, ashy storm-petrels may be more vulnerable to predation by gulls (Factor C), which concentrate around lighted boats to feed on squid. We do not have any evidence at this time that less food availability or decreased fitness will lead to more collisions with lights that result in mortality.

Sea level rise in the Channel Islands is predicted to inundate portions of sea caves, causing the future loss of nesting habitat in areas used by nesting petrels, potentially resulting in some storm-petrels not nesting, or reducing nesting populations in those caves (Factor A). In the event of future skunk predation causing reproductive failure at any one of the caves (Factor C), and sea level rise reducing habitat for nesting populations in caves (Factor A), the Channel Islands population could suffer direct losses of populations and future breeding ability, a loss exacerbated by the lingering presence of organochlorine contaminants that have resulted in thinning of eggshells and thus impacts to hatching success (Factor E). Mortality may result from collisions with artificial light at Offshore Energy Platforms near the Channel Islands (Factor E). We do not have any evidence at this time that less sea level rise, skunk predation or decreased fitness will lead to more collisions with lights that result in mortality. Although we cannot fully quantify these future effects on ashy storm-petrel populations, they are expected to be negative and will likely exacerbate other threats such as avian predation (Factor C) or an oil spill (Factor E) in any location where the species aggregates.

Efforts are underway to manage several of the threats described above to minimize impacts to the ashy storm-petrel. All of the potential threats could act in concert to result in cumulative stress on the ashy storm-petrel population. However, the best available scientific and commercial information currently does not indicate that these potential threats singularly or cumulatively are resulting or will in the future result in a decline of the species.  Therefore, we do not consider the cumulative impact of these threats to the ashy storm petrel to be substantial at this time.

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H. Carter, unpublished data: At Shipwreck Cave, Santa Cruz Island, breeding by Ashy Storm-Petrels was documented only on 19 August 1997 when 7 active nests and 2 eggshell fragments were found by Humboldt State University (Carter *et al*. 2007; H. Carter, unpubl. data). This cave has a moderate amount of potential habitat compared to other sea caves with nesting Ashy Storm-Petrels at Santa Cruz Island so that only relatively small numbers can breed there.

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a) Carter, H.R. Unpublished data. b) Carter, H.R. Unpublished notes. c) Carter, H.R., and D.L. Whitworth. Unpublished data.

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