BEFORE THE SECRETARY OF INTERIOR

PETITION TO LIST THE ASHY STORM-PETREL (*OCEANODROMA HOMOCHROA*) AS A THREATENED OR ENDANGERED SPECIES UNDER THE ENDANGERED SPECIES ACT

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CENTER FOR BIOLOGICAL DIVERSITY

OCTOBER 15, 2007

Notice of Petition

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___________________________ Date this 15th day of October, 2007

Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. §1533(b), Section 553(3) of the Administrative Procedures Act, 5 U.S.C. § 553(e), and 50 C.F.R. §424.14(a), the Center for Biological Diversity hereby petitions the Secretary of the Interior, through the United States Fish and Wildlife Service ("USFWS"), to list the Ashy Storm-petrel (*Oceanodroma homochroa*) as a threatened or endangered species and to designate critical habitat to ensure its recovery.

The Center for Biological Diversity ("Center") is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center has over 40,000 members throughout the United States. The Center and its members are concerned with the conservation of endangered species, including the Ashy Storm-petrel, and the effective implementation of the ESA.

USFWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on USFWS. Specifically, USFWS must issue an initial finding as to whether the petition “presents substantial scientific or commercial information indicating that the petitioned action may be warranted.” 16 U.S.C. §1533(b)(3)(A). USFWS must make this initial finding “[t]o the maximum extent practicable, within 90 days after receiving the petition.” *Id.* Petitioners need not demonstrate that listing *is* warranted, rather, Petitioners must only present information demonstrating that such listing *may* be warranted. While Petitioner believes that the best available science demonstrates that listing the Ashy Storm-petrel as endangered *is* in fact warranted, there can be no reasonable dispute that the available information indicates that listing the species as either threatened or endangered *may* be warranted. As such, USFWS must promptly make a positive initial finding on the petition an commence a status review as required by 16 U.S.C. § 1533(b)(3)(B).

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Introduction

The Ashy Storm-petrel (*Oceanodroma homochroa*) is a small, smoke-gray seabird related to albatrosses and shearwaters that nests on a small number of offshore islands in central and southern California and northern Baja California, México. Its restricted at-sea foraging range is confined to the continental slope waters from northern California to northern Baja California where it surface feeds on small fish and crustaceans. Based on the most recent population estimates, the global population size of the Ashy Storm-petrel numbers only ~5,400 breeding individuals. Approximately 89% of this global population is concentrated at three island groups in central and southern California: South Farallon Islands, San Miguel Island, and Santa Barbara Island. The Ashy Storm-petrel's small global population size, highly restricted distribution, and concentration at a few colony sites make it extremely vulnerable to extirpations of a large percentage of the population from ongoing threats.

Of foremost concern, the world's largest Ashy Storm-petrel population at the South Farallon Islands has declined by 42% over a 20 year period, prompting the World Conservation Union (IUCN) and BirdLife International to classify the Ashy Storm-petrel as Endangered. In the southern portion of the Ashy Storm-petrel range, long-term monitoring on Santa Cruz Island has documented population declines at two of five monitored sites and the loss of three historic nesting colonies. The Ashy Storm-petrel's reproductive success is also decreasing. Breeding success at the South Farallon Islands decreased significantly over the 36-year study period (1971-2006) and has consistently remained below the 36-year average during the last 12 years. At Santa Cruz Island, annual breeding success during the 12-year study period (1995-2006) was consistently lower than the long-term mean from South Farallon Island. If current trends continue, the seabird unique to the California coast is in danger of becoming extinct in all or a significant portion of its range in the foreseeable future and clearly warrants the added protections provided by the ESA.

Existing regulatory mechanisms have been ineffective at preventing the declines of the Ashy Storm-petrel and mitigating many principal threats to the species. Although most populations nest on protected and managed islands, including the Farallon National Wildlife Refuge, Channel Islands National Park, U.S. Navy lands, and Nature Conservancy lands, insufficient mechanisms have been instituted to protect the Ashy Storm-petrel from declines in population size and breeding success. The ongoing threats faced by the Ashy Storm-petrel at its island breeding sites and at-sea foraging range include depredation by introduced and native predators, artificial light pollution from vessels and offshore energy terminals, plastic ingestion, eggshell thinning due to marine contaminants, and oil spills. Ocean climate change in the California Current System poses a serious threat to this species' long-term persistence.

The high volume of vessel traffic and the proliferation of proposed energy terminals in the Ashy Storm-petrels' breeding and foraging range along the southern and central California coast increase the risks from light pollution, oil spills, and chemical pollution to this species. Artificial light pollution from commercial and recreational vessels, offshore energy platforms, and other lighted structures attracts nocturnal seabirds like the Ashy Storm-petrel and disrupts their breeding and foraging activities. Storm-petrels have been observed to continually circle lights (light entrapment); collide with lights or structures around the lights, causing injury or mortality; or strand on lighted platforms where they are vulnerable to injury, oiling, and exhaustion. An oil spill from shipping or energy platforms in the vicinity of breeding and foraging centers at the Farallon Islands, Channel Islands, or the Monterey coast could decimate the small global population of Ashy Storm-petrels. Multiple studies indicate that persistent organochlorine pollutants including DDT and polychlorinated biphenyls (PCBs) continue to lower the breeding success of the Ashy Storm-petrel at its colony sites in the Channel Islands, which support half the global population.

At its island breeding sites, the Ashy Storm-petrel faces depredation from non-native mammalian predators, including cats, rats, and mice, at four island groups. Populations of native predators including the Western Gull and Burrowing Owl have increased at some colonies likely due to human enhancement and are exerting greater predation pressure on the Ashy Storm-petrel. In the Channel Islands, populations are at greater risk from human disturbance, particularly by kayakers visiting sea caves where Ashy Storm-petrels nest, which increases nest abandonment.

Global warming represents perhaps the gravest threat to the long-term survival of the Ashy Storm-petrel. Most immediately, warmer water and reduced upwelling will decrease Ashy Storm-petrel breeding success, and perhaps survival, by reducing primary productivity in the California Current System. Second, global warming is intensifying El Niño events which could lead to Ashy Storm-petrel breeding failures. Third, sea level rise will eliminate important breeding habitat in sea caves and on offshore rocks in the Channel Islands. Finally, ocean acidification caused by the ocean's absorption of excess carbon dioxide may lead to declines in the Ashy Storm-petrel's prey species that use calcium carbonate to strengthen their exoskeletons. Collectively, these multiple threats from global warming in the California Current System will undoubtedly lead to further reductions in already small and vulnerable populations.

This Petition summarizes the natural history of the Ashy Storm-petrel, its population status, and the threats to the species and its habitat. The Petition then clearly demonstrates that, in the context of the ESA's five statutory listing factors, the declining population trend, and ongoing threats to its continued existence, the U.S. Fish and Wildlife Service should list the Ashy Storm-petrel as threatened or endangered.

Natural History and Biology of the Ashy Storm-Petrel

I. Taxonomy and Description

The Ashy Storm-petrel (*Oceanodroma homochroa*) belongs to the order Procellariiformes, family Hydrobatidae. This order includes all petrels, shearwaters, and albatrosses which are distinguished by their "tubenoses." Birds of this order have nostrils that are sheathed in prominent horny tubes arising near the base of the bill (Warham 1990). Storm-petrels (family Hydrobatidae, the "water walkers") are small, typically pelagic, colonial seabirds that consist of 21 species worldwide (Brooke 2004). Ashy Storm-petrels are in the genus Oceanodroma which contains 13 species. There are no recognized subspecies within *Oceanodroma homochroa* (Coues 1864). Recent research by Nur et al. (1999) indicates that there is no genetic differentiation between subpopulations on the Farallon and Channel Islands.

The Ashy Storm-petrel is one of four all-dark storm-petrel species that nest on islands along the west coast of North America. It is a smoke-gray, medium-sized storm-petrel, similar in size to a Purple Martin, with long slender wings, a long forked tail, and webbed feet (Ainley 1995). It averages 189 mm in length, 412 mm in wingspan, and 142 mm in wing length (James-Veitch 1970). Female mass averages 39.2 grams while males average 37.2 grams (James-Veitch 1970). Compared to other storm-petrels in its range, it is recognizable by its darker primaries relative to other feathers, lighter wing lining, and its longer, forked tail (Ainley 1995). At sea, it is best distinguished by its flight style. Ashy Storm-petrels fly with a shallow upstroke and rarely glide in contrast to other storm-petrel species that raise their wings higher than horizontal and have long glides (Ainley 1995).

Ashy Storm-petrels arrive and depart their nesting colonies at night and lay their eggs in difficult-to-find crevices on remote islands (Nur et al. 1999). They spend most of their time at sea, feeding primarily at night and during crepuscular periods, and return to land for courtship and tending their eggs and young (Ainley 1995).

II. Distribution and Habitat

A. Breeding Range

The worldwide breeding range of the Ashy Storm-petrel is restricted to a small number of offshore islands and rocks in central and southern California, U.S.A., and one island group in northern Baja California, México (Ainley 1995). In total, Ashy Storm-petrels are thought to breed on eight island groups, five groups of offshore rocks, and one possible mainland location from Mendocino County, California (~39°N) south to Los Coronados Islands off northern Baja California (~32°N) (Carter et al. 1992, McChesney et al. 2000, Brown et al. 2003). However, breeding has been confirmed at only six island groups (South Farallon, San Miguel, Santa Cruz, Santa Barbara, San Clemente, and Los Coronado Islands) and three groups of offshore rocks (Castle Rock/Hurricane Point, Double Point, and Bird Rocks).

Approximately half of the world's population of Ashy Storm-petrels nests at the South Farallon Islands in central California and half at the Channel Islands in southern California, primarily at Prince Island off San Miguel Island, Santa Barbara Island, and Santa Cruz Island (Carter et al. 1992, Ainley 1995). Specifically, in the Channel Islands, Ashy Storm-petrels have been confirmed to breed on Prince Island and Castle Rock off San Miguel Island; on mainland Santa Cruz Island and its offshore rocks; on mainland Santa Barbara Island and its offshore rocks (Sutil Island and Shag Rock); and on Seal Cove rock off San Clemente Island based on one nest discovered in 1994 (Carter et al. 1992, H.R. Carter, unpublished data). Small numbers are thought to nest on Anacapa Island, Santa Catalina Island, mainland San Miguel Island, and mainland San Clemente Island in the Channel Islands where Ashy Storm-petrels have been mist-netted but where no active nests have yet been found (Carter et al. 1992, Nur et al. 1999, Whitworth et al. 2005, Carter et al. in press). Small numbers of nesting Ashy Storm-petrels were confirmed nesting at offshore rocks near Castle Rock and Hurricane Point south of Monterey (McChesney et al. 2000); at Double Point Rocks, Marin County (H.R. Carter, unpublished data); and at Bird Rock, Marin County (Ainley and Osborne 1972, Carter et al. 1992). From mist-netting records, small numbers are also thought to nest on offshore rocks in Van Damme Cove in

Mendocino County, on Chimney Rock in Marin County, and possibly on the mainland at Vandenberg Air Force Base (Carter et al. 1992, Brown et al. 2003, Carter et al. in press).

Outside of the United States, small numbers of the Ashy Storm-petrel nest at Los Coronados Islands in northern Baja California, Mexico, about 11 km south of the California/Mexico border (Everett and Anderson 1991, Carter et al. 1996, Carter et al. 2006a). Carter et al. (2006b) may have identified an Ashy Storm-petrel nest on the Todos Santos Islands, Baja California, to the south of Los Coronados Islands. However, they could not conclusively determine whether the nest belonged to an Ashy Storm-petrel or another *Oceanodroma* storm-petrel species such as a Leach's (*O. leucorrhoa*) or Black (*O. melania*) Storm-petrel (Carter et al. 2006b).

The Ashy Storm-petrel nests in crevices in talus slopes, cliff sides, and rock piles, from just above sea level to the highest interior portions of nesting islands (Ainley 1995). Ashy Storm-petrel nesting is restricted to smaller islands and offshore rocks devoid of large predatory mammals and to precipitous headlands, sea caves, and offshore rocks of the larger Channel Islands that support larger, predatory mammals (Ainley 1995, McIver 2002, Carter et al. 2007).

B. Foraging Range

At sea, Ashy Storm-petrels remain within the central and southern California Current System year-round (Ainley 1995). The California Current System runs within 300 km of the coast from Vancouver Island, British Columbia, to southern Baja California, Mexico (Tyler et al. 1993). It is characterized by seasonal spring and summer upwelling events which provide nutrients to surface waters, leading to high productivity and food abundance for birds that surface feed (Tyler et al. 1993). Ashy Storm-petrels prefer the waters of the continental slope (200-2000 m deep) which are within a few kilometers of the coast in some areas (Monterey Bay) and more than 50 km offshore in other areas (Gulf of the Farallones) (Ainley 1995). The waters used by Ashy Storm-petrels range in temperature from 9-15 ºC during late spring and summer when upwelling peaks to 11-19 ºC the remainder of the year as upwelling subsides (Ainley 1995).

The small at-sea range of the Ashy Storm-petrel is confined to the continental slope waters off Cape Mendocino, California, to northern Baja California (Ainley 1995). During the spring and summer breeding season, Ashy Storm-petrels congregate near the Farallon Islands (San Francisco County) and the Channel Islands (Santa Barbara County) (Ainley 1995). During fall and winter, birds disperse slightly to offshore waters as far north as Del Norte County, California, but mostly stay within the spring and summer range (Briggs et al. 1987, Ainley 1995). At-sea aerial and shipboard survey data from 1975-1997 indicate that some marine regions concentrate higher densities of Ashy Storm-petrels (Jensen et al. 2005, Figure 5.1.1). Areas of high densities include the region between Point Arena and Monterey Bay, including deep waters of Monterey Canyon; the Southern California Bight, with particularly high numbers in the Santa Barbara Channel; and the shelf between Point Buchon and Point Conception (Jensen et al. 2005). In fall, as many as 4000-6000 birds have congregated in Monterey Bay suggesting that some marine areas are foraging hotspots (Ainley 1995).

In 2004-2005, U.S. Geological Survey researchers conducted a radio-telemetry study of Ashy-storm petrels in the Channel Islands to characterize at-sea foraging habitat (Carter et al. 2007). Locational data from 57 individuals identified storm-petrel aggregations over the continental shelf-break from Point Buchon to Point Conception, in the western Santa Barbara Channel, and in the Santa Cruz Basin that separates Santa Cruz, San Nicolas, and Santa Barbara Islands (Carter et al. 2007). This study also found that storm-petrels from the Channel Islands ranged northward as far as the Gulf of the Farallones National Marine Sanctuary (Carter et al. 2007).

C. Migration and Dispersal

Unlike most other storm-petrels, Ashy Storm-petrels are non-migratory. However, some individuals may disperse short distances during the period of molt in autumn (Ainley 1995). Approximately 1.6% of Ashy Storm-petrels are thought to disperse between the Channel Islands and the Farallon Islands (Nur et al. 1999).

III. Diet and Foraging Behavior

Reported prey items for the Ashy Storm-petrel include small fish, euphausiids and other crustaceans, and squid (Ainley 1995). James-Veitch (1970) noted that the regurgitations and stomach contents of 30 Ashy Storm-petrels contained copepods, decapods, euphausiids, cepahalopods, and a young octopus. McChesney (1988) collected the stomach contents of 38 individuals from Southeast Farallon Island by stomach-pumping. Fish were the dominant prey species, followed by euphausiids (principally *Euphausia pacifica* and *Thysanoessa spinifera*), decapods, amphipods, and cephalapods (McChesney 1988). Ashy Storm-petrels have been observed scavenging from fish-oil slicks on the sea surface and from fishing vessels hauling in their nets (Ainley 1995).

Ashy Storm-petrels likely ingest plastic particles (Ainley 1995). The similarity between clear plastic floating debris and their prey leads to ingestion of plastics (Ainley 1995). Other storm petrel species have been found with large amounts of plastics in the alimentary tract (Spear et al. 1995, Blight and Burger 1997). Therefore, it is reasonable to assume that Ashy Storm-petrels also ingest plastic pieces floating in the same areas as their food sources.

Ashy Storm-petrels are thought to feed mostly at night since sightings of feeding birds during the day are uncommon (Ainley 1995). Using surface air currents and their flexible wings and tails to stay in the correct position, they are able to hover just above the water while their feet patter the sea surface and they pick up small prey with their bills (Ainley 1995). Ashy Storm-petrels will also alight onto the sea surface and make shallow plunges, in which they are barely submerged, to seize prey (Ainley 1995).

IV. Breeding Behavior

Unlike most other storm-petrels that migrate and lay their eggs synchronously, Ashy Storm-petrels occupy their nesting colonies for most of the year and lay their eggs very asynchronously (Ainley et al. 1990, McIver 2002). Some pairs may be laying eggs while other pairs are in the midst of chick-rearing. At Southeast Farallon Island, Ashy Storm-petrels visit the colony year-round although most activity is concentrated in February through October (Ainley et al. 1990). Similarly at Santa Cruz Island, Ashy Storm-petrel nesting activity spans March through December (McIver 2002). The protracted occupation of nesting colonies and long incubation and chick-laying periods make Ashy Storm-petrels particularly vulnerable to threats at their colony sites.

A. Courtship and Nesting

Ashy Storm-petrels do not dig out their nest burrows but instead use existing burrows excavated by other seabirds, natural crevices, or holes in human-constructed rock walls (James-Veitch 1970, Ainley and Lewis 1974, Carter et al. 1992). Nests may be within a few centimeters of the surface or much deeper, up to 1 meter below ground (Ainley 1995), and typically contain little or no nesting material (James-Veitch 1970).

The Ashy Storm-petrel may experience high nest-site competition at some colonies. Nesting pairs will share a nest entrance with other Ashy Storm-petrels if there are separate nesting spaces within the cavity (Ainley et al. 1990). When other cavity-nesting seabirds are present (i.e. Cassin's Auklet, Pigeon Guillemot), Ashy Storm-petrels often seek out crevices that are too small for entry of their nest-site competitors (Ainley et al. 1990). On Southeast Farallon Island, the proportion of cavities occupied by nesting Ashy Storm-petrels ranged between 82-100% during 1972-1983, which is higher than that found for other storm-petrel species and indicates that they may experience intense competition for nest sites (Ainley et al. 1990). McChesney (1988) found that Ashy Storm-petrels on Southeast Farallon Island experienced high reproductive success in 1983 when few Cassin's Auklets (a primary nest site competitor) were present. Nest boxes have been used to increase nesting habitat on the South Farallon Islands with success (Ainley et al. 1990).

Ashy Storm-petrels are presumed monogamous and there are no known criteria for choosing a mate (Ainley 1995). In the initial breeding year, they learn about the nesting island, and in the following year they may find a burrow and a prospective mate (Ainley et al. 1990). Courtship may last for two to three months, and once a pair bond is established, the pair will stay together for a number of years using the same burrow (Ainley et al. 1990). Breeding success appears to be higher when the mate and their burrow are familiar, and loss of either the burrow or the mate results in several years of trying to become reestablished (Ainley et al. 1990). Mating has been rarely witnessed and likely occurs in the burrow (Ainley 1995).

B. Egg-laying and Incubation

Pre-laying nest occupation can last from one to four months (Ainley et al. 1990). For the last eleven days or so prior to laying, the female rarely visits the nest and is presumably using the time to feed. She then lays a single, white egg which weighs 8.3 grams on average and constitutes about 21% of her weight at the time of laying (James-Veitch 1970, Ainley et al. 1990). The majority of eggs are laid between late April and mid-July, although laying may extend from March to October (James-Veitch 1970, Ainley 1995, McIver 2002). During periods of poor food availability egg-laying is skewed towards the later end of the egg-laying season

(Ainley et al. 1990). Replacement laying after the loss of the first egg is rare (Ainley et al. 1990).

The average incubation period is 45 days in length but can range between 42-59 days (Ainley et al. 1990). The egg is incubated by both sexes equally, and parents switch incubation duties every 2.5 days on average (Ainley 1995). Ashy Storm-petrel eggs are typically laid in well-protected burrows allowing the parents to leave the eggs unattended for relatively long periods of time without negatively impacting the viability of the chick (Ainley et al. 1990). Eggs are left unattended for an average of 2-4 days, although one egg was left unattended for 25 days and still hatched (Ainley et al. 1990). One of the main causes of egg neglect is the strength of the wind which can hinder the parent's ability to return to the nest (Ainley et al. 1990).

C. Chick-rearing

Ashy Storm-petrel chicks free themselves from the egg within 24-72 hours after pipping (i.e. first cracking the shell with their bill) (James-Veitch 1970). Chicks are semi-precocial at hatching, are covered in gray down, and weigh 9.2 grams on average but range from 8.6 to 12.1 grams depending on the year (Ainley et al. 1990, Ainley 1995). The female is typically present when the egg hatches, and most chicks are brooded for two to seven days before they are left unattended in the nest during the day (Ainley et al. 1990). Chicks are fed regurgitated, semi-digested oily meal once every 1-3 nights (Ainley 1995) weighing 2-4 grams on average (James-Veitch 1970).

Fledging occurs from late July through January (Ainley et al. 1990, McIver 2002). Chicks fledge fully feathered at 84.4 days old on average (range 72-119 day old) (Ainley et al. 1990). In Ashy Storm-petrels, fledging weight is about equal to adult weight, while in migratory storm-petrel species, fledging weight tends to be 110-170% of adult weight (Ainley et al. 1990). Moonlight also affects the growth and fledging patterns of chicks (Ainley et al. 1990). Chicks are most likely to be fed during the dark of the moon and are also most likely to fledge during the dark moon phases or on cloudy nights (Ainley et al. 1990).

V. Demographic Rates

Demographically, storm-petrels typically exhibit delayed maturity, low reproductive rates, and high adult survival and longevity (Warham 1990) which are associated with a 'slow' life history strategy (Saether and Bakke 2000). Accordingly, their population growth rates are particularly sensitive to changes in adult survival (Saether and Bakke 2000) and they are slow to recover from population declines.

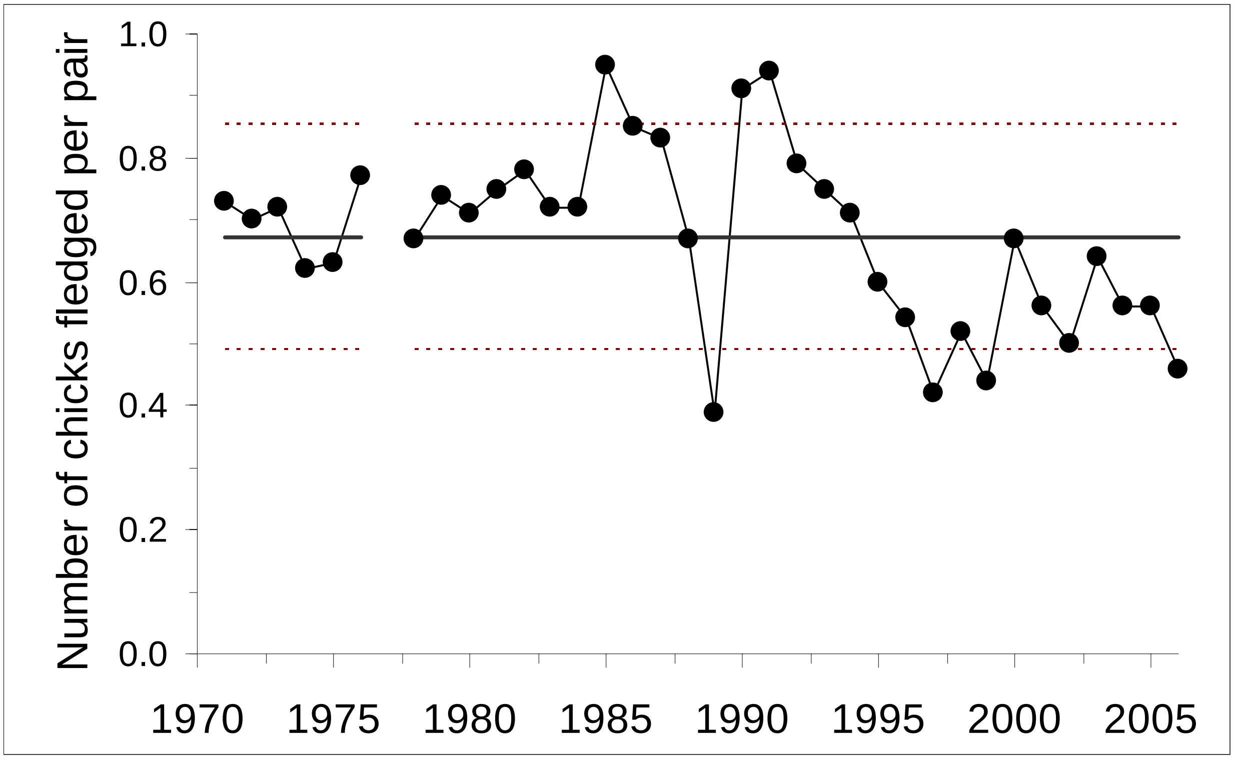
A. Age of Maturity

No data on age of maturity are available for the Ashy Storm-petrel. The well-studied sister species Leach's Storm-petrel (*Oceanodroma leucorhoa*) begins breeding at age five on average (Huntington et al. 1996).

B. Breeding Success

Breeding success of the Ashy Storm-petrel has been well-studied at Southeast Farallon Island and Santa Cruz Island, and the trends are troubling. Breeding success for the world's largest Ashy Storm-petrel population at Southeast Farallon Island decreased significantly over the 36-year study period (1971-2006) and has consistently remained below the 36-year average during the last 12 years (1995-2006) (Figure 1) (Ainley et al. 1990, Sydeman et al. 2001, PRBO Conservation Science and USFWS, unpublished data). Between 1971-2006, breeding success at Southeast Farallon Island has averaged 0.672 ± 0.14 chicks fledged per breeding pair (range: 0.39 – 0.95). Breeding success declined precipitously between 1992-1997 largely due to decreases in hatching success during the 1990s (Sydeman et al. 2001, Figures 4a, 4b). Of particular concern, breeding success did not rebound after 1997 even during the cold, productive La Niña years of 1999-2002 when other seabird species on the Southeast Farallon Islands experienced high breeding success (Durazo et al. 2001, Schwing et al. 2002, Venrick et al. 2003). Three of the four worst breeding seasons (where breeding success was outside the 80% confidence interval) occurred in the past decade, the last in 2006 (Figure 1).

Figure 1. Breeding Success of the Ashy Storm-petrel on Southeast Farallon Island, 1971-2006. Breeding success is measured as number of chicks fledged per breeding pair including first attempts and relays. The bold horizontal line indicates mean productivity from all attempts between 1971 and 2006 (0.672) and dashed lines represent the 80% confidence interval for the long-term mean.
Source: Data reproduced with permission of Point Reyes Bird Observatory (PRBO) Conservation Science and compiled from the following sources: Ainley et al. 1990, Sydeman et al. 2001, and PRBO Conservation Science and USFWS, unpublished data.



At Southeast Farallon Island, depredation of eggs and chicks by introduced House Mice appeared to be the leading causes of egg failure and chick death between 1972-1983 and significantly lowered Ashy Storm-petrel breeding success (Ainley et al. 1990). Egg and chick survival were also affected by depredation by Western Gulls and disruption by Cassin's Auklets (Ainley et al. 1990). Although Western Gulls cannot usually access the nests of Ashy Storm-petrels, they depredate adult and fledgling Ashy Storm-petrels outside the nest. Importantly, the loss of one parent to predation results in the death of the egg or chick (Ainely et al. 1990). Cassin's Auklets have been found to usurp the Ashy Storm-petrel nests while chicks are present (Ainley et al. 1990). Ainley et al. (1990) found that chick survival was highest during warm water years which corresponded with low Cassin's Auklet nesting densities on the Farallones. Nest boxes with entrance tunnels too small for Cassin's Auklets also decreased nest usurpation (Ainley et al. 1990).

Breeding success was also monitored at 2-4 sea caves and one offshore rock at Santa Cruz Island during 1995-1998 (McIver 2002) and in 2006 (Carter et al. 2007). Between 1995-1997, breeding success was monitored in four sea caves and at Orizaba Rock and averaged 0.51 chicks fledged per pair (n=456) (McIver 2002), which is lower than the long-term mean (0.672) from Southeast Farallon Island. In 1998, breeding success was monitored at only two sea caves and averaged 0.65 chicks fledged per pair (n=46) (McIver 2002). In 2006, breeding success was monitored in three sea caves and Orizaba Rock and averaged 0.67 chicks fledged per active nest site (n=61) (Carter et al. 2007). Breeding failures on Santa Cruz Island in 1995-1998 appeared to be caused largely by low hatching success (McIver 2002). McIver (2002) and Carter et al. (1999) ascribe high observed rates of egg breakage to eggshell thinning caused by high levels of persistent organochlorine contaminants in the Southern California Bight where this population forages during the breeding season. More recently, in 2005, the largest-known Ashy Storm-petrel population on Santa Cruz Island (Bat Cave) experienced complete reproductive failure when at least two island spotted skunks (*Spilogole gracilis amphiala*) accessed the cave (McIver and Carter 2006). Although this appears to have been a stochastic event, this occurrence highlights the impacts that mammalian predators have on Ashy Storm-petrel nesting.

C. Survival and Lifespan

No data are currently available on Ashy Storm-petrel juvenile, sub-adult, and adult survival. Banding records indicate that Ashy Storm-petrels can live to 25 years old (Sydeman et al. 1998a, Nur et al. 1999) although maximum lifespan is likely longer since storm-petrels have remarkable longevity for their small body size (Haussmann et al. 2003). The well-studied sister species Leach's Storm-petrel (*Oceanodroma leucorhoa*) has a maximum observed lifespan of 36 years (Huntington et al. 1996).

Abundance and Population Trends of the Ashy Storm-petrel

The abundance of Ashy Storm-petrel populations is difficult to quantify given the nocturnal nature of the species paired with their habit of breeding on geographically isolated islands and offshore rocks. In addition, the nests are cryptic and often inaccessible, being placed in crevices, under rock piles, and on steep cliffs. However, naturalists and researchers have been making observations and gathering data on the Ashy Storm-petrel since the 1800s, primarily from the South Farallon Islands, which has permitted the estimation of abundance throughout the range and of population trends at the South Farallon Islands (the largest Ashy Storm-petrel population) and Santa Cruz Island. These data indicate that the global Ashy Storm-petrel population is small, is concentrated at three breeding colonies, and is declining at the South Farallon Islands and at Santa Cruz Island.

I. Historic Abundance and Trends

Historic estimates of abundance for the Ashy Storm-petrel appear to have been made only for the South Farallon Islands. Ainley and Lewis (1974) summarized the historical population estimates of Ashy Storm-petrels on Southeast Farallon Island from the 1860s to the 1970s. In 1862 Ashy Storm-petrels were simply recorded as "present" (Coues 1862). Two subsequent observations from 1886 noted Ashy Storm-petrels as "rare" (Taylor 1887) and "seventh in abundance" (Bryant 1888) presumably in relation to the 11 other seabird species breeding on the island. However, by the mid-1890s and early 1900s, Ashy Storm-petrels were recorded as abundant on Southeast Farallon Island. Specifically, in 1896, Loomis wrote that Farallon Ashy Storm-petrels "were breeding abundantly in all parts of the island" (Bent 1922). Loomis also observed that finding Ashy Storm-petrels was "easy" when one searched for birds by sniffing between crevices and under rocks to detect their "strong musky odor" (Bent 1922). Dawson wrote in 1911 that Farallon Ashy Storm-petrels were "well distributed throughout the main island" and were "easily third" in abundance on Southeast Farallon Island (Bent 1922).

The observed increase in abundance of Ashy Storm-petrels between the 1880s and mid-1890s could reflect an improvement in the search effort made by later observers who may have been more thorough in finding these cryptic birds. The Farallon Islands have a long history of human disturbance, and the perceived increase might also be related to the elimination of disturbance from commercial eggers in the 1880s. Human disturbance of Southeast Farallon Island seabirds began with American and Russian sealers who occupied the islands from 1807-1840 (Ainley and Lewis 1974). In addition to decimating the islands' populations of elephant seals, fur seals, and sea otters, the sealers collected eggs and birds for food, although records of which species were collected were not kept (Ainley and Lewis 1974). In 1848, commercial egging began on the Farallon Islands. By 1855, the Farallon Egg Company was founded to supply eggs to the burgeoning California gold miner population. Egging was disbanded in 1881, but the number of Common Murre eggs taken over the 45 years exceeded 14 million (Ainley and Lewis 1974). Even though Ashy Storm-petrels were not targeted directly, it is likely that the disturbance impacted the breeding population since Ashy Storm-petrels are very sensitive to nest disturbance.

Other disturbances that may have affected the Southeast Farallon Island Ashy Storm-petrel population were human disturbance from lighthouse keepers and the military, introduced species, and oil pollution. The first lighthouse became operational in 1855 and was staffed by four lighthouse keepers who lived on the island with their families and pets until removed in 1965 (Ainley and Lewis 1974). These families introduced cats, dogs, hogs, and a mule to the islands. An influx of oil pollution to the central California coast began in the early 1900s. From 1900-1940, oil tankers on their way into San Francisco Bay would flush their tanks near the

Farallon Islands (Ainley and Lewis 1974). Observers and the lighthouse keepers recorded oiled bird carcasses strewn throughout the island shores and the presence of oil slicks (Ainely and Lewis 1974). During World War II, approximately fifty people operated gun emplacements on the island (Ainley and Lewis 1974).

In the 1970s, human disturbance to the Ashy Storm-petrel population on Southeast Farallon Island was substantially reduced. In 1969, the South Farallon Islands were added to the National Wildlife Refuge system, which to date had only encompassed North and Middle Farallon Islands. In 1968, Point Reyes Bird Observatory was contracted as caretaker for the islands and subsequently established a year-round research station on Southeast Farallon Island. Breeding sites were closed to wandering personnel in 1968, and in 1972 Coast Guard helicopters developed a flying pattern that reduced disturbance of breeding colonies (Ainley and Lewis 1974).

In the Channel Islands, introduced mammals likely reduced Ashy Storm-petrel numbers at several colonies, especially on Anacapa and Santa Barbara Islands that are free of native mammalian predators other than mice. On Santa Barbara Island, cats (*Felix catus*) were introduced on the main island around 1900 and decimated the colonies of two other small nesting seabirds, the Cassin's Auklet and Xantus's Murrelet (McChesney and Tershy 1998). The last cat was removed in 1978 (McChesney and Tershy 1998). The impacts on the Ashy Storm-petrel at Santa Barbara Island are unknown, but cats likely limited Ashy Storm-petrel nesting to the inaccessible cliff faces where they are currently found nesting. On Anacapa Island, Black rats (*Rattus rattus)* were introduced in the mid- to late 1800s and cats (*Felix catus*) were introduced in the 1930s (McChesney and Tershy 1998). Although there are no historic records of breeding Ashy Storm-petrels on Anacapa Island, the presence of breeding Ashy Storm-petrels in sea caves of adjacent Santa Cruz Island suggests that Ashy Storm-petrels nested on Anacapa but were extirpated by introduced rats and cats.

Military activities in the Channel Islands also likely reduced the Ashy Storm-petrel population at Prince Island off mainland San Miguel Island. Prince Island was used for bombing and target practice in the 1950s by the U.S. Navy, which undoubtedly destroyed breeding habitat and likely led to the mortality and breeding failures of the Ashy Storm-petrel and other seabirds.

II. Current Abundance

Several studies have estimated the current abundance of Ashy Storm-petrels throughout their range, all of which indicate a small global population size. Southeast Farallon Island of the South Farallon Island group supports the largest population. The number of breeding birds at Southeast Farallon Island was first estimated at 3,000-4,000 birds in 1959 by Thoresen (unpublished data cited in Ainley and Lewis (1974)). In 1972, Ainley and Lewis (1974) estimated the Ashy Storm-petrel population at 4000 breeding birds using a mark-recapture study. Ainley later noted that the 1972 figure was likely to be an underestimate because some portions of the population at Southeast Farallon were not sampled adequately (Ainley et al. 1990). In 1987, McChesney (1988) estimated the Southeast Farallon Island population at 1400-1450 breeding birds using a mark-recapture study, although he notes that the numbers may be low due to sampling late in the breeding season. Population size at Southeast Farallon Island was last estimated at 1990 breeding birds in 1992 by Sydman (1998b) using a mark-recapture study.

Censuses of the entire California Ashy Storm-petrel population were first conducted in 1975-1980 through extensive seabird surveys on California islands, offshore rocks, and mainland sites (Hunt et al. 1979, Hunt et al. 1980, Sowls et al. 1980). The California Ashy Storm-petrel population was estimated at 5,187-5,216 breeding birds. This estimate included the Ainley and Lewis (1974) estimate of 4,000 breeding birds for the South Farallon Islands (76% of the total) and approximately 1,187 breeding birds (23% of the total) for the Channel Islands and Bird Rock near Point Reyes (Carter et al. 1992, Table 13, citing Hunt et al. 1979,1980, Sowls et al. 1980).

Carter et al. (1992) attempted to update and improve estimates of California populations through extensive surveys conducted between 1989-1991 and estimated 7,209 breeding Ashy Storm-petrels in California. Carter et al. (1992) used the Ainley and Lewis (1974) estimate of 4,000 breeding birds for the South Farallon Islands and added 3,135 breeding birds for the Channel Islands and 74 birds for Bird Rock near Point Reyes. Specifically, for the Channel Islands, they estimated 1460 breeding birds for mainland Santa Barbara Island and offshore Sutil Island, 1,354 for San Miguel's offshore islands (Prince Island and Castle Rock), and 321 for mainland Santa Cruz Island and its offshore rocks (Carter et al. 1992).

Small numbers of Ashy Storm-petrels have been estimated for the remaining breeding locations not included in Carter et al. (1992). Nur et al. (1999) report that less than 52 individuals are thought to breed on San Clemente and Santa Catalina Islands. Between 20-60 breeding individuals were estimated for the rocks near Castle Rock and Hurricane Point (McChesney et al. 2000), with unknown small numbers at Double Point Rocks. At Los Coronado Islands, México, several estimates have been reported for the islets of this island group over time (Carter et al. 1996). The most recent nest searching effort in 2005 located 40 Ashy Storm-petrel nests on Middle Rock and a few unidentified storm-petrel nests on the larger South Island, suggesting that the nesting population is larger than earlier estimates of a few (4-6) breeding birds on Middle Rock (Carter et al. 2006a).

If the most recent estimates for Ashy Storm-petrels are used, the total global population for Ashy Storm-petrel is approximately 5,371 breeding birds. This includes the 1992 estimate of 1,990 breeding birds for the South Farallon Islands (Sydeman et al. 1998b), the 1989-1991 estimate of 3,209 breeding birds for the Channel Islands and Bird Rock (Carter et al. 1992), the estimate of 52 birds for San Clemente and Santa Catalina Islands (Nur et al. 1999), an average estimate of 40 individuals for Castle Rock and Hurricane Point rocks (McChesney et al. 2000), and at least 80 individuals for Los Coronado Islands (Carter et al. 2006a). Using the most recent estimates, approximately 89% of the global population breeds on only three island groups: South Farallon, Santa Barbara, and San Miguel Islands.

III. Current Population Trends

A study of Ashy Storm-petrel population trends on Southeast Farallon Island indicates that the world's largest population experienced a significant decline over a 20-year period between 1972 and 1992. Sydeman et al. (1998b) examined trends in the Ashy Storm-petrel on

Southeast Farallon Island based upon mark-recapture data collected in 1971, 1972, and 1992. In an area of prime breeding habitat, numbers of breeding birds decreased from 1,271 ± 140 in 1972 to 710 ± 117 in 1992, which is a decline of 44% or -2.8% per year. When the authors considered both prime and peripheral breeding habitats on Southeast Farallon Island, they detected an overall population decline of 34% (from 6,431 birds in 1972 to 4,284 ± 409 birds in 1992) and a decline in breeding birds of 42% (from 3,402 to 1,990 ± 408 breeding birds in 1992) over two decades. Based on these dramatic declines, small population size, limited distribution, and numerous threats, the authors conclude that "the species warrants management and/or additional protective status."

Sydeman et al. (1998a) conducted a population viability analysis (PVA) for the Ashy Storm-petrel population on Southeast Farallon Island to determine the relative magnitude of threats to Ashy Storm-petrel populations and the estimated time to extinction of the population under current conditions. The authors used a starting population of breeding birds based on the 1992 estimates from the Sydeman et al. (1998b) study. Alarmingly, their PVA predicted that Ashy Storm-petrels have a 46% chance of reaching quasi-extinction within 50 years, that is, by 2046. The quasi-extinction marks a critical level of endangerment and was set at 500 breeding birds (Sydeman et al. 1998a). Nur et al. (1999) conducted a more extensive PVA that included all known Ashy Storm-petrel populations and reached similar conclusions as Sydeman et al. (1998a). Therefore, the most comprehensive data on the Ashy Storm-petrel at its largest breeding colony indicates that the Ashy Storm-petrel may face extinction in a significant portion of its range in the foreseeable future.

Long-term monitoring on Santa Cruz Island has documented and overall population decline (i.e. declines at two of five monitored sites) and the loss of nesting colonies. July nest counts have been conducted at Santa Cruz Island in four sea caves and on Orizaba Rock from 1995-2006 (Carter et al. 2007). The number of July nests decreased on Orizaba Rock from 1995-2006, and the total number of nests declined significantly by 10.5% per year during this 12-year period (Carter et al. 2007). At Bat Cave which is the largest known colony on Santa Cruz Island, numbers of July nests declined after 2003 which is particularly worrisome since this colony once contained more nests than all other areas on Santa Cruz Island combined (Carter et al. 2007). Nest declines at Bat Cave were especially severe in 2005 when predation by Channel Islands Spotted Skunks (*Spilogale gracilis amphiala*) caused complete breeding failure (Carter et al. 2007). Nest numbers at Bat Cave in 2006 did not rebound much, totaling 19 nests compared with the peak number of 109 nests in 1996 (Carter et al. 2007). Numbers of July nests have not changed significantly between 1995-2006 at three of the five monitored sites: Cavern Point Cove Caves, Cave of the Birds' Eggs, and Dry Sandy Beach Caves (Carter et al. 2007). Indicative of a downward population trend, historic breeding colonies of the Ashy Storm-petrel at Painted Cave, Scorpion Rocks, and Gull Island off Santa Cruz Island no longer have nesting birds (Carter et al. 2007). The decline in nest numbers at Orizaba Rock and the loss of nesting colonies on Scorpion Rocks and Gull Island have been attributed to greater levels of predation by avian predators, potentially due to colony illumination from the squid fishery (Carter et al. 2007).

IV. IUCN Red List and U.S. Fish and Wildlife Service Classifications

The IUCN Red List classifies species worldwide according to their extinction risk based on objective criteria. A species is listed based on (1) the rate of population decline of the species over three generations, (2) fragmentation or fluctuations in the geographic range of the species, and (3) probability of extinction based on the quantitative analysis of the species over a 10-20 year period (IUCN Red List Criteria at § 5). In 1988, the Ashy Storm-petrel was listed as Lower Risk/least concern. In 1994, it was considered Lower Risk/near threatened. In 2000, the Ashy Storm-petrel again was considered Lower Risk/near threatened.

In 2004, the IUCN uplisted the Ashy Storm-petrel to Endangered based on the Sydeman et al. (1998a) analysis that “suggests that its small population may be declining at a rate equivalent to more than 50% in 48 years (three generations) owing to a variety of threats” (IUCN 2006). The identified threats included organochlorine and oil pollution; predation by expanding Western Gull populations as well as Burrowing Owl and Barn Owl; and colony illumination by bright lights of the squid fishery. While the IUCN listing affords no regulatory protection to the Ashy Storm-petrel, such listing is an unequivocal statement from scientists that the species warrants protection at the national and international level. As such, prompt protection of the species under the ESA must be instituted.

The U.S. Fish and Wildlife Service’s 2005 Seabird Conservation Plan for the Pacific Region ranked the Ashy Storm-petrel as “highly imperiled” in its conservation classification (U.S. Fish and Wildlife Service 2005). Along with the Marbled Murrelet (*Brachyramphus marmoratus*), the Ashy Storm-petrel was one of two species out of 29 that were given this highest ranking. The USFWS lists the threats to the Ashy Storm-petrel as predation by introduced House Mice, Burrowing Owls, and Western Gulls; light pollution from the Market Squid fishery; the liquid natural gas terminal proposed off the Los Coronado Islands; plastic ingestion; eggshell thinning due to DDT and PCBs; and oil spills (U.S. Fish and Wildlife Service 2005). Therefore, the U.S. Fish and Wildlife Service’s own analysis indicates that the Ashy Storm-petrel is highly imperiled and deserves increased protections.

The Ashy Storm-Petrel Warrants Listing Under the ESA

Under the ESA, 16 U.S.C. § 1533(a)(1), USFWS is required to list a species for protection if it is in danger of extinction or threatened by possible extinction in all or a significant portion of its range. In making such a determination, USFWS must analyze the species’ status in light of five statutory listing factors:

(A) the present or threatened destruction, modification, or curtailment of its habitat or range;
(B) overutilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) the inadequacy of existing regulatory mechanisms;
(E) other natural or manmade factors affecting its continued existence.

16 U.S.C. § 1533(a)(1)(A)-(E); 50 C.F.R. § 424.11(c)(1) - (5).

Petitioner believes that all five of these factors have contributed to the declining population trend and low breeding success of the Ashy Storm-petrel and threaten its future existence. The most immediate threats to the Ashy Storm-petrel include the increase in artificial light pollution throughout its range, depredation by introduced predators at its island breeding colonies, lowered breeding success of Channel Island populations due to eggshell thinning produced by persistent organochlorine contamination, and threat of oil spills throughout its range. Additionally, ocean climate change resulting from greenhouse gas emissions poses a significant long-term threat to this California Current System-endemic species. We discuss the threats to the Ashy Storm-petrel in depth below.

The Ashy Storm petrel's small and declining global population size, highly restricted distribution, and concentration at a few colony sites make it vulnerable to further declines. Small, declining populations are prone to entering an "extinction vortex" where losses of genetic diversity, environmental and demographic stochasticity, and Allee effects interact to prompt further declines (Gilpin and Soulé 1986). Furthermore, the Ashy Storm-petrel's concentration at a small number breeding sites and foraging hotspots make it susceptible to decimation by catastrophic events, such as oil spills, at any one site, which could result in the sudden loss of a large percentage of the population.

Finally, the largest breeding populations of the Ashy Storm-petrel inhabit protected federal lands. Yet existing regulatory mechanisms have proven ineffective in preventing declines in population size and breeding success at these sites. Clearly, the Ashy Storm-petrel is in dire need of the additional protections that only listing under the ESA can provide.

I. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

The Ashy Storm-petrel's island breeding habitat is being modified and degraded by artificial light pollution, introduced species, and current and future climate change. Its at-sea foraging habitat is being modified and degraded by artificial light pollution, chemical and plastics pollution, and current and future ocean climate change resulting from greenhouse gas emissions, all of which are described in depth below.

A. Artificial Light Pollution

Artificial light pollution from commercial and recreational vessels, offshore energy platforms, and other lighted structures near Ashy Storm-petrel breeding colonies and at-sea foraging areas poses a significant threat to this species. The Ashy Storm-petrel and many other nocturnally active seabirds are attracted to artificial lights at night (Montevecchi 2006). The negative impacts of artificial night lighting on seabirds have been well-documented (Montevecchi 2006). By attracting nocturnal seabirds like the Ashy Storm-petrel, artificial light disrupts normal breeding and foraging activities. Seabirds have been observed to continually circle lights (light entrapment); collide with lights or structures around the lights, causing injury or mortality; or strand on lighted platforms where they are vulnerable to injury, oiling or other feather contamination, and exhaustion (Telfer et al. 1987, Wiese et al. 2001, Le Corre et al. 2002, Black 2005). Fledgling seabirds appear to be particularly vulnerable to artificial light attraction.

Fledglings of many threatened species, including Barau's petrel (*Pterodroma baraui*), Mascarene petrel (*Pseudobulweria aterrima*), Newell's Shearwater (*Puffinus auricularis newelli*), Dark-rumped Petrel (*Pterodroma phaeopygia sandwichensis*), and Band-rumped Storm-Petrel (*Oceanodroma castro*), have been documented to incur particularly high mortality from attraction to artificial night lighting (Telfer et al. 1987, Le Corre et al. 2002, Day et al. 2003).

Artificial night lighting can also increase seabird susceptibility to predation by illuminating areas at sea and on the colony (Nocera and Kress 1996, Mougeot and Bretagnolle 2000, Keitt et al. 2004, Oro et al. 2005). For example, Oro et al. (2005) found that Yellow-legged Gull (*Larus michahellis*) predation on European Storm-petrels (*Hydrobates pelagicus*) was higher at a colony that was more illuminated by city lights than at a darker colony. Therefore, nighttime light pollution increases the risk of nest site abandonment, nesting failure, predation, and injury or mortality from collision, entanglement, and exhaustion.

Ashy Storm-petrels are attracted to night lights on lighted at-sea oil platforms and vessels and occasionally mainland locations. Ashy Storm-petrels have been recovered dead on at least one lighted at-sea oil platform (Platform Honda (SBNHM #5784, September 1991; SBNHM #5785, October 1991) and from mainland locations in Southern California with bright lights in Goleta, Santa Barbara, Montecito, Ventura, Oxnard, and Point Mugu (SBNHM #4275, #4356, #4544, #5469, #5782, #5847) (Carter et al. 1999). Carter et al. (1996) noted that Ashy Storm-petrels were attracted to their lighted vessel near the Los Coronado Islands, with one individual stranding on deck.

Currently, there is no monitoring of the impacts of lighted platforms or vessels on seabirds in California, so any effects on Ashy Storm-petrels go undetected and unreported. This is especially troubling in view of the large number (>20) of brightly-lit offshore oil platforms in the Santa Barbara Channel and off Point Conception (Carter et al. 2000) near areas where censuses have detected high Ashy Storm-petrels densities (Jensen et al. 2005). In addition, commercial and recreational boat activity and anchorage around the Channel Island, Farallon Island, and Los Coronodo Island colonies is high. In reviewing the impacts of lighted offshore oil platforms on seabirds in the Northwest Atlantic, Wiese et al. (2001) call for the immediate implementation of comprehensive, independent monitoring of the impacts of lighted at-sea platforms on seabirds. Carter et al. (2000) also highlight the need for such monitoring along the California coast to assess impacts on nocturnal storm-petrel and alcid species.

1. Market Squid Fishery

While all types of lighted vessels may affect Ashy Storm-petrels, the expansion of the Market Squid fishery along the southern and central California coast has dramatically increased the levels of artificial night lighting near important Ashy Storm-Petrel colonies during the past decade. The squid fishery has expanded and shifted to areas near the Farallon Islands and Santa Barbara, Santa Cruz, San Miguel, and Anacapa Islands in the Channel Islands (based on California Department of Fish and Game data on monthly Market Squid landings at the Channel Islands from 2000-2006). The squid fishing boats operate close to islands and use high-powered lights to attract squid to the surface, where they are then encircled with nets (Nur et al. 1999). The fishery lights can cause extensive colony illumination at night that likely leads to site abandonment, disturbance of breeding and nesting behavior, and depredation (Burkett et al. 2003). Birds also may be attracted to the vessel lights and be entangled in nets, collide with structures, or strand on deck where they are vulnerable to oiling (Montevecchi 2006).

Specifically, light boat activity from the Market Squid fishery was high along the coasts of Santa Cruz and Santa Catalina Islands in 1995-1997 in late summer and fall during the Ashy Storm-petrel nesting season (H.R. Carter and D.L. Whitworth, personal observations in Carter et al. (2000)) and during the main breeding season in 1999 at Santa Cruz Island (Carter et al. 1999). Squid boat activity was also extremely high around Santa Barbara, Anacapa, and Prince Island colonies in 1995, 1997, and 1999 (Burkett et al. 2003, Figure 22), with Park staff recording up to 13 light boats per night within a few kilometers of Santa Barbara Island in 1999 (Wolf et al. 2000). In the 2000s, the squid fishery moved northward to work in close proximity to the Farallon Islands. In 2000, the California Fish and Game Commission adopted measures requiring light shields and a maximum 30,000 light wattage limit per squid light boat to reduce light pollution in the Channel Islands. However, there have been no observer programs for the squid fishery and no studies of the effectiveness of the light shielding. Observers elsewhere have documented massive strandings of storm-petrels and other procellarid species on lighted vessels at night (Black 2005). These incidents resulted in high seabird mortality due to collision with the ship, hypothermia, and birds drowning in water-filled recesses on deck (Black 2005). Furthermore, even with these wattage and shielding regulations, a multitude of boats working in close proximity to Ashy Storm-petrel breeding colonies and the rocking of boats from waves and wind undoubtedly create a highly lighted environment. Therefore, there is sufficient cause for concern that the bright lights of the squid fishery vessels are impacting Ashy Storm-petrel populations.

2. Offshore Energy Terminals

Offshore liquid natural gas terminals (hereafter LNG terminals) proposed for the California coast would also greatly increase artificial light pollution near important Ashy Storm-petrel breeding colonies and foraging areas. LNG terminals are immense lighted structures that regularly receive lighted tankers. Proposals to construct LNG terminals off the California coast have proliferated in the past five years. Four energy companies have current proposals for constructing LNG terminals near Ashy Storm-petrel colonies in Channel Islands National Park and on the border of the Channel Islands National Marine Sanctuary: (1) BHP Billiton’s Cabrillo Deepwater Port terminal sited 21 miles offshore of Port Hueneme, measuring 938 x 213 ft and 14 stories high; (2) Crystal Energy’s Clearwater Port that will convert a retired oil rig into an LNG terminal, sited 12 miles from Oxnard; (3) Woodside Energy’s terminal, which would not include a gasification facility, proposed 22 miles offshore from Malibu; and (4) Esperanza Energy’s Esperanza Port, tentatively located 15 miles south of Long Beach Harbor (California Energy Commission, http://energy.ca.gov/lng/documents/4_WEST_COAST_PROJECTS_PROPOSALS_STATUS_UPDATE.PDF, accessed 7/10/07). The proposed BHP Billiton and Crystal Energy LNG terminals would be located within 10-15 km of the Santa Cruz and Anacapa Island Ashy Storm-petrel colonies. Both will be within the Santa Barbara Channel near areas where at-sea censuses have detected high densities of Ashy Storm-petrels (Jensen et al. 2005, Figure 5.1.1). The proposed Woodside Energy terminal would be located northwest of the important Ashy Storm-petrel colony of Santa Barbara in an area where there are currently no lighted energy platforms (California Energy Commission website, http://energy.ca.gov/lng/index.html, accessed 7/10/07).

B. Marine Pollution

1. Chemical contaminants

Multiple studies indicate that organochlorine pollutants including DDT and polychlorinated biphenyls (PCBs) continue to lower the breeding success of the Ashy Storm-petrel at its colony sites in the Channel Islands, which support half the global population. The Southern California Bight, the marine region bordering the southern California mainland that constitutes the southern portion of the Ashy Storm-petrel range, has particularly high concentrations of DDT and PCBs. From the 1940s to the early 1970s, Montrose Chemical Corporation and other industrial sources dumped millions of pounds of DDTs and PCBs through a wastewater outfall into the Southern California Bight near Los Angeles. DDT, PCBs, and their break-down products bioaccumulate in the food web and become concentrated in fat stores of upper trophic level predators such as seabirds. In seabirds, these fat stores are then transferred to the egg yolks produced by contaminated females during egg formation (Thompson and Hamer 2000). This contamination has resulted in eggshell thinning, deformation of embryos and chicks, and associated reproductive failure of many seabird species that use the Southern California Bight to feed and nest (Thompson and Hamer 2000). Of particular concern, DDT breakdown products are extremely persistent in the surface sediments of the Southern California Bight and are periodically re-suspended and reintroduced into the food web (Montrose Settlements Restoration Program 2005). Therefore, DDT and PCB contamination in sediments will continue to affect southern California seabirds well into the future.

In 1994, a study prepared by Michael Fry for the U.S. Fish And Wildlife Service evaluated environmental contamination in California seabird populations by measuring eggshell thicknesses (Fry 1994). Ashy Storm-petrel eggs were collected at Santa Cruz Island in the Channel Islands and at Southeast Farallon Island. The Santa Cruz Island eggs averaged DDT residue concentrations of 11.35 ppm while the only egg from Southeast Farallon Island contained 6.66 ppm of DDT. In comparison, 30% of the Brown Pelican eggs collected from the Channel Islands contained levels of 3.0 ppm of DDT which is the “critical” level that impairs reproduction in pelicans. The Ashy Storm-petrel eggs averaged almost four times the critical DDT level for pelicans. Fry speculated that the high levels of DDT in the Ashy Storm-petrel eggs might be due to consumption of contaminated fish egg clusters at ocean surface (Fry 1994). A study of Santa Cruz Island Ashy Storm-petrel populations from 1995-1997 found that they experienced lower breeding success than the Southeast Farallon Island population during the same time period (Carter et al. 1999). The authors concluded that the reduced breeding success on Santa Cruz Island appeared to be mainly due to relatively high levels of contaminants and associated eggshell thinning (Carter et al. 1999).

As described above, only one Ashy Storm-petrel egg was collected from Southeast Farallon Island (Fry 1994). Although the DDT level of this egg (6.66 ppm) was lower than that of Channel Island Ashy Storm-petrels, it was a striking order of magnitude greater than that found in any other Southeast Farallon Island seabird species: Brandt’s Cormorant (0.79 ppm), Pigeon Guillemot (0.45 ppm), and Western Gull (0.52 ppm). The levels of PCBs in Ashy Storm-petrel eggs from Santa Cruz Island and Southeast Farallon Island were also higher than in other seabird species (Fry 1994). This study suggests that Ashy Storm-petrels experience higher levels of contamination throughout their range in southern and central California.

In a second study, Kiff (1994) compared thicknesses of eggshells collected prior to 1947 (pre-DDT) with those of eggshells collected between 1991-1994 from the Channel Islands. Kiff found that Ashy Storm-petrel eggs collected from Santa Cruz Island in the 1990s were significantly thinner than the pre-DDT eggs. Overall, 28% of the Ashy Storm-petrel eggs exhibited a 15% thinning of the eggshell which indicated they were “at particular risk from breakage associated with eggshell thinning” (Kiff 1994). Kiff described the eggshell thinning of the Ashy Storm-petrel as “severe.” Finally, in concordance with Fry and Kiff’s studies, a third study by Welsh et al. (2001) found that Ashy Storm-petrel eggshells collected from Santa Cruz Island between 1995-1997 contained high DDE concentrations averaging from 8.60-16.00 ppm, with the most contaminated eggs exceeding 20 ppm. Overall, these contaminant studies have consistently concluded that this species is heavily impacted by marine pollution.

2. Oil Contamination

Many researchers have identified oil pollution as a likely source of Ashy Storm-petrel mortality and a great risk to this species (Sydeman et al. 1998b, Brown et al. 2003, Carter 2003, U.S. Fish and Wildlife Service 2005). A major concern is that a large oil spill in the vicinity of the Farallon Islands, Channel Islands, or the Monterey coast could decimate the small global population of Ashy Storm-petrels (Sydeman et al. 1998b). While it is widely recognized that Ashy Storm-petrels are vulnerable to oil spills around their concentrated colony sites and marine foraging hotspots, data specifically linking oil spills to impacts on the Ashy Storm-petrel are limited (Nur et al. 1999).

One principal difficulty in assessing Ashy Storm-petrel mortality from oil spills is that Ashy Storm-petrel carcasses are seldom recovered on beaches. For Ashy Storm-petrels and other seabirds that forage far offshore, the likelihood that carcasses will be deposited on beaches is very low due to limited on-shore transport of carcasses by currents, at-sea carcass sinkage, and carcass scavenging (Carter 2003). Efforts to document seabird mortality from oil spills have improved during the 1990s with the standardization of beach monitoring programs and the development of correction factors for search effort, searcher efficiency, scavenging, unsearched beaches, sinking of carcasses at sea, and background mortality (Carter 2003). Accordingly, two Ashy Storm-petrel beached carcasses were recovered from the *S. S. Jacob Luckenbach* oil spills (chronic oil leaks from a sunken vessel 17 miles west-southwest of San Francisco near the Farallon Islands), and correction factors were applied to yield a total estimated mortality of 21 individuals (Luckenbach Trustee Council 2006, p. 74). The assessment team also concluded that “Ashy Storm-Petrels were impacted in significant numbers relative to their population size” (Luckenbach Trustee Council 2006, p. 5).

Storm-petrels may also be at high risk from oil ingestion since they feed on food floating on the ocean surface. During an oil spill, their food would become embedded in the surface slick resulting in consumption of potentially large quantities of oil (Boersma and Groom 1993).

Consumption of oil appears to change the basal metabolic rate of storm-petrels (Butler et al. 1986). Parents that become oiled seem less able to meet the energy demands of growing chicks which leads to increased mortality of chicks (Butler et al. 1986).

There are many oil-related threats to Ashy Storm-petrels in the Southern California Bight which is surrounded by a densely populated coastal region used for a variety of commercial, military, industrial, and recreational purposes. These threats include spills from offshore platforms, pipelines, on-shore oil facilities, tankers, and other military and commercial shipping; spills from tankers in marine traffic lanes near Santa Barbara Island; and chronic oiling from bilge-pumping, spewings from two-stroke outboard engines, and terrestrial sources (Carter et al. 1999). The Farallons, Channel Islands, and Los Coronados Islands are also near heavily used shipping lanes. The California coast is impacted by traffic from over 3,000 tankers along its shores each year, which poses a significant threat of oil pollution throughout the Ashy Storm-petrels habitat.

3. Plastic Debris

The degree to which plastic ingestion may be affecting Ashy Storm-petrels is unknown (Ainley 1995), making this an area where further research is needed. Although the California Current System where the Ashy Storm-petrel forages is undeniably heavily polluted with plastics, diet studies of Ashy Storm-petrels that could detect plastic ingestion are limited. High incidence of plastic ingestion and its associated impacts have been well-documented for storm-petrels and other procellariid species which feed on surface prey that is easily confused with floating plastic particles (Nisbet 1994, Greenpeace 2006). For example, a study of seabirds in the eastern North Pacific found plastics in the gut contents of all five surface-feeding procellarid species examined, including Leach's Storm-petrel (Blight and Burger 1997), suggesting a high likelihood of plastic ingestion for the Ashy Storm-petrel. In total, 63% of all procellarid species have been found to ingest plastics (Greenpeace 2006).

Plastic ingestion negatively affects seabirds in three main ways. First, plastic can block the digestive system, reduce digestive efficiency, and reduce feeding, leading to lowered fitness. Spear et al. (1995) found that storm-petrels with large plastic loads in their guts had significantly lower body weights (a proxy of physical condition) than those with low or no plastics. Blight and Burger (1997) concluded that the amount of plastic found in two storm-petrel species in the Eastern North Pacific was enough to reduce the food volume in the gizzard and affect food assimilation. Plastic ingestion may also reduce seabirds' abilities to lay down fat deposits, lowering fitness (Derraik 2002). Second, adults pass plastics to their chicks when regurgitating meals which can lead to lower chick fledging masses and survival (Sievert and Sileo 1993). Finally, seabirds can assimilate and accumulate toxins from ingested plastics. Plastic debris contains toxic additives, and floating plastics absorb toxic organochorines such as DDE and polychlorinated biphenyls (PCBs) from the ambient seawater (Azzarello and VanVleet 1987, Derraik 2002). The adverse effects of organochlorides toxins on seabirds include altered hormones levels, reproductive failures, and increased susceptibility to diseases (Azzarello and VanVleet 1987, Derraik 2002). The Ashy Storm-petrel and other procellariids are particularly vulnerable to the impacts of plastic ingestion because they cannot readily regurgitate hard, indigestible plastics due to a constriction between the gizzard and proventriculus (Azzarello and VanVleet 1987).

Plastic ingestion is becoming more problematic for seabirds because of the increase in global plastic production and dumping. Plastic production in the U.S. increased from 3 million tons in 1960 to nearly 48 million tons in 1995, reflecting larger worldwide trends (Tickell 2000). Floating plastic in all oceans has increased accordingly, including raw plastic and the fragmented, weathered remains of manufactured items like bottles, disposable cigarette lighters, and children's toys (Tickell 2000). The North Pacific Ocean, where the Ashy Storm-petrel forages, is thought to have the largest quantity, mostly discharged from Japan and the U.S. (Tickell 2000). In concordance, Moore et al. (2001) found that in the North Pacific central gyre the mass of plastic was approximately six times that of plankton. Seabird ingestion of plastics is also increasing. Robards et al. (1995) examined the gut content of thousands of birds in two separate studies and found that the ingestion of plastics by seabirds had significantly increased during the 10–15 years interval between studies.

C. Global Warming

Global warming represents perhaps the gravest threat to the long-term survival of the Ashy Storm-petrel. Global warming will likely affect the Ashy Storm-petrel in several ways. First, warmer water and reduced upwelling will decrease Ashy Storm-petrel breeding success, and perhaps survival, by reducing primary productivity in the California Current System. Second, global warming will likely lead to more intense El Niño events which are associated with Ashy Storm-petrel breeding failures. Third, sea level rise will eliminate important Ashy Storm-petrel breeding habitat on the Channel Islands. Finally, ocean acidification caused by the ocean's absorption of excess carbon dioxide may eventually lead to declines in prey species that use calcium carbonate to strengthen their exoskeletons. Collectively, these multiple threats from global warming in the California Current System will undoubtedly lead to further reductions in already small and vulnerable populations.

1. The Best Available Science and Global Warming

That global warming as a result of anthropogenic greenhouse gas emissions is occurring, and will continue to occur, is no longer subject to credible scientific dispute. There is an international scientific consensus that most of the warming observed has been caused by human activities, and that it is "very likely" that it is largely due to emissions of greenhouse gases (Solomon et al. 2007). The Fourth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC)[1] has recently synthesized the best available science on global warming.

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[1] The IPCC was established by the World Meteorological Organization and the United Nations Environment Programme in 1988 (IPCC 2001). The IPCC's mission is to assess available scientific and socio-economic information on climate change and its impacts and the options for mitigating climate change and to provide, on request, scientific and technical advice to the Conference of the Parties to the United Nations Framework Convention on Climate Change (IPCC 2001). Since 1990, the IPCC has produced a series of reports, papers, methodologies, and other products that have become the standard works of reference on climate change (IPCC 2001). The IPCC's comprehensive Assessment Reports are

The basic physics underlying global warming are as well established as any phenomena in the planetary sciences. The earth absorbs heat in the form of radiation from the sun, which is then redistributed by atmospheric and oceanic circulations and also radiated back to space (Le Treut et al. 2007). The earth's climate is the result of a state in which the amount of incoming and outgoing radiation is approximately in balance (Le Treut et al. 2007). Changes in the earth's climate can be caused by any factor that alters the amount of radiation that reaches the earth or the amount that is lost back into space, or that alters the redistribution of energy within the atmosphere and between the atmosphere, land, and ocean (Le Treut et al. 2007). A change in the net radiative energy available to the global earth-atmosphere system is called "radiative forcing" (Le Treut et al. 2007). Positive radiative forcings tend to warm the earth's surface while negative radiative forcings tend to cool it (Albritton et al. 2001).

Radiative forcings are caused by both natural and anthropogenic factors (Albritton et al. 2001, ACIA 2004, Le Treut et al. 2007). The level of scientific understanding of these different forcings varies widely, and the forcings themselves and interactions between them are complex (Le Treut et al. 2007). The primary cause of global warming, however, is society's production of massive amounts of "greenhouse gases" such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and halocarbons that cause positive radiative forcings (Forster et al. 2007, Le Treut et al. 2007). Greenhouse gases are, in fact, the radiative forcing mechanism that is currently best understood (Albritton et al. 2001).

The Enhanced Greenhouse Effect is caused by increasing concentrations of these greenhouse gases in the earth's atmosphere. As greenhouse gas concentrations increase, more heat reflected from the earth's surface is absorbed by these greenhouse gases and radiated back into the atmosphere and to the earth's surface. Increases in the concentrations of greenhouse gases slow the rate of heat loss back into space and warm the climate, much like the effect of a common garden greenhouse (Forster et al. 2007, Le Treut et al. 2007). The higher the level of greenhouse gas concentrations, the larger the degree of warming experienced. Carbon dioxide is by far the most important greenhouse gas because anthropogenic emissions of carbon dioxide dwarf those of all other compounds (Forster et al. 2007). While much smaller amounts of other greenhouse gases are emitted, these other gases can still make an important contribution to climate change because they have global warming potentials many times that of carbon dioxide (Forster et al. 2007). Increases in major greenhouse gas concentrations and their contribution to global warming are reviewed below.

By the time of the Fourth Assessment Report of the IPCC in 2007, the atmospheric concentration of carbon dioxide had increased by 36% since 1750 to a level that has not been exceeded during the past 650,000 years and likely not during the past 20 million years (Denman et al. 2007). About three fourths of manmade carbon dioxide emissions come from fossil fuel burning, and most of the remaining emissions are due to land-use changes, primarily deforestation (Denman et al. 2007). Carbon dioxide is considered the most

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produced approximately every seven years and build upon and expand past IPCC products. The *Fourth Assessment Report* was released in 2007.

important greenhouse gas overall because the volumes emitted dwarf those of all the other greenhouse gases combined. Not surprisingly, the rate of increase of total atmospheric carbon dioxide concentrations is speeding up as well. Carbon dioxide emissions increased during 2000 to 2005 (4.1 ± 0.1 GtC yr–1) compared to emissions during the 1990s (3.2 ± 0.1 GtC yr–1) (Denman et al. 2007). As of March, 2006, the atmospheric carbon dioxide concentration was 381 ppm, and rising at over 2 ppm per year (Shukman 2006).

The atmospheric concentration of methane, another important greenhouse gas, has increased by about 150% since 1750, continues to increase, and has not been exceeded during the past 650,000 years (Forster et al. 2007). About 60% of current methane emissions come from human activities, and there is also evidence that current carbon monoxide (CO) emissions are a cause of increasing methane concentrations (Denman et al. 2007). Over a 100-year period, methane will trap about 23 times more heat than an equal amount of carbon dioxide (Albritton et al. 2001).

The atmospheric concentration of nitrous oxide has increased by about 18% since 1750, continues to increase, and has not been exceeded during at least the last 2000 years (Forster et al. 2007). About half of the nitrous oxide emissions to the atmosphere come from human activities (Denman et al. 2007). Over a 100-year period, nitrous oxide will trap about 296 times more heat than an equal amount of carbon dioxide (Albritton et al. 2001).

Halocarbons are carbon compounds that contain fluorine, chlorine, bromine, or iodine (Forster et al. 2007). Most types of halocarbons are produced exclusively by human activities (Forster et al. 2007). Halocarbons that contain chlorine, like chlorofluorocarbons, ("CFCs") also cause depletion of the stratospheric ozone layer and are regulated under the Montreal Protocol (Forster et al. 2007). The combined tropospheric abundance of ozone-depleting gases peaked in 1994 and is now declining slowly (Forster et al. 2007). However, some compounds which have been promoted as substitutes for now-regulated CFCs are themselves greenhouse gases, and concentrations of these gases, such as hydrochloroflurocarbons ("HCFCs") and hydroflurocarbons ("HFCs") are now increasing (Forster et al. 2007). There are many different types of halocarbons, which have global warming potentials that vary between 12 and 12,000 times that of carbon dioxide (Forster et al. 2007).

Many other natural and human caused factors that are less understood than greenhouse gases contribute to positive or negative radiative forcing, including aerosol emissions, land-use changes, and changes in solar and volcanic activity, water vapor, and cloud cover (Le Treut et al. 2007). Nevertheless, scientists now know that greenhouse gases are the most important force driving global warming, and that carbon dioxide is in turn the most important of the greenhouse gases (Forster et al. 2007, Solomon et al. 2007). Carbon dioxide emissions from fossil fuel burning are virtually certain to remain the dominant control over trends in atmospheric carbon dioxide concentrations during this century (Forster et al. 2007).

As scientific understanding of global warming has advanced, so too has the urgency of the warnings from scientists about the consequences of our greenhouse gas emissions.

Scientists are now able to tell us, with a high degree of certainty, that additional warming of more than 1° C (1.8° F) above year 2000 levels will constitute "dangerous climate change," with particular reference to sea level rise and species extinction (Hansen et al. 2006, Hansen et al. 2007). Furthermore, scientists are able tell us the atmospheric greenhouse gas level "ceiling" that must not be exceeded in order to prevent additional warming of more than 1° C (1.8° F) above year 2000 levels (Hansen et al. 2006, Hansen et al. 2007). In turn, scientists can tell us the limitations that must be placed on greenhouse gas emissions in order to not exceed this "ceiling" of approximately 450-475 ppm of carbon dioxide (Hansen et al. 2006)

In order to stay within the ceiling, emissions must follow the "alternative," rather than the "business as usual," greenhouse gas emissions scenario (Hansen 2006, Hansen et al. 2006, Hansen et al. 2007). In the business as usual scenario, carbon dioxide emissions continue to grow at about 2% per year, and other greenhouse gases such as methane and nitrous oxide also continue to increase. In the alternative scenario, by contrast, carbon dioxide emissions decline moderately between now and 2050, and much more steeply after 2050, so that atmospheric carbon dioxide never exceeds 475 parts per million. The alternative scenario would limit global warming to less than an additional 1° C in this century (Hansen et al. 2006, Hansen et al. 2007).

Since the year 2000, however, society has not followed the alternative scenario. Instead, carbon dioxide emissions have continued to increase by 2% per year since 2000 (Hansen et al. 2006, Hansen et al. 2007). This rate of increase itself appears to be increasing (Denman et al. 2007). If this growth continues for just ten more years, the 35% increase in CO_2 emissions between 2000 and 2015 will make it impractical if not impossible to achieve the alternative scenario (Hansen et al. 2006, Hansen et al. 2007). Moreover, the "tripwire" between keeping global warming to less than 1° C, as opposed to having a warming that approaches the range of 2-3° C, may depend upon a relatively small difference in anthropogenic greenhouse gas emissions (Hansen et al. 2006, Hansen et al. 2007). This is because warming of greater than 1° C may induce positive climate feedbacks, such as the release of large amounts of methane from thawing arctic permafrost, that will further amplify the warming (Hansen et al. 2006, Hansen et al. 2007).

Just ten more years on current greenhouse gas emissions trajectories will essentially commit us to climate disaster. Dr. James E. Hansen, Director of the NASA Goddard Institute for Space Studies, and NASA's top climate scientist, has stated: "In my opinion there is no significant doubt (probability > 99%) that . . . additional global warming of 2° C would push the earth beyond the tipping point and cause dramatic climate impacts including eventual sea level rise of at least several meters, extermination of a substantial fraction of the animal and plant species on the planet, and major regional climate disruptions" (Hansen 2006:30).

Studies that have used climate model projections to forecast species extinctions have predicted large species losses. Using a mid-range climate scenario, Thomas et al. (2004) predicted that 15-37% of species are already committed to extinction by 2050. Malcolm et al. (2006) estimated that 11-43% of endemic species in biodiversity hotspots will go extinct by the end of the century under a scenario of doubled carbon dioxide concentrations, which includes an average of 56,000 endemic plants and 3,700 endemic vertebrate species.

In order to avoid truly unacceptable consequences of global warming, we must stop the growth of greenhouse gas emissions, and, in relatively short order, begin reducing them. Achieving the reductions necessary to keep additional global warming between the years 2000-2100 within 1° C will be extremely challenging, and will require deep reductions in emissions from industrialized nations such as the United States.

2. Ocean Climate Change and the California Current System

The increasing temperature of the global ocean is triggering a meltdown of carefully balanced interactions in the marine community. Water temperature is an important factor determining habitat ranges and physiological functioning of marine organisms, and even minor changes are seriously disruptive. Global ocean temperatures have increased by 0.31 °C on average in the upper 300 m during the past 60 years (1948-1998) (Levitus et al. 2000), and locally, some ocean regions are experiencing even greater warming (Bindoff et al. 2007). Changes in ocean heat content have penetrated as deep as 3000 m. Global ocean temperatures increased by 0.10 °C in the upper 700 m between 1961-2003 (Bindoff et al. 2007) and by 0.037 °C in the upper 3000 m (Levitus et al. 2005). Notably, the largest increases in global ocean temperature have occurred in the upper ocean where primary production is concentrated and are impacting ocean productivity (Behrenfeld et al. 2006). Significant global declines in net primary production between 1997-2005 were attributed to reduced nutrient enhancement due to ocean surface warming (Behrenfeld et al. 2006).

The California Current System, which runs along the west coast of North America from southern British Columbia to northern Baja California, has experienced some of the most well-documented changes in ocean climate due to global warming. This highly productive coastal upwelling ecosystem relies on seasonal, wind-driven upwelling of deep, cold, nutrient-rich water to the surface layer that stimulates phytoplankton production (Huyer 1983). The ecosystem is sensitive to changes in the strength and timing of seasonal upwelling which can produce dramatic effects that cascade through the trophic web. During El Niño Southern Oscillation (ENSO) events, for example, the slackening of upwelling-favorable winds coupled with the northward transport of warm water results in the upwelling of warmer, nutrient-depleted waters which leads to breeding failures, mortality, and population declines across trophic levels (Barber and Chavez 1983). Delays in the onset of upwelling can also have severe ecosystem consequences. A one-month delay in the onset of spring upwelling in 2005 (Schwing et al. 2006) resulted in a large-scale ecosystem collapse that included anomalously warm water, low nutrient levels, low primary production (Thomas and Brickley 2006), reduced zooplankton biomass (Mackas et al. 2006), anomalously low recruitment of rocky intertidal organisms (Barth et al. 2007) and unprecedented seabird breeding failures (Sydeman et al. 2006).

The temperature of the upper 100m of the southern California Current System increased by 1.2-1.6 ºC between the 1950s and 1990s (Roemmich and McGowan 1995) and this trend appears to have continued at least through the late 1990s (Lynn et al. 1998). This surface warming is weakening the upwelling of nutrient-rich waters off the California coast. Surface warming causes increased stratification of the water column by intensifying the density differences between the warmer surface layer and deeper, cold, nutrient-rich layer (Behrenfeld et al. 2006). Surface warming is also associated with the deepening of the thermocline (i.e. a deepening of warmer waters) in coastal regions of the California Current System in the last 50 years (Palacios et al. 2004), meaning that upwelling is more likely to bring warm, nutrient-poor waters to the surface. In short, stronger thermal stratification and a deepening of the thermocline inhibit cool, nutrient-rich waters from being upwelled (Roemmich and McGowan 1995, Harley et al. 2006). Under this scenario, the future may more closely resemble a prolonged ENSO event characterized by lowered productivity across trophic levels.

Surface warming and reduced upwelling in the California Current System are having marked ecological effects including decreased productivity and altered ecosystem structure. Between 1951 and 1993, macrozooplankton off the California coast declined by 80 percent due to surface water warming up to 1.5°C (McGowan et al. 1998). The composition of coastal and pelagic prey species, including euphausiid and larval fish assemblages, has shifted (Brinton and Townsend 2003, Smith and Moser 2003). In the nearshore realm, Giant Kelp (*Macrocycstis pyrifera*) abundance declined by nearly two thirds between the 1950s and 1990s (Tegner et al. 1996). Tidal pools studied along the Monterey coast of California already demonstrate that species abundance and distribution is changing due to climate change. In just six decades, shoreline ocean temperatures warmed by 0.79° C, cold-water species declined, and warm-water species increased (Sagarin et al. 1999). Similarly, in reef fish assemblages in the Southern California Bight, northern and endemic species declined and southern species increased following the shift to warm water conditions in the late 1970s (Holbrook et al. 1997).

Warming waters are devastating for species that are unable to migrate toward cooler waters because of habitat requirements, environmental barriers, or lack of mobility (Scavia et al. 2002). These climatic changes are occurring at an unprecedented rate which also hinders the adaptation of many organisms (Parmesan 2006). Invasive species may gain an advantage over native species in these warmer conditions (Stachowicz et al. 2002). Warmer waters favor different species of phytoplankton, some of which are associated with “red tides” that shade ocean vegetation, deplete oxygen, and often have toxic properties (Smith et al. 2000). Overall, California’s marine ecosystems are losing diversity and experiencing large alterations in structure as a result of changing ocean climate conditions.

The decreased productivity of the California Current System due to ocean warming has also affected the distribution and productivity of the seabird community (Hyrenbach and Veit 2003). Seabirds that rely on the California Current System include locally breeding species, far-ranging migratory species (shearwater and petrels), and overwintering subarctic taxa (Northern Fulmar *Fulmaris glacialis*, Black-legged Kittiwake *Rissa tridactyla*) that use its rich foraging grounds. Therefore, changes in California Current System productivity affect seabird species throughout the Pacific Ocean. Between 1987-1998, two locally breeding, cold-water-dependent alcids--Cassin’s Auklet (*Ptychoramphus aleuticus*) and Rhinoceros Auklet (*Cerorhinca monocerata*)--declined by 75% and 93%, respectively, and failed to increase in abundance during cold-water conditions which suggests that their breeding populations have been depleted (Hyrenbach and Veit 2003). The cold-water associated Sooty Shearwater (*Puffinus griseus*), which visits the California Current System in the millions each summer, declined in abundance by 91% between 1987-1994 (Veit et al. 1996). Only one of the six warm-water associated species, Pink-footed Shearwater (*Puffinus creatopus*), increased during 1987-1998 (Hyrenbach and Veit 2003). These studies suggest that ocean warming not only affects the distribution of seabird species based on their temperature affinities, but has resulted in an overall decrease in seabird abundance in the California Current System due to declining ocean productivity. Although these studies did not examine effects on the Ashy Storm-petrel, warmer water and reduced upwelling will undoubtedly decrease Ashy Storm-petrel breeding success, and perhaps survival, by reducing primary productivity in the California Current System.

3. El Niño Southern Oscillation (ENSO)

El Niño Southern Oscillation (ENSO) events reduce the upwelling of cold, nutrient-rich waters in the California Current System, causing declines in productivity and large-scale breeding failures, mortality, and population declines across trophic levels (Barber and Chavez 1983). Although the effects of climate change on the ENSO cycle are difficult to predict, leading climate scientists believe that near-term global warming will lead to an increased likelihood of stronger ENSO events (Hansen et al. 2006). Most climate models yield a tendency towards a more ENSO-like state or no clear change (Collins 2005). Some climate scientists have hypothesized that during the early Pliocene, when the Earth was 3° C (5.4° F) warmer than today, a permanent ENSO-like condition existed (Hansen et al. 2006). From the observational record, intense ENSO events were more abundant in the later part of the 20th century. The 1982-83 and 1997-98 ENSO events were successively labeled the "El Niño of the Century" because the warming in the Eastern Equatorial Pacific was unprecedented in the past 100 years (Hansen et al. 2006).

Stronger ENSO events are likely to negatively impact the Ashy Storm-petrel. The low productivity conditions produced by ENSO events will likely reduce Ashy Storm-petrel breeding success, and perhaps, survival since birds would not be able to adequately provision themselves or their young. Parents would likely need to spend more time away from the nest locating prey which could increase the frequency of egg predation at colony sites (Nur et al. 1999). In the 36-year data set on breeding success at Southeast Farallon Island, Ashy Storm-petrel breeding success decreased during two of three major ENSO events: little effect in 1982-83 and decreases during 1992-93 and 1997-98 ENSO events. At Santa Cruz Island, small differences in phenology and reproductive success were found across 1995-1998 suggesting that the 1997-1998 ENSO event did not significantly affect storm-petrels (Carter et al. 2007). These studies indicate that low productivity conditions during ENSO events may negatively impact Ashy Storm-petrel fecundity in some years.

4. Sea Level Rise

In 2007 the IPCC projected that global sea level will rise between 18-59 cm in this century (Solomon et al. 2007). One of the most troubling of recent scientific findings is that this projection is almost certainly a substantial underestimate. Melting of the Greenland ice sheet has accelerated far beyond what scientists predicted even just a few years ago, with a more than doubling of the mass loss from Greenland due to melting observed in the past decade alone (Rignot and Kangaratnam 2006). The acceleration in the rate of melt is due in part to the creation of rivers of melt water, called "moulins," that flow down several miles to the base of the ice sheet, where they lubricate the area between the ice sheet and the rock, speeding the movement of the ice towards the ocean. The IPCC projection of 18-59 cm in this century assumes a negligible contribution to sea level rise by 2100 from loss of Greenland and Antarctic ice, but leading experts have stated that that conclusion is no longer plausible due to multiple positive feedback mechanisms including dynamical processes such as the formation of moulins, reduced surface albedo, loss of buttressing ice shelves, and lowered ice surface altitude (Hansen et al. 2006). Paleoclimatic evidence also provides strong evidence that the rate of future melting and related sea-level rise could be faster than previously widely believed (Overpeck et al. 2006).

While it has been commonly assumed that the response time of ice sheets is millennia, this may reflect the time scale of the forcings that cause the changes, rather than the inherent response time of the ice sheets (Hansen et al. 2007). The forcing from continued unabated greenhouse gas emissions in this century could lead to a dynamically changing ice sheet that is out of our control (Hansen et al. 2007). Just 2-3°C (3.6-5.4° F) of warming would likely cause sea level to rise by at least 6 m (18 feet) within a century (Hansen 2006). Temperature changes of 2-3°C (3.6-5.4° F) are well within the range of estimates for this century provided by the IPCC (Solomon et al. 2007). Change of this magnitude is very likely if carbon dioxide concentrations exceed 475 ppm, and, if current greenhouse gas emission trajectories continue for just 10 more years, it will be difficult if not impossible to keep carbon dioxide levels below 475 ppm (Hansen 2006, Hansen et al. 2006, Hansen et al. 2007).

Sea level rise will have negative consequences for Ashy Storm-petrels by eliminating important habitat in sea caves and offshore rocks in the Channel Islands. On the larger Channel Islands that support mammalian predators, sea caves and offshore rocks provide crucial predator-free nesting habitat for Ashy Storm-petrels. On Santa Cruz Island, for example, Ashy Storm-petrels nests have only been documented in sea caves and offshore rocks (McIver 2002, Carter et al. 2007). Sea level rise in this century will make habitat in sea caves and offshore rocks unsuitable or inaccessible, further diminishing the small populations on the larger California Channel Islands. Therefore, sea level rise must be considered an important future threat to the Ashy Storm-petrel.

5. Ocean Acidification

The world's oceans are an important part of the planet's carbon cycle, absorbing large volumes of carbon dioxide and cycling it through various chemical, biological, and hydrological processes. The oceans have thus far absorbed approximately 30% of the excess carbon dioxide emitted since the beginning of the industrial revolution (Feely et al. 2004, WBGU 2006). The world's oceans, in fact, store about 50 times more carbon dioxide than the atmosphere (WBGU 2006), and most carbon dioxide released into the atmosphere from the use of fossil fuels will eventually be absorbed by the ocean (Caldeira and Wickett 2003). As the ocean absorbs carbon dioxide from the atmosphere it changes the chemistry of the sea water by lowering its pH. The oceans' uptake of these excess anthropogenic carbon dioxide emissions, therefore, is causing ocean acidification (WBGU 2006).

Surface ocean pH has already dropped by about 0.1 units on the pH scale, from 8.16 in 1800 to 8.05 today -- a rise in acidity of about thirty percent (Orr et al. 2005). The pH of the ocean is currently changing rapidly at a rate 100 times anything seen in hundreds of millennia, and may drop by another 0.3 or 0.4 (100 – 150% increase in the concentration of H+ ions) by the end of this century (Orr et al. 2005, Meehl et al. 2007). If carbon dioxide emissions continue unabated, resulting changes in ocean acidity could exceed anything experienced in the past 300 million years (Caldeira and Wickett 2003). Even if carbon dioxide emissions stopped immediately, the ocean would continue to absorb the excess carbon dioxide in the atmosphere, resulting in further acidification until the planet's carbon budget returned to equilibrium.

Ocean acidification from unabated anthropogenic carbon dioxide emissions poses a profound threat to marine ecosystems because it affects the physiology of numerous marine organisms, causing detrimental impacts that may ripple up the food chain. Changes that have been observed in laboratory experiments include impacts to the productivity of algae, photosynthesis of phytoplankton, metabolic rates of zooplankton and fish, oxygen supply of squid, reproduction of clams, nitrification by microorganisms, and the uptake of metals (WBGU 2006). Perhaps most importantly, increasing ocean acidity reduces the availability of carbonate ions needed by marine life to build shells and skeletons (Orr et al. 2005).

Phytoplankton, corals, coralline macroalgae, urchins, starfish, clams, oysters, crustaceans and many other organisms rely on calcium carbonate in the ocean to build skeletons (WBGU 2006). Normally, ocean waters are saturated with carbonate ions that marine organisms use to build skeletons (WBGU 2006). However, the acidification of the oceans shifts the water chemistry to favor bicarbonate, thus reducing the availability of carbonate to marine organisms (WBGU 2006). Acidic waters also dissolve existing protective carbonate skeletons and shells (Orr et al. 2005). Already the ocean surface layer has lost 10% of its carbonate compared to preindustrial levels (WBGU 2006). Continuing carbon dioxide emissions could result in a decrease in calcification rates by up to 60% by the end of this century (Ruttimann 2006). Alarmingly, the Southern Ocean will be under-saturated at the surface in aragonite (a form of calcium carbonate) in a matter of decades (by 2050), and marine organisms that use aragonite, such as shelled pteropod marine snails, will no longer be able to survive in the Southern Ocean (Orr et al. 2005).

For the Ashy Storm-petrel, ocean acidification may eventually have detrimental impacts to its crustacean prey species that may be impaired in building their exoskeletons in the coming decades. Mid-latitude waters, where the California Current Ecosystem is located, are experiencing the largest decreases in surface carbonate ion concentrations (Orr et al. 2005). By the close of this century, the acidification of the ocean will almost certainly have a significant impact on calcifying organisms if greenhouse gas emissions are not abated (WBGU 2006).

D. Modification of Breeding Habitat by Introduced Grasses

At Southeast Farallon Island, introduced grasses have increased, rendering some nesting areas unusable for Ashy Storm-petrels (Ainley 1995). Introduced grasses are widespread at all Ashy Storm-petrel colonies and their effects have not been evaluated.

II. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Ashy Storm-petrels are sensitive to research activities, and when disturbed, they will desert their nests (Ainley et al. 1990). As a result, research activities may impact Ashy Storm-petrels, but there is no evidence that this impact has had significant negative consequences on studied populations.

III. Disease or Predation

A. Native predators

Native predators of the Ashy Storm-petrel are primarily avian since Ashy Storm-petrels nest on offshore islands devoid of large mammalian predators and on cliffs and in sea caves largely inaccessible to mammalian predators. Native avian predators include Western Gulls (*Larus occidentalis*), Burrrowing Owls (*Athene cunicularia*), Barn Owls (*Tyto alba*), Peregrine Falcons (*Falco peregrinus*), and Common Ravens (*Corvus corax*) (Ainley 1995, McIver 2002, Carter et al. 2007). In addition, native Deer Mice (*Peromyscus maniculatus*) may eat Ashy Storm-petrel eggs (Carter et al. 1999, McIver 2002), and Channel Islands Spotted Skunks (*Spilogale gracilis amphiala*) depredated at least 70 adult Storm-petrels and eggs from all nesting attempts in Bat Cave on Santa Cruz Island in 2005 (McIver and Carter 2006, Carter et al. 2007). Ashy Storm-petrels avoid depredation by diurnal avian predators by arriving and leaving their nests at night. The importance of darkness as camouflage was highlighted in a study that found that storm-petrels decreased their movements during the brighter moon phases (Ainley et al. 1990). The fledging of chicks is also associated with the cycles of the moon, with most chicks fledging during the dark of the moon or during cloudy nights. In addition, Ashy Storm-petrels appear to time the fledging of chicks after most Western Gulls have left the colonies (Ainley et al. 1990).

Populations of Western Gulls have increased at some colonies likely due to human enhancement and are exerting greater predation pressure on the Ashy Storm-petrel. The Western Gull is the Ashy Storm-petrel's primary predator on the Farallon Islands (Nur et al. 1999) where large numbers of Western Gulls breed (~20,000-25,000 individuals and 30% of the global population) (Pierotti and Annett 1995). Western Gull predation pressure is thought to be heaviest on immature, non-breeding storm-petrels, particularly fledglings (Ainley et al. 1990). Due to the crevice-nesting habit of the Ashy Storm-petrel, gulls are unable to molest the eggs and the chicks in the nest. However, fledglings are clumsy, disoriented, and naïve and have been found sitting on the ground in the open at night where they can be easily picked off by gulls (Ainley et al. 1990). Therefore, the proximity and quantity of Western Gulls in Ashy Storm-petrel breeding areas can greatly influence the mortality rate of fledgling and adult Ashy Storm-petrels.

On the Farallon Islands, Ashy Storm-petrels historically nested in areas that were free of nesting gulls, presumably to escape gull predation pressure (Ainley et al. 1990). However, since the mid-1970s, Western Gulls have expanded their nesting areas to overlap with most of the Ashy Storm-petrel breeding habitat on Southeast Farallon Island (Ainley 1995, Mills 2000). McChesney (1988), Ainley (1995), and Sydeman et al. (1998a,b) identify expansion of the gull population as one of the leading causes of the population decline. Sydeman et al. (1998a) estimated that the Western Gull was causing 2.53% of the 2.87% annual decline in the Ashy Storm-petrel population on Southeast Farallon Island.

Some researchers have attributed the expansion of the Western Gull population to human enhancement through increased availability of anthropogenic food sources (Ainley and Lewis 1974, Sydeman et al. 1998b). Human food sources in the form of open dumps, refuse, and discards from commercial fishing vessels are readily available in the Western Gull's breeding range along the California coast. Western Gulls will eat human refuse in years when natural food sources are low such as during El Niño Southern Oscillation events (Pierotti and Annett 1995). For example, for birds nesting on the Farallon Islands, human refuse comprised 1-5% of the Western gull diet in good food years and 30% in low food years (Pierotti and Annett 1995). Therefore, feeding on human refuse may increase survival during poor food years and increase the over-winter survival of juveniles in all years (Pierotti and Annett 1995), and may have allowed the population to expand. Other factors that may have contributed to gull expansion include the automation of U.S. Coast Guard Stations and the closure of the Alcatraz Federal Penitentiary, both of which decreased the disturbance that gulls faced from personnel (Pierotti and Annett 1995).

B. Non-native predators

Ashy Storm-petrels occupy their nesting colonies for most of the year and have a prolonged incubation and chick-rearing period, making them particularly vulnerable to non-native predators that depredate adults, chicks or eggs. In total, non-native mammalian predators are present at four of the eight island groups where the Ashy Storm-petrel breeds: Southeast Farallon, mainland San Miguel (excluding Prince Island), mainland San Clemente, and Santa Catalina Islands.

Non-native House Mice (*Mus musculus*) depredate Ashy Storm-petrel eggs and chicks (Ainley et al. 1990) and subsidize other predators of the Ashy Storm-petrel. On Southeast Farallon Island, House Mouse depredation of eggs and chicks was the leading causes of egg failure and chick death and significantly lowered Ashy Storm-petrel breeding success (Ainley et al. 1990). The *S. S. Jacob Luckenbach* Damage Assessment and Restoration Plan proposes to eradicate House Mice from Southeast Farallon Island to benefit Ashy Storm-petrels, but this proposal has not yet been funded (Luckenbach Trustee Council 2006). Meanwhile, House Mice continue to impact the largest Ashy Storm-petrel population at Southeast Farallon Island and likely impact smaller populations at San Clemente and Santa Catalina Islands.

Non-native House Mice on Southeast Farallon Islands appear to be subsidizing non-resident Burrowing Owls, allowing owls to sustain an elevated population size and “hyper-predate” Ashy Storm-petrels (Luckenbach Trustee Council 2006). In fall, young Burrowing Owls stop on Southeast Farallon Island during migration (Pyle and Henderson 1991) when the House Mouse population is at its peak. It is thought that the Burrowing Owls remain on the Farallones instead of continuing their migration to more favorable wintering locations because of the ample food supply provided by the mice (Luckenbach Trustee Council 2006). However, the House Mouse population crashes in the winter, forcing the owls to seek alternate food sources which include Ashy Storm-petrels and other small seabirds (Luckenbach Trustee Council 2006). Since Ashy Storm-petrels occupy Southeast Farallon Island year-round, owls are able to depredate the Ashy Storm-petrels throughout winter and spring, although the owls typically die of starvation before the spring migration arrives (Luckenbach Trustee Council 2006). Farallon biologists have recorded up to 10 wintering Burrowing Owls, and emaciated Burrowing Owl carcasses are routinely found on the Farallones (Luckenbach Trustee Council 2006). The wings off up to 20 storm-petrels have been found at one owl roost site (Luckenbach Trustee Council 2006). Furthermore, about 65% of collected owl pellets have been found to contain storm-petrel and auklet feathers in late winter and spring (Mills 2001). The heightened predation pressure from Burrowing Owls is thought to add a significant source of mortality for the Southeast Farallon Island Ashy Storm-Petrel population (Luckenbach Trustee Council 2006).

Non-native Black Rats (*Rattus rattus*) and cats (*Felis domesticus*) are well-documented predators of seabird eggs, chicks, and adults and have caused seabird population declines worldwide (Moors and Atkinson 1984). Black Rats were successfully eradiated from Anacapa Island between 2003-2004 (Howald et al. 2005) but are still extant on three islands where Ashy Storm-petrels are thought to breed in small numbers: San Miguel, Santa Catalina, and San Clemente Islands. Eradication of Black Rats from San Miguel Island is currently planned under the Montrose Settlements Restoration Plan (Montrose Settlements Restoration Program 2005). Feral cats have been removed from Southeast Farallon Island, Santa Barbara Island, and Los Coronados Islands but may impact Ashy Storm-petrel populations at Santa Catalina and San Clemente Islands.

IV. Inadequacy of Existing Regulatory Mechanisms

Existing regulatory mechanisms have been ineffective at preventing the decline of the Ashy Storm-petrel and mitigating many principal threats to the species. Although most populations nest on protected and managed islands, including the Farallon National Wildlife Refuge, Channel Islands National Park, U.S. Navy lands, and Nature Conservancy lands, insufficient mechanisms have been instituted to protect the Ashy Storm-petrel from declines in population size and breeding success.

A. Management of Non-native Species

Non-native predators that depredate Ashy Storm-petrel adults, chicks, and eggs have not been eradicated from three of the eight island groups where Ashy Storm-petrels breed or are thought to breed: Southeast Farallon, San Clemente, and Santa Catalina Islands.

Eradication of Black Rats from San Miguel Island is currently planned under the Montrose Settlements Restoration Plan (Montrose Settlements Restoration Program 2005). The *S. S. Jacob Luckenbach* Damage Assessment and Restoration Plan proposes to eradicate House Mice from Southeast Farallon Island to benefit Ashy Storm-petrels, but this proposal has not yet been funded (Luckenbach Trustee Council 2006).

B. Regulation of Artificial Light Pollution

There are no adequate regulations to reduce or limit bright lights on commercial and recreational vessels or offshore energy platforms near Ashy Storm-petrel breeding colonies. Of foremost concern, the Market Squid fishery is still permitted to use bright lights near Ashy Storm-petrel colonies at the Channel Islands and the Farallon Islands. In 2000, the California Fish and Game Commission adopted measures requiring light shields and a maximum 30,000 light wattage limit per squid boat in response to concerns over impacts of bright lights on seabirds. However, there have been no subsequent studies of the effectiveness of the light shielding and no observer programs to document potential injury of the squid fishery on Ashy Storm-petrels and other nocturnal seabirds, including the Xantus's Murrelet, which is listed as threatened in California and a candidate species for federal listing. In 2004, the California Fish and Game Commission did not adopt regulations in the Market Squid Fishery Management Plan (MSFMP) to reduce night-lighting near seabird colonies. The preferred alternative R.4 of the draft MSFMP, recommended by the California Department of Fish and Game (CDFG), was to adopt seasonal closures for the squid fishery at Santa Barbara and Anacapa Islands to benefit Xantus's Murrelet, the Ashy Storm-petrel, and the California Brown Pelican. However, at its August 27, 2004, meeting, the California Fish and Game Commission failed to adopt any seasonal closures or any other mitigation measures to reduce lighting near seabird breeding sites. The Commission failed to adopt the preferred alternative despite evidence on the impacts of artificial light on nocturnal seabirds in the Channel Islands presented in a comprehensive review prepared by the CDFG (Rojek, N. 2001. Biological rationale for artificial night-lighting concerns in the Channel Islands. Unpublished report. California Department of Fish and Game, Marine Region, Monterey, California) and in the 2003 Status Review of the Xantus's Murrelet, presented to the Commission by the CDFG that reviewed the impacts of artificial light pollution on nocturnal seabirds (Burkett et al. 2003).

The network of marine reserves and marine conservation areas within the Channel Islands National Marine Sanctuary established by the State of California in 2003 and by NOAA in 2007 provide closures on commercial fisheries in very limited areas around the Channel Island Ashy Storm-petrel colonies (Federal Register 2007). These limited closures do not afford sufficient elimination of artificial light pollution from the Market Squid Fishery and other commercial fisheries. For example, marine reserves bound less than one quarter of the coast of the important Santa Barbara Island Ashy Storm-petrel colony. Currently, there are no regulations to limit artificial light pollution levels from other commercial or recreational vessels near Ashy Storm-petrel colonies. In addition, there are no regulations or observer programs to document potential impacts of lighted offshore oil platforms near Ashy Storm-petrel colonies.

C. Management of Human Disturbance

While the Farallon National Wildlife Refuge is closed to public access, Channel Islands National Park (particularly at Santa Cruz Island and Anacapa Islands), Point Reyes National Seashore, and the California Islands National Monument do not have adequate restrictions on public access to sensitive Ashy Storm-petrel breeding habitat, especially in sea caves.

D. Regulation of Global Warming

Ocean climate change due to greenhouse gas emission poses a long-term threat to the Ashy Storm-petrel. However, there are currently no legal mechanisms regulating greenhouse gasses on a national level in the United States. The primary international regulatory mechanisms addressing global warming--United Nations Framework Convention on Climate Change and the Kyoto Protocol--do not and cannot adequately address the impacts of global warming that will threaten the Ashy Storm-petrel. A review of the inadequacy of these existing regulatory mechanisms for global warming can be found in the 2004 federal listing petition for the Polar Bear (*Ursus maritimus*) prepared by the Center For Biological Diversity (http://www.biologicaldiversity.org/swcbd/species/polarbear/petition.pdf) and in the 2006 Range-wide Status Review of the Polar Bear prepared by the U.S. Fish and Wildlife Service (http://www.biologicaldiversity.org/swcbd/species/polarbear/Status-Review-12-21-2006.pdf).

E. Migratory Bird Treaty Act

While the Migratory Bird Treaty Act ("MBTA")(16 U.S.C. § 703 et seq.) provides some protection to the Ashy Storm-petrel, the statute does not adequately address all threats to the species. The MBTA provides that "it shall be unlawful at any time, by any means or in any manner," to, among many other prohibited actions, "pursue, hunt, take, capture, [or] kill" any migratory bird included in the terms of the treaties. 16 U.S.C. § 703. The term "take" is defined as to "pursue, hunt, shoot, wound, kill, trap, capture, or collect." 50 C.F.R. § 10.12 (1997). The Ashy Storm-petrel is included in the list of migratory birds protected by the MBTA. See 50 C.F.R. § 10.13 (list of protected migratory birds).

The MBTA applies to federal agencies such as NMFS as well as private persons. See Humane Society v. Glickman, No. 98-1510, 1999 U.S. Dist. LEXIS 19759 (D.D.C. July 6, 1999), affirmed, Humane Society v. Glickman, 217 F.3d 882, 885 (D.C. Cir. 2000)("There is no exemption in § 703 for farmers, or golf course superintendents, or ornithologists, or airport officials, or state officers, or federal agencies."). Following Glickman, FWS issued Director's Order No. 131, confirming that it is FWS's position that the MBTA applies equally to federal and non-federal entities, and that "take of migratory birds by Federal agencies is prohibited unless authorized pursuant to regulations promulgated under the MBTA."

The MBTA authorizes the Secretary of the Interior to "determine when, to what extent, if at all, and by what means, it is compatible with the terms of the conventions to allow hunting, take, capture, [or] killing . . . of any such bird." 16 U.S.C. § 704. FWS may issue a permit allowing the take of migratory birds if consistent with the treaties, statute and FWS regulations.

While the MBTA should protect the Ashy Storm-petrel from intentional killing, as well as fisheries bycatch,[2] it simply does not provide protection from many of the threats facing the species such as from plastic pollution, light pollution, non-native predators, and changing ocean conditions as a consequence of global warming. Moreover, unlike the ESA, the MBTA provides no citizen suit provision, no requirement for designation or protection of critical habitat, no consultation provision to ensure federal agency actions do not jeopardize the species, nor an affirmative conservation mandate to recover the species. Therefore, the MBTA is not adequate to protect the Ashy Storm-petrel.

V. Other Natural and Anthropogenic Factors

A. Human Disturbance

1. Tourism

Ashy Storm-petrels are sensitive to human disturbance at their nest sites and may abandon their nests with frequent disturbance (McIver 2002). Channel Islands populations are at greater risk from human disturbance, particularly by kayakers visiting sea caves where Ashy Storm-petrels nest (McIver 2002). Sea caves that have entrances associated with beaches (for example, Bat Cave and Cavern Point Cove Caves on Santa Cruz Island) may be more easily accessible to landings by sea kayakers (Carter et al. 2007). Additionally, Ashy Storm-petrels nesting in sea caves tend to nest in shallower crevices and in vulnerable open surfaces, driftwood piles, and loose boulders, which are more vulnerable to disturbances by humans (Carter et al. 2007). McIver (2002) concludes that kayaker visits to sea caves at Santa Cruz Island during the nine-month nesting period pose a threat to nesting and that "tourism in sea caves where storm-petrels nest should be prohibited" (p. 63). Carter et al. (1999) concurs that human presence in sea caves during the main breeding season is a potential threat to nesting.

2. Military Activities

San Clemente Island, which supports a small breeding population of Ashy Storm-petrels (Carter et al. 1992), is used as a Department of Defense U.S. Navy training facility. The U.S. Navy took control of San Clemente Island in 1934 and constructed facilities in 1935-1936. During World War II, the U.S. Navy conducted bombing exercises on the island, and it developed the first underwater test ranges in 1950-1951. Currently, the U.S. Navy

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[2] Additionally, the National Marine Fisheries Service ("NMFS") has claimed that the MBTA does not apply beyond the 3 nautical mile territorial sea and therefore does not apply to federal fisheries management. See, e.g. 69 FR 17334 (April 2, 2004)(Highly Migratory Species Fishery Management Plan response to comments). This is simply wrong. In 2001 an Interior Solicitor's Opinion concluded that the MBTA does in fact apply in the U.S. EEZ. Nevertheless, NMFS's position that the MBTA does not apply in federal waters further highlights the inadequacy of the MBTA as a regulatory mechanism to protect the Ashy Storm-petrel.

performs some nighttime operations around the island and has used sea stacks and rocky shores as targets. Approximately 500 personnel are stationed on San Clemente Island which occasionally grows to 1000. The U.S. Navy also operates an extensive Sea Test Range for military weapons testing and training exercises in the Southern California Bight. Weapons testing includes air-to-air, surface-to-air, sea-to-air, and air-to-sea detonations, and training exercises include live-fire-missile and target-drone testing, low-level aircraft flights, and naval fleet maneuvers. How these military operations impact the Ashy Storm-petrel is not known.

Research and Management Recommendations

The researchers studying the Ashy Storm-petrel have made important recommendations regarding studies for monitoring population trends and understanding the impacts of light pollution, predation, human disturbance, and other threats to Ashy Storm-petrel populations. We include these points here because future monitoring will be essential to protecting the Ashy Storm-petrels from future population extinctions. The FWS should consider these points in its recovery plan process and in its research funding decisions.

Research and management recommendations given in the draft species account for the Ashy Storm-petrel for the California Bird Species of Special Concern update (Carter et al. in press) are as follows:

- Reduce predation by Western Gulls at the South Farallon Islands (e.g., with gull exclusion or other methods to reduce gull nesting or presence in storm-petrel habitats).
- Reduce Burrowing Owl predation on storm-petrels at the South Farallon Islands by eradicating non-native House Mice, as loss of the owl's primary prey should result in owl death or dispersal from the islands.
- Maintain old rock walls at Southeast Farallon Island and create new nesting habitat widely in areas with relatively low gull numbers.
- Encourage colony growth and a wider distribution at Anacapa Island, following recent eradication of rats, by using social attraction techniques to encourage storm-petrel colonization of suitable habitats with low gull numbers.
- Install artificial nesting habitat to reduce predation and human disturbance at Orizaba Rock, Scorpion Rocks, and sea caves at Santa Cruz Island.
- Establish protective at-sea zones that ban or greatly reduce bright lights for squid fishing or other purposes around large colonies at Santa Barbara Island, Prince Island, Santa Cruz Island, Anacapa Island, and South Farallon Islands. Similar protections also should be considered at smaller colonies (e.g., Coronado Islands, Bird Rock, Double Point Rocks, Castle Rocks and Mainland, and Hurricane Point Rocks).
- Establish year-round closures to human visitation (except for research and monitoring) at sea caves with breeding Ashy Storm-Petrels at Santa Cruz

Island. Post unobtrusive signs in cave entrances to inform people of the closures.

- Educate kayakers and other tourists about human impacts to nesting birds and habitat to discourage landings at storm-petrel colonies. If possible, revise guidebooks (that currently promote cave visitations) to identify cave closures and provide reasons for closing these few of the 112 named sea caves at Santa Cruz Island.
- Investigate effects of contaminants on breeding success and population size at colonies in the Channel and South Farallon Islands.
- Investigate effects of bright lights on predation and breeding success at colonies in the Channel Islands.
- Conduct research on different techniques, including mist-net captures and nest searches, to monitor storm-petrel populations and to estimate population sizes.
- Conduct surveys to confirm status at possible breeding locations and locate small overlooked or newly-established colonies along the central and northern California coasts from Point Conception to Cape Mendocino. (Carter et al. in press: 11-13)

In addition, monitoring priorities should include the continuation of existing long-term monitoring programs at Southeast Farallon Island (the largest Ashy Storm-petrel colony) and Santa Cruz Island to understand long-term trends and ongoing threats across the range. Monitoring populations at the largest Ashy Storm-petrel colonies in the Channel Islands—Santa Barbara Island and Prince Island—could be achieved through standard mist-netting programs conducted during the breeding season. Mark-recapture analysis of data from properly conducted mist-netting programs would also allow researchers to estimate adult survival rates for the Ashy Storm-petrel which is the most important demographic variable underlying seabird population growth rates. Finally, the analysis of mist-netting data at Southeast Farallon Island since 1992 would provide important information on the most recent population trends at this colony.

Critical Habitat

The ESA mandates that, when the USFWS lists a species as endangered or threatened, the agency generally must also concurrently designate critical habitat for that species. Section 4(a)(3)(A)(i) of the ESA states that, "to the maximum extent prudent and determinable," the USFWS:

> shall, concurrently with making a determination . . . that a species is an endangered species or threatened species, designate any habitat of such species which is then considered to be critical habitat . . . .

16 U.S.C. § 1533(a)(3)(A)(i); *see also id.* at § 1533(b)(6)(C). The ESA defines the term "critical habitat" to mean:

> i. the specific areas within the geographical area occupied by the species, at the time it is listed . . . , on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and
>
> ii. specific areas outside the geographical area occupied by the species at the time it is listed . . . , upon a determination by the Secretary that such areas are essential for the conservation of the species.

Id. at § 1532(5)(A).

Petitioner expects that USFWS will comply with this unambiguous mandate and designate critical habitat concurrently with the listing of the Ashy Storm-petrel. We believe that all current and historic nesting islands and waters utilized by the species for foraging meet the criteria for designation as critical habitat and must therefore be designated as such.

Conclusion

For all the reasons discussed above, Petitioner Center for Biological Diversity requests that the U.S. Fish and Wildlife Service list the Ashy Storm-petrel as a threatened or endangered species because it is in danger of extinction or likely to become so in the foreseeable future in all or a significant portion of its range. Delaying protection of this species until populations have declined further will only undermine any future conservation efforts. If, however, federal regulatory forces can be mustered to protect this seabird from multiple ongoing threats, then it will have a renewed chance at survival. Listing this rare and sensitive seabird species now will allow the necessary conservation mechanisms to be implemented to the fullest extent possible.

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[3] All references are provided in pdf format on the accompanying compact disk except for those denoted with an asterisk. We are happy to provide the USFWS with copies of any references upon request.

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