BEFORE THE SECRETARY OF THE INTERIOR
PETITION TO LIST 12 PENGUIN SPECIES UNDER THE ENDANGERED SPECIES ACT

Macaroni Penguin ©Thomas D. Mangelsen/Imagesofnaturestock.com

CENTER FOR BIOLOGICAL DIVERSITY

Submitted November 28, 2006

Petitioned Species

COMMON NAME	SCIENTIFIC NAME
Emperor Penguin	*Aptenodytes forsteri*
Southern Rockhopper Penguin	*Eudyptes chrysocome*
Southern Rockhopper Penguin	*Eudyptes chrysocome chrysocome*
Eastern Rockhopper Penguin	*Eudyptes chrysocome filholi*
Northern Rockhopper Penguin	*Eudyptes moseleyi (E. chrysocome moseleyi)*
Fiordland Crested Penguin	*Eudyptes pachyrhynchus*
Snares Crested Penguin	*Eudyptes robustus*
Erect-crested Penguin	*Eudyptes sclateri*
Macaroni Penguin	*Eudyptes chrysolophus*
Royal Penguin	*Eudyptes schlegeli*
White-flippered Penguin	*Eudyptula albosignata (E. minor albosignata)*
Yellow-eyed Penguin	*Megadyptes antipodes*
African Penguin	*Spheniscus demersus*
Humboldt Penguin	*Spheniscus humboldti*

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EXECUTIVE SUMMARY

The penguins (Order: Sphenisciformes; Family: Spheniscidae) are among the more threatened groups of birds in the world, with over half of the approximately 19 currently recognized species considered imperiled by the IUCN and BirdLife International (BirdLife 2006). Nevertheless, only one species of penguin, the Galápagos Penguin (*Spheniscus mendiculus*), is actually protected under the United States Endangered Species Act ("ESA"). This Petition requests that 12 additional species of penguin be similarly protected and listed as Threatened or Endangered under the ESA.

The petitioned species are the Emperor Penguin (*Aptenodytes forsteri*), Southern Rockhopper Penguin (*Eudyptes chrysocome*), Northern Rockhopper Penguin (*Eudyptes moseleyi*), Fiordland Crested Penguin (*Eudyptes pachyrhynchus*), Snares Crested Penguin (*Eudyptes robustus*), Erect-crested Penguin (*Eudyptes sclateri*), Macaroni Penguin (*Eudyptes chrysolophus*), Royal Penguin (*Eudyptes schlegeli*), White-flippered Penguin (*Eudyptula albosignata*), Yellow-eyed Penguin (*Megadyptes antipodes*), African Penguin *Spheniscus demersus*), and Humboldt Penguin (*Spheniscus humboldti*).

Each of the petitioned penguin species faces unique and specific threats, ranging from introduced predators, disease, habitat destruction, disturbance at breeding colonies, oil spills, marine pollution, and in some cases, direct harvest. Additionally, most species are also impacted by fisheries, either directly, such as when individuals are caught and killed in trawls, nets and longlines, or indirectly, through the depletion of essential prey species such as krill. Cumulatively, these threats are for most of the petitioned species already of significant magnitude and impact such that listing under the ESA is warranted.

Moreover, an additional overriding threat, affecting each species, makes listing under the ESA all the more urgent. Global warming has already been linked to past, ongoing, and/or projected population declines in numerous species of penguins. Even under the most optimistic emission scenarios, continued warming over the next several decades will dramatically and irreversibly affect Antarctica, the Sub-Antarctic islands, the Southern Ocean, and the penguins dependant on these and adjoining ecosystems. Global warming then represents the most significant and pervasive threat to the continued existence of penguins, and absent prompt action to cut United States and global greenhouse gas emissions, the march of the penguins will be a march towards extinction.

The penguin species subject of this Petition are either already endangered or will likely be endangered in the foreseeable future; they therefore meet the criteria for listing as "Endangered" or "Threatened" under the ESA. Although species like the Emperor Penguin may not disappear for several decades, decisions made and actions taken over the next decade will likely dictate whether such species can survive. Only with prompt action to drastically reduce greenhouse gas emissions can the future of the Emperor and all other penguins be assured. The United States must play a leading role in this global effort. Listing the petitioned penguin species under the ESA is a small but significant step in that direction.

NOTICE OF PETITION

Dirk Kempthorne, Secretary
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Washington, D.C. 20240

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PETITIONERS

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Date: this 2?/4day of November, 2006

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 ("FWS"), to list twelve penguin species as threatened or endangered under the federal Endangered Species Act ("ESA"), 16 U.S.C. § 1531-1544.

The Center for Biological Diversity ("Center") is a non-profit, public interest environmental organization dedicated to the protection of imperiled species and their habitats through science, policy, and environmental law. The Center has over 25,000 members throughout the United States.

Petitioners seek listing and protection under the ESA for the following species and subspecies:

COMMON NAME	SCIENTIFIC NAME
Emperor Penguin	*Aptenodytes forsteri*
Southern Rockhopper Penguin	*Eudyptes chrysocome*
Southern Rockhopper Penguin	*Eudyptes chrysocome chrysocome*

Eastern Rockhopper Penguin	*Eudyptes chrysocome filholi*
Northern Rockhopper Penguin	*Eudyptes moseleyi (E. chrysocome moseleyi)*
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White-flippered Penguin	*Eudyptula albosignata (E. minor albosignata)*
Yellow-eyed Penguin	*Megadyptes antipodes*
African Penguin	*Spheniscus demersus*
Humboldt Penguin	*Spheniscus humboldti*

With the exception of the Emperor Penguin, each of these species is recognized as threatened with extinction (Vulnerable or Endangered) by the World Conservation Union ("IUCN") and BirdLife International. For each species, the primary threats to its continued existence stem from changing environmental conditions, including reduced food availability, as a result of human-induced global warming and industrial fishing. For many of the species additional threats include introduced predators, disease, habitat destruction, disturbance to breeding colonies, oil spills, marine pollution, and in some cases, direct harvest.

The term "species" is defined broadly under the ESA to include "any subspecies of fish or wildlife or plants and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." 16 U.S.C. § 1532 (16). A Distinct Population Segment ("DPS") of a vertebrate species can be protected as a "species" under the ESA even though it has not formally been described as a "species" in the scientific literature. A species may be composed of several DPSs, some or all of which warrant listing under the ESA. As described in this Petition, penguin taxonomy is rapidly changing, with between 16 and 19 species currently recognized. In the current cases of taxonomic dispute regarding penguins, the primary issue is whether a distinct breeding population should be recognized as a separate species or subspecies or be considered part of a more widely distributed taxon. We have followed the treatments using the most recent genetic data (Baker et al. 2006; Jouventin et al. 2006) and recognize 19 species. However, regardless of whether the petitioned taxa are recognized by FWS as biological species (or subspecies), each of these populations also constitute DPSs under the ESA and FWS' "Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act." 61 Fed. Reg. 4721. As such, each petitioned taxon is a "species" under the ESA. Petitioners therefore request that FWS evaluate whether each of the penguin taxa described in this petition may warrant listing under the ESA as threatened or endangered.

In analyzing whether a species warrants listing under the ESA, FWS must examine whether the species is threatened or endangered throughout all <u>or</u> a significant portion of its range. In the event FWS determines that the Petition fails to demonstrate that listing of any of the petitioned species may be warranted in all of its range, we request that, in the alternative, FWS consider whether the species is imperiled in "a significant portion of its range."

FWS has jurisdiction over this Petition. This Petition sets in motion a specific process, placing definite response requirements on FWS. Specifically, FWS 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). FWS 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 of each species is warranted, rather, Petitioners must only present information demonstrating that such listing <u>may</u> be warranted. While Petitioners believe that the best available science demonstrates that listing each of the petitioned species of penguin as threatened or endangered <u>is</u> in fact warranted, there can be no reasonable dispute that the available information indicates that listing each species as either threatened or endangered <u>may</u> be warranted. As such, FWS must promptly make a positive initial finding on the petition and commence a status review as required by 16 U.S.C. § 1533(b)(3)(B).

As each of the Petitioned species occurs in areas outside of the United States, Petitioners believe this petition should be processed by FWS's Division of Scientific Authority pursuant to the agency's current policy for listing foreign species. <u>See</u> 69 Fed. Reg. 29354 (May 21, 2004)(Annual Notice of Findings on Resubmitted Petitions for Foreign Species; Annual Description of Progress on Listing Actions).

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INTRODUCTION

The penguins (Order: Sphenisciformes; Family: Spheniscidae) are among the more threatened groups of birds in the world, with over half of the approximately 19 currently recognized species considered imperiled by the IUCN and BirdLife International (BirdLife 2006). Nevertheless, only one species of penguin, the Galápagos Penguin (*Spheniscus mendiculus*), is actually protected under the ESA. See 35 Fed. Reg. 8491 (June 2, 1970)(Final rule listing Galápagos Penguin as Endangered). This Petition requests that 12 additional species of penguin be similarly protected and listed as Threatened or Endangered under the ESA.

This Petition is divided in two parts. Part One contains species accounts, briefly summarizing the description, taxonomy, natural history, distribution, and status for each of the petitioned species. Part Two describes current and future threats to these species in the context of the five statutory listing factors contained in the ESA. Taken together, the information in these two sections demonstrates that each of the petitioned species warrants the protections of the ESA.

Each of the petitioned penguin species faces unique and specific threats, ranging from introduced predators, disease, habitat destruction, disturbance at breeding colonies, oil spills, marine pollution, and in some cases, direct harvest. These threats are described in the relevant species accounts. Additionally, most species are also impacted by fisheries, either directly, such as when individuals are caught and killed in trawls, nets and longlines, or indirectly, through the depletion of essential prey species such as krill. Cumulatively, these threats are for most of the petitioned species already of significant magnitude and impact such that listing under the ESA is warranted.

Moreover, an additional overriding threat, affecting each species, makes listing under the ESA all the more urgent. Global warming has already been linked to past, ongoing, and/or projected population declines in numerous species of penguins. Even under the most optimistic emission scenarios, continued warming over the next several decades will dramatically and adversely affect Antarctica, the Sub-Antarctic islands, the Southern Ocean, and the penguins dependant on these and adjoining ecosystems. Global warming then represents the most significant and pervasive threat to the continued existence of penguins, and absent prompt action to cut United States and global greenhouse gas emissions, the march of the penguins will be a march towards extinction.

PART ONE: SPECIES ACCOUNTS

Scientists currently recognize between 16 and 19 species of penguins (Williams 1995; Baker et al. 2006; Jouventin et al. 2006). For purposes of this petition, consistent with the most recent literature (e.g. Baker et al. 2006; Jouventin et al. 2006), we treat modern Spheniscidae as comprised of 19 extant species in 6 genera. The Galápagos Penguin (*Spheniscus mendiculus*) is already ESA-listed. We seek ESA listing of 12 additional species from 5 genera (*Aptenodytes*, *Eudyptes*, *Eudyptula*, *Megadyptes*, and *Spheniscus*). While all three species (Adelie, Gentoo and

Chinstrap) in the remaining genus (*Pygoscelis*) have shown documented declines in at least some populations (Woehler and Croxall 1997), they are generally not yet considered to be globally threatened (BirdLife 2006). Similarly, the three remaining unpetitioned species (King, Little Blue, and Magellanic) are also not considered threatened by BirdLife International or the IUCN. (BirdLife 2006). While we do not officially petition for ESA listing for these 6 species at this time, given the ever-growing threat of global warming, combined with expanding industrial fishing fleets operating in essential penguin foraging ranges, we do not believe that any penguin species can be considered truly secure.

For the 12 petitioned species, the species accounts that follow rely heavily on the IUCN Red List and BirdLife International database of threatened birds (BirdLife 2006) combined with an in-depth review of published literature.

I.   GENUS: APTENODYTES

There are two extant species in the genus *Aptenodytes*: the Emperor Penguin (*A. forsteri*) and the King Penguin (*A. patagonicus*). A third, long-extinct species, Ridgen's Penguin (*Aptenodytes ridgeni*) is known from the Early Pliocene and is intermediate in size between the Emperor and King penguins. This petition seeks to list the Emperor Penguin as Threatened under the ESA.

A. Emperor Penguin (*Aptenodytes forsteri*)

Figure 2: Emperor Penguin Range

Figure 1: Emperor Penguin and Chicks

Photo by National Oceanic and Atmospheric Administration/
Department of Commerce.

The Emperor Penguin warrants listing as Threatened under the ESA. Such status is appropriate based on observed and projected population declines correlated with increasing sea temperatures, changes in sea-ice extent and duration, and declines in krill and other prey species

availability. Global warming resulting from anthropogenic greenhouse gas emissions is the primary driver of significant changes in the Antarctic marine ecosystem upon which the Emperor Penguin depends. Studied populations have declined by upwards of 70% in the face of changing climate conditions. Additionally, the ongoing and projected growth of the krill fishery in and near important Emperor Penguin foraging areas threatens to reduce food availability at critical times in the species' life cycle. Finally, rapidly expanding Antarctic tourism and other human visitation brings with it the increased risk of disturbance of breeding colonies, oil spills, and the risk of disease and other exotic species introductions.

1. Description

The Emperor Penguin is the largest extant species of penguin measuring 100-130 cm in length with flippers 30-40 cm long and weighing 20-41 kg (Marchant and Higgins 1990; Shirihai 2002). Adults have blackish heads grading to bluish-gray on upperparts, which are separated from glossy white underparts by a black band, which extends upwards to the lower neck (Shirihai 2002). A diagnostic large, oval-shaped pale yellow neck patch, variably tinged orange, is almost entirely enclosed by black above and below (Shirihai 2002). The iris is dark brown and the bill is black with a pinkish or lilac stripe on the lower mandible (Shirihai 2002). Immature birds are paler and browner above and on the head, the neck patch is ill-defined and whitish, and the bill stripe is a dull pinkish-orange (Shirihai 2002). Immatures molt into adult plumage when about 18 months old (Shirihai 2002). The chick is silvery-gray to whitish, with a distinctive white face bordered by a black crown and neck sides (Shirihai 2002).

2. Taxonomy

The Emperor Penguin is monotypic with no recognized subspecies (Shirihai 2002). It diverged from its nearest living relative, the King Penguin, during the Middle Miocene Climate Transition between 12 and 14 mya (Baker et al. 2006).

3. Distribution and Habitat

Emperor Penguins are the most ice-adapted of any penguin species, breeding on pack ice. They are distributed in marine, circumpolar areas in and near pack ice of coastal Antarctica (Marchant and Higgins 1990).

a. Breeding Range

Emperor Penguins have been reported to breed at a total of at least 45 widely-spaced colonies rimming the Antarctic continent (Woehler 1993, Mellick & Bremers 1995, Coria & Montalti 2000, Todd et al. 2004, Lea and Soper 2005). Their known breeding distribution extends from the Antarctic Peninsula at Snow Hill Island (64°31′S, 57°27′W) eastwards along the coasts of Dronning Maud Land, Enderby Land, Mac.Robertson Land and Wilkes Land to Cape Crozier on Ross Island (77°31′S, 169°23′E) (Marchant and Higgins 1990). In the Ross Sea area, colonies were reported spaced out approximately 50 to 100 km apart (Kooyman 1993).

Emperor Penguins breed almost exclusively on stable pack ice near coastal areas and up to 18 km offshore. Only two small breeding colonies are known to occur on land. Breeding colonies usually occur in sheltered areas, where ice cliffs and icebergs protect the site from the harshest of winds (Williams 1995).

According to Kooyman (1993) the most important physical characteristics of breeding habitats in the Ross Sea appear to be stable fast ice, nearby (<6 km) open water or polynyas, fresh snow, and shelter from wind. In other regions, access to open water is much less readily available (Budd 1961, 1962). For many colonies, at the time the male Emperor is relieved by his mate around hatching time, the distance between the colony and the open sea may be 100km or more (Shirihai 2002).

b. Foraging Range

Emperor penguins forage exclusively in the cold waters of the Antarctic, with only rare individuals being found further north than 65° S (Williams 1995). While breeding, adults make foraging trips 50 km to 300 km away from breeding sites, probably to the continental shelf and shelf-break (Ainley et al. 1984; Kooyman 2002).

Emperors are considered dispersive but little information exists on non-breeding movements (Marchant and Higgins 1990). Breeding grounds are deserted for only three months each year so Emperor Penguins probably do not travel far from the Antarctic (Marchant and Higgins 1990). In the Ross Sea, Emperors concentrate during the non-breeding season at the continental shelf slope and Antarctic Convergence. Most adults stay within 300 km of breeding sites, while immature birds made up one-third of the Emperors recorded beyond 300 km (Ainley et al. 1984). According to Kooyman et al. (2004) Emperor Penguins travel more than 2000 km on the return journey to their colonies of the western Ross Sea. Following fledging, Emperor penguins may disperse as much as 3000 km from the colony (Kooyman 2002).

4. Life History

a. Diet and Feeding Behavior

Emperor Penguins forage only at sea and mainly take krill (*E. superba*), fish (primarily *Pleuragramma antarcticum*), and small cephalopods (Shirihai 2002). The proportions of prey types vary depending on locality and time of year (Kirkwood and Robertson 1997). At the Drescher Island colony, which is near the continental shelf slope, krill is the predominant prey (Kooyman 2002). In contrast, for the Ross Sea colonies where the nearest foraging areas are over the shelf, Emperors eat fish almost exclusively (Kooyman 2002). At the Auster colony, Emperors switched from a diet of only 5% squid to one of over 60% squid between spring and summer in a single season (Kooyman 2002).

The distance between the colony and open sea may be over 100 km when males transfer chick rearing to the returning females (Shirihai 2002). Ancel et al. (1992) satellite monitored the foraging routes taken by Emperor Penguins and compared them with satellite images of sea ice. Emperor Penguins walking over fast ice traveled up to 296 km to feed in polynyas, whereas those swimming in light pack-ice traveled as far as 895 km from the breeding colony (Ancel et al. 1992).

Emperor penguins search for prey in the open water of the Southern Ocean or in ice-free polynyas and tidal cracks in pack ice (Shirihai 2002, Williams 1995). They have been recorded diving to depths of 400 to 500 meters and traveling 150 to 1000 km in a single foraging trip (Williams 1995, Shirihai 2002). Emperors take krill and fish from the undersurface of the sea ice and benthic prey at depth ((Kooyman 2002).

Robertson and Newgrain (1996) examined the food and energy requirements of adult emperor penguins raising chicks at Auster (about 11,000 pairs) and Taylor Glacier (about 2,900 pairs) colonies during the winter, spring and summer of 1988. Adults assimilated 84–92% of their daily food intake themselves and retained the remainder for the chick. The food ration of chick for the three seasons (42 kg) constituted only about 9.5% of adult maintenance requirements during the same period. Adults consumed an estimated 482 kg of food (including the ration for the chick), which amounted to about 10,700 tons and 2,800 tons of fish and squid consumed by the breeding populations at Auster and Taylor Glacier, respectively (Robertson and Newgrain 1996).

b. Breeding Behavior

The annual breeding cycle of the Emperor Penguin is among the most improbable of any vertebrate species. The Emperor Penguin is the only species to breed during the Antarctic winter. The unique breeding cycle begins in early winter (April/May) when male and female Emperors congregate on fast ice in a traditional colony area. Adults arrive at breeding sites weighing up to 40 kg. Courtship involves trumpeting calls and displaying of the golden neck patches (Shirihai 2002). Emperor Penguin pairs are monogamous in a given season, but have low pair fidelity with a comparatively high percentage of pairs not renewing their bond the following season (Shirihai 2002). Females lay a single large greenish-white egg in May/June, which is transferred to and incubated on the feet of the male for 62-67 days (Shirihai 2002). Females return to sea to forage during this time. Males fast during incubation and can lose up to 45% of their body weight during this period. Incubating males form large groups that huddle together as a conglomerate mass during the coldest weather which can reach negative 30 °C and below (Shirihai 2002).

Females time their return to the colony to be near the time of hatching, providing the first food to the newly hatched chick. At this point the male, which has fasted for the 4 months since arrival on the breeding grounds, transfers responsibility over the chick to the female and walks the 6-100+ km to open water to forage. Over the next 5 months the male and female alternate

tending the chick and foraging, with trips away shortening from 3 weeks long in August to as short as 3 days in December when the chick is near ready to fledge (Kooyman 2002).

Shortly after hatching, chicks molt into a suit of down, and fledge at about 150 days. Chicks are abandoned prior to acquiring their full complement of adult feathers. Chicks enter the water when the fast ice has broken up weighing 9.9-14.8 kg. They will then spend about 4 years entirely at sea before returning to the colony, and then breeding the subsequent year (Shirihai 2002).

Given the extreme temperatures and winds at the colony sites, in certain years chick survival is low, with chicks lost to starvation, predation, cold, and entrapment in tidecracks (Lavery 1986). Strong winds may also cause the ice to break up early, causing the loss of the entire cohort of chicks from the colony that year (Kooyman 1993). At other times the winds may take their toll by forcing adults to desert eggs or chicks when the thermoregulatory needs of the adult take priority over survival of the chicks (Kooyman 1993).

5. Abundance and Trend

Emperor Penguins are extremely difficult to monitor because the only time an accurate census can be made is when they are on their breeding ground. But since breeding occurs in winter, and breeding colonies are generally at very remote locations, most colonies have not been consistently censused or otherwise monitored. Nevertheless, the colonies for which long term monitoring data is available tend to show worrying declines.

In the 1980s, the total Emperor Penguin population was estimated to be around 270,000 to 350,000 breeding adults (Marchant and Higgins 1990, del Hoyo et al. 1992). More recently, Micol and Jouventin (2001) estimate the global population to be around 220,000 individuals.

The best studied Emperor Penguin colony is located near the French research station Dumont d'Urville Station (66.78 S, 140.08 E) at Pointe Geologie, Terre Adelie. The population has been monitored continuously since 1952, the longest data set for an Antarctic seabird (Woehler et al. 2001; Barbraud and Weimerskirch 2001; Micol and Jouventin 2001). The number of breeding pairs has decreased from over 6,000 to around 2,700 over that time period, a decline of 55%. A prolonged decrease in adult survival related to a period of warming and of reduced sea-ice extent was identified as the likely driver of the decline (Barbraud and Weimerskirch 2001). In addition, reproductive success has also declined: 72% success for 1962-1971, 57% success for 1974-1989, and 38% success for 1990-1998 (Micol and Jouventin 2001). More recently, Ainley (2006) characterized the population as undergoing a 70% decline since the 1960s.

Other Emperor Penguin populations have also demonstrated declines in recent decades. At Fold Island in Kemp Land, the population of Emperor Penguins has declined by more than half (Marchant and Higgins 1990). In 1957, there were an estimated 2000 birds, by 1977 the population was reduced to 900, and by 1985 only 700 individuals remained.

Even more dramatically, at Cape Roget in Victoria Land, the breeding population declined from an estimated 11,700-17,000 pairs in the early 1960s to only 3,777 pairs in 1983 and 3,851 pairs in 1990 (Marchant and Higgins 1990; Kooyman and Mullins 1990).

The nearby colony at Cape Crozier also underwent declines during this time period, linked primarily to several years of early sea-ice breakouts in the 1970s (Harper et al. 1984).

Elsewhere, the colonies on the Riiser-Larsen Peninsula and Umebosi Rock showed strong fluctuations. Breeding colonies of Emperor Penguins on the Riiser-Larsen Peninsula and Umebosi Rock are located on the fast sea-ice at the foot of a cliff of the ice shelf. Population size fluctuated between 4,000 and 9,000 pairs on the Riiser-Larsen Peninsula and between 200 and 600 pairs at Umebosi Rock during 1984-2000. Populations of both colonies during the mid-1990s were twice to three times greater than those during the 1980s, but rapidly decreased to half of the 1990s populations in 2000 (Kato et al. 2004).

Finally, a small colony of Emperor Penguins on Dion Island in the Western Antarctic Peninsula saw a decline from 250 pairs in 1960 to 10 pairs in 2001 (Ainley 2006).

In sum, while many Emperor Penguin colonies remain uncensused and a range-wide population trend is not available, what data that are available show that the species is undergoing substantial declines in at least a significant portion of its range. Moreover, as discussed below, given the ongoing and projected impacts from global warming, such declines are likely to become more widespread and pronounced, putting the species as a whole at risk.

6. Threats

a. Global Warming

As the penguin species most adapted to the extreme cold and ice of Antarctica, the Emperor Penguin is also the species most threatened by warming temperatures and the loss of ice. Studied populations have declined by more than 50%. Such declines have been correlated with warming temperatures, reduced sea ice, and declines in krill stocks. Moreover, impacts of the changing climate have altered breeding timing in some populations, resulted in earlier sea-ice break up causing reproductive failure and juvenile mortality. Under most climate scenarios for the remainder of this century, such impacts will likely become more widespread and severe.

In 2001, Barbraud and Weimerskirch published an article in the preeminent scientific journal *Nature* entitled "Emperor Penguins and Climate Change." In the article, Barbraud and Weimerskirch (2001) documented a warming-related decline of Emperor Penguins.

> We show that over the past 50 years, the population of emperor penguins (*Aptenodytes forsteri*) in Terre Adelie has declined by 50% because of a decrease in adult survival during the late 1970s. At this time there was a prolonged

abnormally warm period with reduced sea-ice extent. Mortality rates increased when warm sea-surface temperatures occurred in the foraging area and when annual sea-ice extent was reduced, and were higher for males than for females.

(Barbraud and Weimerskirch 2001).

Figure 3: Emperor Penguin breeding pairs at Terre Adelie 1952-1999.
From Barbraud and Weimerskirch (2001).
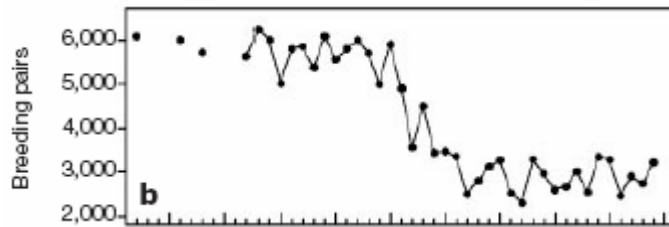
Barbraud and Weimerskirch (2001) identified the likely mechanism for the link between warm sea surface temperatures (SST) and Emperor Penguin population declines as linked to sea-ice associated prey availability.

Prey availability is influenced by physical parameters such as sea-ice extent or sea-surface temperature (or both). Decreased frequency of krill recruitment associated with a decreased frequency of extensive winter sea-ice may be responsible for low population sizes of krill, and lower krill abundance is associated with areas with less winter sea-ice cover. In years with high SSTs, emperor penguins probably have difficulties in finding food, which could increase mortality.

(Barbraud and Weimerskirch 2001).   This effect is significant enough that it overrides the increased fledging success that can occur in years with less winter sea-ice.

Sea-ice extent in winter negatively affects hatching success, by increasing the distance between the colony and feeding grounds. Conversely, annual sea-ice extent positively affects adult survival by increasing food availability. Therefore there exists in emperor penguins a trade-off between the advantages and disadvantages of extensive pack ice. In population terms, the trophic advantage of extensive pack ice, by favouring higher survival and further reproduction, outmatches its physical disadvantage of reducing fecundity.

(Barbraud and Weimerskirch 2001)(internal citations omitted).

While Barbraud and Weimerskirch (2001) demonstrate that low ice years can improve breeding success (at the expense of adult survivorship), in years of very low sea-ice, rather than enhanced breeding success, colonies can undergo complete breeding failure.

Complete or extensive breeding failures in some years resulted from early break-out of the sea-ice holding up the colony, or from prolonged blizzards during the early chick-rearing period

(Barbraud and Weimerskirch 2001).

Kooyman (1993) described colonies in the Ross Sea that were in areas of limited fast ice. Limited ice resulted in high chick mortality and occasional complete breeding failure.

> This restricts the ability of the birds to move away from guano-contaminated snow and ice, and limits the option for shelter from winds, which must result in high chick mortality during years of bad weather. Strong winds may also cause the ice to break up, an event that destroys the colony for that year.

(Kooyman 1993).

Harper et al. (1984) also described the negative impacts of reduced and unstable sea ice on the Cape Crozier Emperor Penguin colony.

> In some years when the sea-ice has broken out early, very few chicks have survived…the colony appears to have declined in the 1970s, perhaps for several reasons. Both 1975 and 1977 were years of early sea-ice breakout, and some chicks may have been swept out to sea. In 1976 a slide or avalanche from the cliffs of Cape Crozier destroyed part of the colony, killing breeding adults. If, because of early breakout of the sea-ice, the penguins are forced to breed adjacent to these unstable rock cliffs there must be a risk of further adult mortality. High adult mortality may be more serious than high chick mortality in such a long-lived species.

(Harper et al. 1984)(internal citations omitted).

The conclusions of Barbraud and Weimerskirch (2001) regarding the drivers of Emperor Penguin declines have been reinforced in a subsequent analysis of the same colony at Terre Adelie.

> Barbraud and Weimerskirch (2001a) have suggested that the population of Emperor Penguins has declined by 50% because of a decrease in adult survival during the late 1970s related to reduced winter sea ice extent. Our retrospective analysis confirms that the variation in adult survival makes the strongest contribution to the variability of Emperor Penguin population growth rate. During the late 1970s, a regime shift probably occurred in the Southern Indian Ocean (Weimerskirch et al. 2003, Jenouvrier et al. 2005b), with an important warm event affecting the marine ecosystem. The dramatic decrease in the Emperor Penguin population during this regime shift suggests that this species may be very susceptible to environmental variability, and particularly to sudden changes in the environment.

(Jenouvrier et al. 2005c). Moreover, Jenouvrier et al. (2005c) analyzed the breeding success of Emperor Penguins at the colony and concluded that it too had declined in conjunction with warmer waters and reduced sea ice.

> Emperor Penguin breeding success decreased continually from a maximum in the early 1960s to a minimum in the mid 1990s, and this decrease probably explains why the Emperor Penguin population did not recover to the levels prior to the 50% population decrease. Emperor Penguin breeding success was positively related to the Southern Oscillation Index. In years with a negative SOI (warm sea surface temperature and lower sea ice extent), Emperor Penguins may have difficulties in finding food to rear their chicks until fledging.

(Jenouvrier et al. 2005c).

While Barbraud and Weimerskirch (2001) clearly identified the relationship of increased sea temperatures, reduced krill, and lowered adult survivorship of Emperor Penguins, they left open the question of when such temperature induced food stress actually impairs survival.

> It is not known when the survival of adult emperor penguins is affected by warm water events: whether during winter when males and females undertake long incubation and chick brooding fasts, or during the summer when they disperse to moult.

(Barbraud and Weimerskirch 2001).

Kooyman et al. (2004) have answered that question, showing that the time of the molt is the most stressful in an Emperor Penguin's yearly cycle. Kooyman et al. (2004) concluded that Emperor Penguins are close to starvation by the end of the molt, and that it is essential that an abundant food supply is in close proximity to the molt area. Any reduction in the extent and seasonal duration of the pack ice would likely reduce penguin prey species (Atkinson et al. 2004). Any reduction in food supply, especially at the critical time following the molt will result in a rapid change in the size of the breeding population of Emperor Penguins in coastal west Antarctica and rangewide.

> We propose that during the summer, emperor penguins are at greatest risk. At this time there are at least 2 critical aspects to their ecology: (1) access to large stable floes that will not break up prior to the completed moult, and (2) an abundant food supply accessible immediately post-moult when their body mass is critically low. Any significant reduction in either of those 2 components in the eastern Ross Sea could be a significant detriment to the survival of the birds, and more critical than similar factors at other times of the year.

(Kooyman et al. 2004).

As Kooyman et al. (2004) demonstrate, the relationship between sea-ice and krill availability is not the only critical link between sea-ice extent and Emperor Penguin survival.

> During the approximately 30 d moult, birds must not enter the water because in this transitional state their old and new feathers are not waterproof. Without waterproofing, the feathers would become waterlogged, thermal conduction would be excessive, hypothermia would result, and death would probably follow. Therefore, it is essential that the birds select ice floes that remain intact through this period of time.

(Kooyman et al. 2004). Just as early breakup of the fast ice upon which Emperor Penguin chicks develop can cause high or complete chick mortality, summertime reduction in ice floes upon which the adults molt can lead to significant adult mortality. Either dynamic, both of which are likely to increase in frequency and severity in a warming climate, will be catastrophic for the species.

Summing up the observed impacts of warming temperatures on the declining Emperor Penguin colony at Terre Adelie, Barbraud and Weimerskirch (2001) concluded that the species faces an uncertain future in a changing climate.

> Our results also indicate that emperor penguins may be very susceptible to environmental variability and that further long-lasting coupled anomalies are likely to affect their populations.

(Barbraud and Weimerskirch 2001).

Similarly, in discussing the documented decline of the Emperor Penguin along with that of other Antarctic seabirds, the take home message of Micol and Jouventin (2001) was also cautionary.

> The clearest fact in terms of conservation is that the two species that decreased are already the least numerous in Antarctica, these being the emperor penguins -- 220,000 pairs -- and the southern giant petrels-- less than 300 pairs.

(Micol and Jouventin 2001)

While warming related decreases in sea-ice extent are clearly detrimental to Emperor Penguin survival, in some areas, global warming is causing localized increases in sea-ice as a result of ice sheet calving and collapse. Such impacts can also be detrimental to Emperor Penguin colonies. The calving of the B-15 iceberg from the Ross ice shelf in March, 2000 impacted Emperor Penguins by reducing overall productivity in the Ross Sea, changing the timing of food availability, and blocking the entrance to Emperor Penguin breeding grounds near Cape Crozier and traditional Emperor Penguin breeding grounds (Arrigo et al. 2002). Unprecedented levels of ice sheet collapse have already been documented on the Antarctic

Peninsula, and this phenomenon can be expected to continue. A further discussion of global warming's impacts on Antarctic ice sheet and sea-ice extent is contained in Section II of this Petition.

Studies of the same Emperor Penguin colony in Terre Adelie that declined in the face of warming temperatures and reduced sea-ice in the 1970s have also shown phenological changes in response to the changing conditions. Barbraud and Weimerskirch (2006) documented that Emperor Penguins tended to arrive later and breed later than over the period 1950-2004. In contrast with northern hemisphere trends in which animals tend to breed earlier in the spring in response to warming, for Emperor Penguins the response has been the opposite. Barbraud and Weimerskirch (2006) hypothesize that difficulty in getting enough food prior to breeding may be the cause of the delay.

> [T]he large (12–20%) reduction in sea ice extent since the 1950s has been associated with a decline in abundances of krill and other marine organisms, which are major food resources for most Antarctic seabirds. Their decline may be driving the observed delays in bird arrival and breeding.

Barbraud and Weimerskirch (2006). While sea-ice extent is decreasing, local sea-ice duration is increasing. This counterintuitive trend is explained because "recent research suggests that sea ice extent is connected to large-scale features of the global climate system…whereas the length of the sea ice season is connected to more regional features such as temperature." (Barbraud and Weimerskirch 2006). Combined, these sea-ice trends made the Emperor Penguin's already stressful breeding cycle even more difficult.

> Therefore, we suggest that decreasing sea ice extent and increasing sea ice season duration have reduced the quantity and accessibility of the food supplies available in early spring and may partly explain the delays observed in arrival and laying dates, with seabirds needing more time to build up the reserves necessary for breeding.

(Barbraud and Weimerskirch 2006). Moreover, Emperor Penguins and other Antarctic seabirds are unlikely to be able to adapt to such changes in their limited breeding areas.

> Because southern shifts in the distribution of Antarctic species are extremely limited by the presence of the Antarctic ice cap, unless microevolutionary responses to climate change progress with sufficient speed, these species may be unable to respond appropriately to changes occurring in their breeding area and therefore may be disproportionately negatively affected by current climate changes.

(Barbraud and Weimerskirch 2006).

The reduction of sea-ice extent associated with the warm period in the 1970s and the decline of the Terre Adelie Emperor Penguin population are likely to continue and intensify in large areas of the Antarctic coast. (Curran et al. 2003; Clarke and Harris 2002). Decreased winter sea-ice is responsible for lowering the population sizes and relative abundance of krill and other prey that the Emperors rely on throughout the stressful breeding cycle (Loeb et al. 1997; Nicol et al. 2000; Barbraud and Weimerskirch 2001; Atkinson et al. 2004). A further discussion of global warming's impacts on krill is contained in Section II of this Petition.

In sum, global warming is already changing Emperor Penguin phenology, survival, reproductive success, and population size. Absent a significant reduction in greenhouse gas emissions these trends are likely to continue. Global warming then is likely to place the Emperor Penguin in danger of extinction throughout all or a significant portion of its range in the foreseeable future.

b. Fisheries

Emperor Penguins are dependant at different times and locations on krill, fish and squid (Shirihai 2002). Each of these is subject to some level of harvest in Emperor Penguin foraging areas (Croxall and Nicol 2004). Krill fisheries in particular are predicted to greatly expand in the near future (Marris 2004). As discussed above, Emperor Penguins operate near their metabolic limits and any reduction in food availability can lead to mortality, reduced breeding success, and population declines (Barbraud and Weimerskirch 2001; Jenouvrier et al. 2005c; Kooyman et al. 2004). Current fisheries management does not take into account either the specific foraging areas Emperor Penguins rely upon or the ongoing declines in krill stocks related to global warming (Marris 2004). Given that krill are the main food source for many Emperor Penguin populations in winter, increased harvest of Antarctic krill has the potential to remove vital food resources from breeding adults at their most vulnerable stage (Ellis et al. 1998). In conjunction with the already observed and projected impacts of global warming on Emperor Penguins, fishing poses a significant and growing threat to the continued existence of the species. A further discussion of fishing impacts on penguins, and the inadequacies of current fisheries management is contained in Section II of this Petition.

c. Disturbance and Other Threats

While Emperor Penguins inhabit some of the most inaccessible areas of the planet, there colonies are not immune to disturbance. Tourist boats, exploration teams and other sources of human disturbance may impact Emperor Penguin colonies. Many Emperor Penguin colonies are exposed to moderate to intense levels of aircraft activity. Researchers utilize both fixed-wing aircraft and helicopters around Emperor Penguin colonies. Antarctic tour operators use helicopters to take tourists to breeding colonies, causing stress and potentially mortality to adults and juveniles (Giese and Riddle 1999). Emperor Penguin chicks exposed to a helicopter flying at 1,000 meters (3,300 feet) above the colony displayed more vigilant behavior and flapping that indicated nervous apprehension (Giese and Riddle 1999). Depending on the condition of the chicks and the time of year, additional stress may lead to reduced survival for entire colonies. A

discussion of the rise of Antarctic tourism and the potential threats to penguins is contained in Section II of this Petition.

The Emperor Penguins inhospitable location has shielded the species from most other anthropogenic threats. Nevertheless, disease, introduced species, oil pollution, and other impacts on the species can not be discounted. For example, antibodies for infectious bursal disease virus (IBDV), a pathogen of domestic chickens, have been found in Emperor Penguins at the Auster colony; the likely source of such pathogens was chicken imported to Antarctica for human consumption (Gardner et al. 1997). In summing up the disease threat, Gardner et al. (1997) stated that such a virus could have grave consequences for Emperor Penguins and other Antarctic species.

> At this time it must be assumed that IBDV may be pathogenic in Antarctic penguins, and is likely to be spread by human activity. The potential for expeditioners and tourists to be vectors of disease as they move around Antarctica <u>may pose the greatest threat yet to its avian fauna</u>.

(Gardner et al. 1997)(emphasis added). Further information on disease and other impacts on penguins in the context of the ESA listing factors is contained in Section II of this Petition.

II. GENUS: EUDYPTES

Crested penguins of the genus *Eudyptes* are the most diverse and abundant of all penguins. (Shirihai 2002; Jouventin et al. 2006). Unfortunately, these penguins are also the most imperiled. Each of the species in the genus *Eudyptes* is currently listed as Vulnerable or Endangered by the IUCN and BirdLife International (BirdLife 2006). Most of the species have experienced substantial declines in recent decades (BirdLife 2006).

While the IUCN has been slow to incorporate threats from climate change into its assessments of species status (Akçakaya et al. 2006), and only 25 of 1215 globally threatened birds have been listed as threatened by climate change (BirdLife 2006), the species in the genus *Eudyptes* are among the few for which such a climate impacts assessment has been completed, and for each of them climate change is now considered an important threat to their continued existence (BirdLife 2006; Hilton et al. 2006).

Various treatments have recognized between 5 and 7 species in the genus *Eudyptes*. Based on recent genetic data, we treat the genus as comprised of 7 species with the Northern Rockhopper and Royal Penguins elevated to full species status (Baker et al. 2006; Jouventin et al. 2006). The Eastern Rockhopper Penguin (*E. chrysocome filholi*) is treated as a subspecies of the Southern Rockhopper Penguin (*E. chrysocome*).

This Petition seeks ESA listing of all currently recognized species in the genus *Eudyptes*, the Southern Rockhopper Penguin (*E. chrysocome*), Northern Rockhopper Penguin (*E.*

moseleyi), Fiordland Crested Penguin (*E. pachyrhychus*), Snares Crested Penguin (*E. robustus*), Erect-crested Penguin (*E. sclateri*), Macaroni Penguin (*E. chrysolophus*), and Royal Penguin (*E. schlegeli*). We believe Endangered status is appropriate for the Northern Rockhopper, Fiordland Crested, and Erect-crested penguins, while Threatened status is appropriate for the Southern Rockhopper, Macaroni, and Royal penguins.

Figure 4: Southern Rockhopper Penguin   **Figure 5: Rockhopper Range Map**

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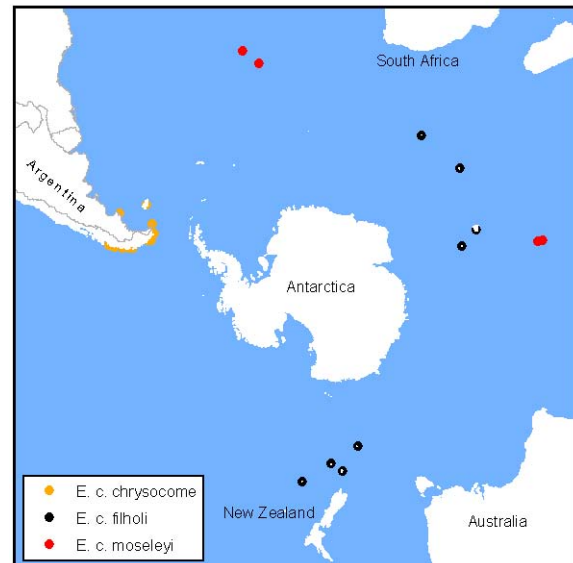
A.   Southern Rockhopper Penguin (*Eudyptes chrysocome*)

1. Description

Rockhopper penguins are the smallest of the crested penguins. Adults have blackish upperparts, head and throat divided from white underparts. A bright yellow eyebrow starts at the base of the bill and ends as long plumes projecting and falling sideways away from the eye. The bill is reddish-orange brown and black at the base in *E. c chrysocome* while with *E. c filholi* the base of the bill is pinkish (Shirihai 2002).

2. Taxonomy

The Rockhopper Penguin complex likely consists of multiple species. Until recently the common treatment was a single species (*E. chrysocome*) comprised of three subspecies: the Southern Rockhopper Penguin (*E. c. chrysocome*), Eastern Rockhopper Penguin (*E. c. filhole*), and Northern Rockhopper Penguin (*E. c. moseleyi*)(Shirihai 2002). However, using mitochondrial genetic data, Jouventin et al. (2006) determined that the northern form warranted full species status.

Our findings demonstrate that the northern form of rockhopper penguin found on Amsterdam and Gough islands is reproductively isolated from the southern form occurring on Crozet and Kerguelen islands. The rockhopper penguin is monophyletic, with a deep split in the mitochondrial DNA trees, forming two well-defined clades: the northern and southern rockhopper. Our results on mitochondrial DNA diversity support the notion that the two taxa, often considered as two subspecies, can be recognized as true species (*Eudyptes chrysocome* and *Eudyptes moseleyi*), as previously suggested on the basis of mating signals differences (Jouventin 1982).

(Jouventin et al. 2006).

The southern form consists of the two remaining subspecies, the nominate Southern Rockhopper Penguin (*E. c. chrysocome*) on the Falkland Islands, South Georgia and South American offshore islands, and an eastern form, the Eastern Rockhopper Penguin (*E. c. filholi*), breeding on Crozet, Kerguelen, Prince Edward, Marion, Macquarie and the Sub-Antarctic islands of New Zealand (Jouventin et al. 2006). Further analysis may result in these two southern subspecies as well as the geographically and genetically distinct Atlantic and Indian Ocean forms of the Northern Rockhopper Penguin (*E. moseleyi*) also being elevated to full species status.

3. Distribution and Habitat

a. Breeding Range

The Southern Rockhopper Penguin (*E. c. chrysocome*) breeds on the Falkland Islands, South Georgia and South American offshore islands (Ellis et al. 1998; Shirihai 2002; Jouventin et al. 2006).

The Eastern Rockhopper Penguin (*E. c. filholi*), breeds on Prince Edward and Marion Islands (South Africa), Crozet Islands, Kerguelen Islands (French Southern Territories), Heard Island (Australia), Macquarie Island (Australia), and Campbell, Auckland and Antipodes Islands (New Zealand) (BirdLife 2006; Shirihai 2002; Jouventin et al. 2006).

b. Foraging Range

The Southern Rockhopper Penguin (*E. c. chrysocome*) forages in the southern Atlantic Ocean and the Southern Ocean (Shirihai 2002).

The foraging range of the Eastern Rockhopper Penguin (*E. c. filholi*) spans between 44-55 degrees south latitude in the Indian, South Pacific and Southern Oceans (Shirihai 2002).

4. Life History

a. Diet and Feeding Behavior

Most accounts of diet and feeding behavior do not distinguish between rockhopper subspecies. Southern Rockhopper Penguins feed on krill, squid, octopus and fish by pursuit diving (Shirihai 2002). Dietary analysis showed that Rockhopper Penguins fed upon benthic prey (a few fish and the mysid *Mysidetes morbihanensis*) and pelagic organisms, including krill *Euphausia vallentini* (Tremblay and Cherel 2000). There was a positive linear relationship between the mass of food brought ashore and an index of the proportion of benthic dives during the daily trips, thus emphasizing the importance of feeding on pelagic prey trapped at or near the sea floor during the day (Tremblay and Cherel 2000).

Other studies have demonstrated foraging trips of different duration and distance for birds breeding at different islands. During the 2002/2003 breeding season at the Antipodes Islands, female Rockhopper Penguins traveled 22-54 km away from breeding colonies in search of food (Sagar et al. 2005). The foraging trips of female Rockhopper penguins at Antipodes Islands were usually of longer duration and extended farther from the nest than birds breeding at Amsterdam, Kerguelen and Crozet Islands, but occupied a similar time and covered a greater distance than birds breeding at Staten Island (Sagar et al 2005). However, these foraging trip were of considerably shorter duration and distance than those of birds breeding at Macquarie Island. (Sagar et al. 2005).

b. Breeding Behavior

While differences in breeding behavior have been noted between Northern and Southern Rockhoppers (Jouventin et al. 2006) little information distinguishes the two subspecies of the southern species. Southern Rockhoppers breed October through March in colonies on scree and lava slopes, often with tussock grass and sometimes inland (Shirihai 2002). Females lay two eggs, the first egg being smaller which apparently never survives, in a shallow depression and incubates for 32-38 days (Shirihai 2002). The chick fledges in 66-73 days. However, Bingham (1998) states that *E. c. chrysocome* can successfully raise both chicks under favorable conditions, while *E. c. filholi* cannot.

7. Abundance and Trend

Most global population estimates for Rockhopper Penguins do not differentiate between the Northern and Southern species, complicating any analysis of trend. The most recent estimate for combined Rockhoppers is approximately 1.5 million pairs (Hilton et al. 2006). This is less than half of estimates of a decade ago when Woehler (1993) and Woehler and Croxall (1997) estimated a global population of 3.67 million pairs.

In one of the few estimates breaking out Rockhoppers by subspecies, Bingham (1998) concluded there were 650,000 breeding pairs in *E. c. chrysocome*, 800,000 breeding pairs in *E. c. filholi*, and 350,000 breeding pairs in what was then *E. c. moseleyi* (now *E. moseleyi*). Combining *E. c. chrysocome* and *E. c. filholi* results in a global estimate for the full species of

Southern Rockhopper Penguin of 1,450,000 pairs in 1998. The number is almost certainly lower today.

Probably more important than the absolute numbers of Southern Rockhoppers, are the unambiguous and very disturbing trends in most surveyed populations. In some areas, the populations have dropped by over 90% in recent decades. Hilton et al. (2006) estimate that overall populations have declined by several million pairs since the early 20th century.

a. E. c. chrysocome

Historically, most of the world's Southern Rockhopper Penguins (*E. c. chrysocome*) occurred in the Falkland Islands. The first comprehensive island-wide census reported more than three million breeding pairs in the Falklands (Bennett 1933). Subsequently, local decreases were reported and by the 1980s it was suggested that the breeding population had decreased considerably (Croxall et al. 1984). Still, Croxall et al. (1984) estimated the Falklands population to be approximately 2.5 million breeding pairs in 1984. However, by 1989, the population declined dramatically to between 540,000-700,000 pairs (Ellis et al. 1998). Surveys of breeding colonies showed dramatic decline in the number of colonies from 1986-1992, post-dating an earlier decline of molting adults in 1985-86 (Keymer 1988, Ellis et al. 1998). Population declines continued, and in the 1995/96 breeding season another island-wide census of breeding Rockhopper Penguins was performed in the Falkland Islands. This census found only 297,000 breeding pairs in 36 colonies, a decrease in excess of 90% from previous estimates (Bingham 1996).

Woehler (1993) estimated a total population of *E. c. chrysocome* of about 700,000 pairs divided between the Falkland Islands (90%) and southern South America, including 175,000 pairs in the Chilean population. This combined estimate predated Bingham's 1995/96 census of the Falklands which showed further declines (Bingham 1996). In Argentina, *E. c. chrysocome* is known to breed only at Isla Pinguino (47° 45' S, 65° 54' W) and Staten Island (54° 40' S, 64° 30' W) (Ellis et al. 1998). The colony at Isla Pinguino consisted of only 450 breeding pairs (Ellis et al. 1998).

A 1996/97 census of Argentinean and Chilean colonies showed that South America holds a breeding population of about 175,000 pairs of *E. c. chrysocome*, at a total of 15 breeding sites. Apart from the very small colony near Puerto Deseado (Frere et al. 1993), these breeding sites are restricted to the islands off Tierra del Fuego and Chile. Combined with the Falkland Islands population of approximately 300,000 pairs at 36 sites (Bingham 1996), this gives a world population of 475,000 breeding pairs at 51 sites (Bingham 1998).

A repeat census in 2000/01 of the Falklands breeding sites recorded a population of 272,000 breeding pairs, representing a further decline of over 8%.

b. E. c. filholi

The eastern subspecies of the Southern Rockhopper Penguin (*E. c. filholi*) is more widely distributed and likely more numerous than the nominate form (*E. c. chrysocome*). Because it occupies more breeding islands, a complete rangewide trend is difficult to ascertain. Nevertheless, monitored populations show similar dramatic recent population declines with the subspecies' overall abundance likely less than half of what it was in the mid 20th century.

Estimates from the 1940s of several million Rockhoppers nesting on Campbell Island (Bailey and Sorensen 1962) made the island a major stronghold of the species in the Australasian region, and one of the largest concentrations anywhere in the world. However, the Campbell Island population has declined precipitously since these early surveys (Moors 1986). Campbell Island Rockhoppers declined by 94% from the 1940s to 1985 (Taylor 2000). Campbell Island had a total of 51,500 pairs over nine colonies in 1985 (Moors 1986; Cunningham and Moors 1994; Taylor 2000). Most colonies have continued to shrink from 1985 to the mid-1990s (Taylor 2000).

The smaller Rockhopper colonies in the Auckland Islands have also declined both in number of colonies and number of birds. There were 12 colonies at the Auckland Islands in 1973 and an estimated 5,000 to 10,000 pairs (Bell 1975; Taylor 2000). However, a survey in 1990 found only 10 colonies (including 5 sites not reported in 1972) and an estimated total breeding population of 2,700 to 3,600 pairs (Cooper 1992; Taylor 2000).

A 1995 survey on the main Antipodes and Bollons Islands found a maximum of 3,400 pairs (Taylor 2000). In 1978 the population estimate was over an order of magnitude larger at 50,000 breeding pairs (Marchant and Higgins 1990). A large decline has also taken place at Ringdove Bay, Antipodes Island; from tens of thousands in 1950 to a few individuals in 1995 (Taylor 2000).

The population on Macquarie Island was thought to be 100,000-300,000 pairs in the early 1980s (Marchant & Higgins 1990). There is no recent estimate of population size but studies started in 1993 suggest that declines are also occurring at Macquarie Island (Taylor 2000).

The current status of Rockhopper Penguin populations in the Indian Ocean is less well known. There were an estimated 420,000 pairs on these Sub-Antarctic islands in the 1970s and 1980s (Woehler 1993; Taylor 2000). However, surveys on Marion Island in the Prince Edwards Island group of the Indian Ocean showed declines similar to those found elsewhere. The number of Eastern Rockhopper Penguins breeding at Marion Island decreased from about 173,000 pairs in the 1994-1995 breeding season to about 67,000 pairs in the 2001-2002 breeding season, a decline of over 60% (Crawford et al. 2003).

The total world population of the subspecies *E. c. filholi* has apparently declined by about 50% since 1940 (when at least 1.5 million pairs were present) to a population of fewer than 780,000 pairs in 1995 (Taylor 2000; Ellis et al. 1998). If the more recent Marion Island declines

are representative of declines elsewhere in the Indian Ocean then the total population of *E. c. filholi* may be less than 500,000.

5. Threats

While the Southern Rockhopper Penguin faces numerous and diverse threats throughout its breeding and foraging ranges, the overriding factor driving population declines has been reduced prey availability linked to changing ocean conditions (Cunningham and Moors 1994; Ellis et al. 1998; Taylor 2000; Hilton et al. 2006). As shown above in the discussion of abundance and trends, Southern Rockhopper Penguin overall numbers have declined by over 70% range wide from a mid 20th Century total of approximately 5 million breeding pairs (3.5 million *E. c. chrysocome* and 1.5 million *E. c. filholi*) to less than 1.3 million pairs today (< 475,000 *E. c. chrysocome* and < 780,000 *E. c. filholi*). There is no indication these declines have stopped. As described below and further discussed in Section II of this Petition, these changing ocean conditions are likely caused by global warming, and given the most credible emissions and climate scenarios for the coming decades, are likely to greatly intensify.

a. Global Warming

Several studies have correlated Southern Rockhopper Penguin declines with changing ocean conditions (Cunningham and Moors 1994; Ellis et al. 1998; Taylor 2000; Hilton et al. 2006). Cunningham and Moors (1994) noted that the decline of Rockhopper Penguins coincided with sea surface temperature increases recorded in Perseverance Harbour, Campbell Island, and suggested that warmer seas resulted in fewer euphausiids, the preferred prey of the penguins. Consequently, Cunningham and Moors (1994) argued that Rockhopper Penguins had been forced to switch to prey of lower quality, primarily small fish, with subsequent detrimental consequences to their population size. Chambers et al. (2005) came to a similar conclusion, finding the population decline at Campbell Island likely to have been caused by a reduced food supply from prey species concentrations moving farther away from the colony because of rising sea surface temperatures.

Hilton et al. (2006) used stable isotopes of carbon and nitrogen in a time-series of Rockhopper Penguin feather samples, dating back to 1861, in an attempt to reconstruct the species' ecological history. Overall, certain carbon isotope signatures decreased significantly over time in Rockhopper Penguins from seven breeding sites, indicating that decreases in primary productivity and carrying capacity have been associated with the decline of Rockhopper Penguin populations (Hilton et al. 2006). In addition, a long-term decline in certain nitrogen isotopes indicated a shift in diet to prey of lower trophic status over time and in warm years (Hilton et al. 2006). The authors concluded that Rockhopper Penguin declines are likely a result of a decrease in overall food availablity and may reflect a fundamental shift in the marine food web (Hilton et al. 2006).

Crawford et al. (2003) carried out studies on Rockhopper Penguins at Marion Island in an attempt to determine the cause of decline there. Over an eight-year period (1994/95–2002/03),

pairs of adult penguins fledged on average 0.40 chicks per year, an amount insufficient to balance mortality of breeding adults. Moreover there was a decrease in the body mass at arrival at breeding colonies of both males and females (Crawford et al. 2003). Except in 1997/98, the mass of chicks at fledging was less than that recorded at two other localities (Crawford et al. 2003). According to Crawford et al. (2003), these factors suggest an inadequate supply of food for Rockhopper Penguins at Marion Island.

Each of these studies or reviews shows that the decline in food availability for Southern Rockhopper Penguins near their breeding colonies is strongly correlated with warmer ocean temperatures. As discussed in Section II of this Petition, these changing ocean conditions are likely caused by global warming, and are likely to greatly intensify in both the near and long term. Absent comprehensive action to reduce greenhouse gas emissions, the forces driving Southern Rockhopper Penguin population declines will continue and the viability of breeding colonies, and eventually the entire species, will be irreversibly compromised.

b. Fisheries Interactions

While the ocean-wide decline in food availability for the Southern Rockhopper Penguin is likely the result of ocean warming resulting from anthropogenic climate change, significant localized prey depletion in critical penguin foraging habitats has also likely played a role in observed population declines (Ellis et al. 1998; Bingham 2002).

The 90% decline of Southern Rockhopper Penguins in the Falkland Islands corresponded with the growth of intensive commercial fishing near the islands (Bingham 2002). Bingham (2002) concluded that it "is probable that the rapid penguin declines observed in the Falklands during the 1980s were a result of uncontrolled commercial fishing." The growth of the loligo squid (*Loligo gahi*) and blue whiting (*Micromesistius australis*) fisheries have the greatest overlap in area and diet with Rockhopper foraging near the Falklands (Bingham 2002). Similar fisheries occur near Rockhopper breeding colonies in the New Zealand Sub-Antarctic (Croxall 1998; Taylor 2000). A further discussion of fishing impacts on penguins, and the inadequacies of current fisheries management is contained in Section II of this Petition.

c. Disturbance and Other Threats

Southern Rockhopper Penguins face a wide array of threats on their breeding grounds ranging from disease, introduced predators, disturbance, and pollution. In Patagonian coastal waters, which are an important wintering ground for the Falklands population, hydrocarbon exploitation is a significant threat (Ellis et al. 1998). According to Bingham (2002), oil exploration in the Falklands has already resulted in several spills and the oiling of penguins.

During 1998 an oil rig was sent to the Falkland Islands to look for oil. During the five months of operation 3 separate oil spills occurred killing hundreds of penguins. It is unlikely that the oil came from the rig itself, which claimed never

> to have found oil in commercially viable quantities. The oil is presumed to have come from oil rig supply vessels operating in Falkland waters at the time.

(Bingham 2002). Similarly, oiled Rockhopper Penguins are frequently found along the Argentine coast, from Buenos Aires to Tierra del Fuego (Ellis et al. 1998, Frere et al. 1993).

Numerous breeding islands including Auckland, Macquarie and Kerguelen have populations of introduced predators which affect breeding success (Ellis et al. 1998). Avian cholera has caused deaths of Rockhopper Penguin adults and chicks at Campbell Island and may be a problem in some seasons at other Rockhopper Penguin colonies (de Lisle et al. 1990).

Direct exploitation continues in some place such as on Nightingale Island where egg harvest occurs (Ellis et al. 1998). Further information on the threats to this and other species of penguins in the context of the ESA listing factors is contained in Section II of this Petition.

In sum, Southern Rockhopper Penguins have declined by as much as 70% from population levels in the mid-20th Century. Based on these dramatic declines, the IUCN considers the combined (Northern and Southern) Rockhopper species complex to be Vulnerable (BirdLife 2006). However, the IUCN assessment noted that if the three taxa within the Rockhopper complex (*E. c. chrysocome*, *E. c. filholi* and *E. moseleyi*) were considered separately, each would likely warrant listing as Endangered. Given the perilous status of the Southern Rockhopper Penguin species (*E. chrysocome*), we believe that listing under the ESA as, at a minimum, Threatened is clearly warranted.

B. Northern Rockhopper Penguin (*Eudyptes moseleyi*)

1. Description

All plumage characteristics for the Northern Rockhopper Penguin (*Eudyptes moseleyi*) are similar to those of the Southern Rockhopper Penguin described above (Shirihai 2002). Jouventin (1982) described differences in the length of crest and vocalizations that separates *E. mosleyi* from other Rockhoppers.

2. Taxonomy

See discussion for Southern Rockhopper Penguin for an explanation of current Rockhopper taxonomy. Jouventin et al. (2006) provides the genetic evidence for awarding full species status to the Northern Rockhopper Penguin (*E. moseleyi*).

3. Distribution and Habitat

a. Breeding Range

The Northern Rockhopper Penguin breeds on Gough Island and islands in Tristan da Cunha (United Kingdom) in the southern Atlantic Ocean, and Amsterdam and St. Paul Islands (France) in the southern Indian Ocean (Shirihai 2002).

b. *Foraging Range*

The Northern Rockhopper Penguin has a pelagic range between 35 and 50 degrees south latitude in the southern Atlantic and southern Indian Oceans (Shirihai 2002). The species relies on areas of high productivity, especially in the area of the Patagonian Shelf, Antarctic Peninsula and the Antarctic Convergence (Shirihai 2002).

4. Life History

a. *Diet and Feeding Behavior*

Little specific information exists, but presumably the diet and feeding behavior is similar to the Southern Rockhopper species (Shirihai 2002).

b. *Breeding Behavior*

Breeding behavior of Northern Rockhopper Penguins is largely the same as for Southern Rockhoppers, but breeding begins earlier in the year and the chick rearing period is shorter (Shirihai 2002). Northern Rockhopper Penguins on Gough, Tristan da Cunha, Amsterdam and St. Paul Islands initiate their breeding cycle 2 months earlier than Southern Rockhopper Penguins on Sub-Antarctic islands (Jouventin et al. 2006).

5. Abundance and Trend

The current overall population of Northern Rockhopper Penguins is likely no more than 350,000 pairs, with about 300,000 pairs on Tristan da Cunha and Gough Island in the Atlantic and between 26,000 and 48,000 pairs on Amsterdam and St. Paul Islands in the Indian Ocean (Bingham 1998; Shirihai 2002; Jouventin et al. 2006).

The Amsterdam Island population decreased by 57% between 1971 and 1993 to 25,000 pairs (Guinard et al. 1998; Jouventin et al. 2006). Guinard et al. (1998) linked this decline to increased sea surface temperatures. In contrast to the declines at Amsterdam, the population on St. Paul Island increased by 56% to 9,000 pairs during the same period. Prior to this increase on St. Paul, the population was greatly depleted from exploitation by fishermen who killed penguins and used them as bait in crayfish fisheries (Guinard et al. 1998).

In the Atlantic Ocean, Northern Rockhopper Penguins are more numerous than in the Indian Ocean, but are still small compared to Southern Rockhopper populations. The largest single population of Northern Rockhoppers of approximately 145,000 pairs on Gough Island was thought to have remained stable over the last 20 years (Cuthbert and Sommer 2004). However,

recent population counts from Gough Island indicate that this population too has recently undergone substantial declines (Jouventin et al. 2006).

6. Threats

a. Global Warming

The declines seen in the Northern Rockhopper Penguin are similar to those experienced by the Southern Rockhopper Penguin. Guinard et al. (1998) linked the decline at Amsterdam Island to increasing sea surface temperatures since the 1950s and the consequent change in the distribution of prey species (Jouventin et al. 2006; Hilton et al. 2006). The study by Hilton et al. (2006) addressed both Northern and Southern Rockhopper Penguins. As summarized in the Southern Rockhopper species account, Hilton et al. (2006) found that there have been major changes in the feeding ecology of Rockhopper Penguins over the past 150 years, with decreases in primary productivity associated with the recent decline of Rockhopper Penguin populations. As discussed in Section II of this Petition, these changing ocean conditions are likely caused by global warming, and are subject to intensification in the future.

b. Other Factors

Each of the islands that the Northern Rockhopper Penguin breeds upon has suffered some combination of the suite of insults that most oceanic islands have experience: introduced predators, depletion of fisheries, disturbance of breeding, disease, and direct harvest and persecution. Jones et al. (2003) details such threats to penguin populations on Gough Island as a result of human activity. Around Tristan da Cunha, driftnet fishing and rock-lobster fisheries (which used birds for bait) caused significant mortality (Ellis et al. 1998, Ryan and Cooper 1991). Further information on threats to this and other species of penguins in the context of the ESA listing factors is contained in Section II of this Petition.

C. Fiordland Crested Penguin (*Eudyptes pachyrhynchus*)

The Fiordland Crested Penguin (*Eudyptes pachyrhynchus*) has one of the smallest populations of any penguin species with less the 3000 breeding pairs (BirdLife 2006). Its already small population has declined by as much as 30% over the past two decades (BirdLife 2006). Breeding habitat for the species is restricted to a few small areas in New Zealand. The species is currently listed as Vulnerable by the IUCN and BirdLife International. The main threats are from extractive fisheries that degrade marine prey abundance and cause direct mortality through bycatch, combined with the impacts of invasive predator species and global warming (BirdLife 2006). This Petition seeks listing of the Fiordland Crested Penguin as Endangered under the ESA.

Figure 6: Fiordland Crested Penguin

Photo by Peter and Barbara Barham

Figure 7: Fiordland Crested Penguin Range

1. Description

The Fiordland Crested Penguin has an average body length of 55-60 cm. The head and body of this penguin are black, with the exception of its white front and the white markings on its cheeks. Fiordland Penguins have a crest of brilliant yellow feathers which are visible at the base of the bill and extend over the eye. These are the only crested penguins with white cheek-stripes (Shirihai 2002).

2. Taxonomy

The Fiordland Crested Penguin is considered monotypic with no recognized subspecies (Shirihai 2002). The species diverged from other member of the genus within the past 8 million years, and from the closely related Snares Penguin within the past 2 million years following the onset of the Pleistocene glaciations (Baker et al. 2006).

3. Distribution and Habitat

a. Breeding Range

The Fiordland Crested Penguin has a very restricted breeding range. The species nests on Stewart Island and several adjacent offshore islands, Solander Island, and on the west to south-west coast of the South Island, New Zealand (BirdLife 2006). The current occupied range may

be remnant refugia where the species has not yet been extirpated rather than representing optimal habitat (Ellis et al. 1998).

Distribution is patchy between Jackson Bay and Stewart Island along the southwest coast and offshore islands (Taylor 2000). Twelve fragmented nesting areas of approximately 100 nests each include Codfish Island, Solander Island, Breaksea and adjacent islands, Shelter Island, Yates Point, Cascade Point and the coast north, Jackson's Head, Open Bay Island, the coasts south of the Paringa River, Hope River and Gorge River, and Martins Bay (Ellis et al. 1998).

b. Foraging Range

Outside of the breeding season, birds disperse around North and South Islands, and south to the Sub-Antarctic islands. The species is a regular vagrant to south-eastern Australia (Taylor 2000).

4. Life History

a. Diet and Feeding Behavior

The Fiordland Crested Penguin is known or suspected to feed on fish, squid, octopus and krill (Shirihai 2002).

b. Breeding Behavior

The Fiordland Crested Penguin first breeds at 5-6 years old and birds may live for 10-20 years (Ellis et al. 1998). The species typically breeds inland from the coast (distances vary), with some nest sites at areas up to 100m above sea level. Nesting in loose colonies, Fiordlands locate their nests out of sight from one another. Unlike most crested penguins, the Fiordland Penguin does not nest in the open. Fiordland nests are shallow scrapes which can be located in caves, under logs, at the base of trees or boulders, and under bushes (Shirihai 2002).

5. Abundance and Trend

The Fiordland Crested Penguin is among the rarest of all penguins with a population of likely less than 3000 breeding pairs (Taylor 2000; BirdLife 2006). Indications are that the species has suffered declines and colony extirpations over the past century (Ellis et al. 1998; Taylor 2000).

Historical accounts from around 1890 reported thousands of individuals at colonies (Ellis et al. 1998). Reports from the mid-20th Century has records of breeding further north than currently with colonies near Cooks Straits and perhaps on the southern most part of the North Island, New Zealand (Oliver 1955; Taylor 2000). At Dusky Sound thousands of birds were recorded in 1900 but only a few hundred were reported in the 1990s (Russ et al. 1992).

From a series of surveys conducted in the 1990s, the population was estimated at only 2,500-3,000 breeding pairs (McLean et al. 1997; Taylor 2000; Shirihai 2002). Numbers appear to be declining in some major populations (BirdLife 2006). At Open Bay Island, there has been a recent decline of 33% between 1988 and 1995 (Ellis et al. 1998). Similarly, a decline may have occurred on Solander Island in the 20th Century (Ellis et al. 1998; Cooper et al. 1986).

6. Threats

A full suite of threats have been identified by various researchers for the Fiordland Crested Penguins. These include climate change, decline in prey species, competition with and mortality in fisheries, human disturbance, marine perturbations, predation, disease, and pollution (Ellis et al. 1998; Taylor 2000; Shirihai 2002).

a. Global Warming

The Fiordland Crested Penguin is one of only a handful of species for which BirdLife International has explicitly identified climate change as a threat (BirdLife 2006; Hilton et al. 2006). Given the extremely low population abundance and documented declines, any reduction of food availability caused by changing climate conditions could be catastrophic for the species. A further discussion of global warming and its impacts on penguins can be found in Part II of this Petition.

b. Fisheries Interactions

Squid fishing operates in and near Fiordland Crested Penguin breeding colonies and is a likely source of food competition for the species (Ellis et al. 1998; Shirihai 2002; BirdLife 2006). Both trawl and set nets are used near colonies and are a potential source of direct entanglement and death (Ellis et al. 1998; Taylor 2000; BirdLife 2006). A further discussion of fishing impacts on penguins, and the inadequacies of current fisheries management is contained in Section II of this Petition.

c. Predation and other Threats

Predation by introduced species is one of the greatest threats to the Fiordland Crested Penguin (Taylor 2000). Taylor summarizes the menagerie of non-native species that harm the penguins.

> Mustelids, especially stoats, are reported to take eggs and chicks on mainland colonies and may occasionally attack adult penguins (Warham 1974a, Morrison 1980). Domestic dogs may kill adult penguins (especially moulting birds), and disturb colonies near human habitation (Marchant & Higgins 1990). Norway, ship, and Pacific rats may also be predators of small chicks although there is no direct evidence of predation. Feral cats and pigs are potential predators but appear to be uncommon in areas where penguins currently nest. Weka have been

observed taking eggs and chicks (St Clair & St Clair 1992) and are a threat at sites that are otherwise free of introduced predators, e.g. Open Bay Islands, Solander Island. Deer are present in some colonies and may trample nests or open up the habitat for predators. Possums are scarce or absent in most areas with penguins but may compete for nest sites.

(Taylor 2000).

Fiordland Crested Penguin are also disturbed by humans at nest-sites, killed on roads, and exposed to potentially devastating diseases (Taylor 2000; BirdLife 2006). Further information on threats to this and other species of penguins in the context of the ESA listing factors is contained in Section II of this Petition.

D. Snares Crested Penguin (*Eudyptes robustus*)

Figure 8: Snares Crested Penguin   **Figure 9: Snares Crested Penguin Range**

Photo by Peter and Barbara Barham

The Snares Crested Penguin (*Eudyptes robustus*) is another New Zealand endemic, restricted to one small island group (BirdLife 2006). The species is currently listed as Vulnerable by the IUCN and BirdLife International (BirdLife 2006). While declines have not yet been documented for the Snares Crested Penguin, other penguin species in the region have shown marked declines in response to changing ocean conditions that are expected to affect this species as well (Ellis et al. 1998; BirdLife 2006). Additionally, a large-scale squid fishery near the breeding colonies may be creating a situation of food competition for the species. This Petition seeks listing of the Snares Crested Penguin as Threatened under the ESA.

1. Description

The Snares Crested Penguin (*Eudyptes robustus*) has dark blue-black upperparts, head and throat, and white underparts with a bright yellow stripe above the eye which forms a slight bushy crest behind the eye (Shirihai 2002). The bill is red, large and heavily grooved with pink skin at the base. Length 51-61 cm, weight 2.4-4.3 kg. Females are on average smaller in flipper and bill lengths and overall mass. This species can be confused with the Fiordland Crested Penguin and the Erect-crested Penguin, particularly at sea.

2. Taxonomy

The Snares Crested Penguin is considered monotypic with no recognized subspecies (Shirihai 2002). However, significantly different breeding timing between birds in the Western Chain of the Snares from the Main island suggest subspecific diversity (Taylor 2000). The species diverged from other member of the genus within the past 8 million years, and from the closely related Fiordland Crested Penguin within the past 2 million years following the onset of the Pleistocene glaciations (Baker et al. 2006).

3. Distribution and Habitat

a. Breeding Range

Snares Crested Penguin is restricted to a single small island group, the Snares Islands, the nearest of the Sub-Antarctic island to New Zealand (Shirihai 2002; Marchant and Higgins 1990). The total island area is on the order of 3 km^2 (Shirihai 2002).

b. Foraging Range

Snares Crested Penguins are not thought to range very far during winter, with virtually no sightings at sea away from the breeding islands (Taylor 2000). Moulting birds have been seen ashore on Macquarie, Campbell, Antipodes, and Chatham Islands, and birds are occasionally seen on beaches at Stewart Island and the South New Zealand mainland (Taylor 2000; Shirihai 2002). However, one individual was recorded in the Falkland Islands, suggesting the species' foraging range is larger than generally thought (Taylor 2000).

4. Life History

a. Diet and Feeding Behavior

Snares Crested Penguins feed mainly on krill, supplemented by squid and small fish (Heather and Robertson 1997).

b. Breeding Behavior

The Snares Crested Penguin nests mostly within forests of North-East Island in dense colonies, usually between 50-200 pairs (BirdLife 2006). Eggs are laid in shallow nests of twigs and mud. The species probably first breeds at 4 years old (Shirihai 2002; Heather and Robertson 1997). The oldest known bird lived to 20 years (Heather and Robertson 1997).

Birds breeding on the three islands in the Western Chain of the Snares breed 6 weeks earlier than those on the Main Snares Island, indicating likely breeding isolation and potentially a distinct subspecies (Taylor 2000).

5. Abundance and Trend

The population of Snares Crested Penguins was estimated at 23,250 breeding pairs in 1985-1986, with 19,000 on North-East Island, 3,500 on Broughton and 750 on the Western Chain islets (Marchant and Higgins 1990; Taylor 2000; BirdLife 2006). Insufficient data exists to determine if there is any trend in abundance (Taylor 2000).

6. Threats

The primary threats facing the Snares Crested Penguin are those inherent to a species restricted to small oceanic islands. Taylor (2000) summarized them as follows.

> There are no mammalian predators at the Snares Islands. The islands are Nature Reserves and landing is restricted. Therefore human disturbance of colonies is minimal. The species could potentially be caught in trawl nets but there are no records of Snares crested penguins being caught in subantarctic waters by this fishing method. Competition with fisheries for prey species may be a potential threat. An oil spill near the colonies would be a significant potential threat to this species.

(Taylor 2000). Additionally, as for virtually all penguin species, reduced prey availability due to changing ocean conditions threatens to swamp out all other threats to the species. Further discussion of the various threats to this and other penguin species in the context of ESA listing criteria is contained in Part II of this Petition.

E. Erect-crested Penguin (*Eudyptes sclateri*)

The Erect-crested Penguin (*Eudyptes sclateri*) is another New Zealand endemic, restricted to a few small islands (BirdLife 2006). The species is currently is listed as Endangered by the IUCN and BirdLife International (BirdLife 2006). The species has declined by over 50% since the 1970s, in response to changing ocean conditions that have diminished prey availability

(Ellis et al. 1998; Taylor 2000; BirdLife 2006). This Petition seeks listing of the Erect-crested Penguin as Endangered under the ESA.

Figure 10: Erect Crested Penguins

Figure 11: Erect Crested Penguin Range

Photo by Peter and Barbara Barham

1. Description

Adult Erect-crested Penguins have black upperparts and head and throat, contrasting with white below; a broad yellow eyebrow starts at the bill base and forms an erect brushy crest above and behind the eye. They have a distinct profile, with a domed crown, longer bill, and a large chin. Body length is 60-67 cm, with a weight of 3.3-7.0 kg. Females are usually smaller and lighter than males (Shirihai 2002).

2. Taxonomy

The Erect-crested Penguin is considered monotypic with no recognized subspecies (Shirihai 2002). The species diverged from other members of the genus within the past 8 million years (Baker et al. 2006).

3. Distribution and Habitat

a. *Breeding Range*

Erect-crested Penguins breed only on the Bounty and Antipodes Islands (1 km^2 and 20 km^2 respectively), New Zealand (BirdLife 2006). They formerly bred at Campbell Island and on the South Island mainland at Taiaroa Head (Taylor 2000).

b. Foraging Range

In winter, Erect-crested Penguins disperse from colonies and ranges to most subantarctic islands in the region. Rare or vagrant to South Australia, Tasmania, Macquarie, mainland New Zealand, the Falklands and Kerguelen (Shirihai 2002).

4. Life History

a. Diet and Feeding Behavior

Krill and squid are the principal prey species, with some small fish included in the diet (Shirihai 2002).

b. Breeding Behavior

The Erect-crested Penguin nests colonially at high densities, with some rookeries containing thousands of pairs, and in association with colonies of Salvin's Albatross (*Thalassarche salvini)* on Bounty Island (Shirihai 2002). On Antipodes Island the species also nests with Rockhopper Penguins and fur seals (Shirihai 2002). Breeding begins in September on bare exposed rocks, tussac-clad beaches and cliffs. Two pale bluish or greenish eggs are laid in shallow depressions between boulders. Eggs are incubated for about 35 days and chicks fledge at about 70 days; only one young chick is raised per nest (Shirihai 2002).

5. Abundance and Trend

The Erect-crested Penguin has demonstrated significant declines since the late 1970s, with current populations likely less than half of what they were at that time (BirdLife 2006). In 1978, the population on the Bounty Islands was estimated at 115,000 pairs, spread over nine tiny islands (Robertson and van Tets 1982). The population on the Antipodes in 1978 was believed to be of a similar size to the Bounty Islands in the same year (Taylor 2000). A few hundred birds bred on Campbell Island in the 1940s (Taylor 2000).

However, subsequent surveys found far fewer birds. In 1995, ground surveys on Antipodes Island indicated around 49,000-57,000 pairs (Taylor 2000), representing a decline of roughly 50% in 20 years (Taylor 2000; BirdLife 2006). The population on the Antipodes has continued to decline (BirdLife 2006). A survey in 1997-1998 estimated a total of 28,000 breeding pairs on the Bounty Islands, about a 75% decrease from previous counts (Taylor 2000; BirdLIfe 2006). The population on Campbell Island numbered only 20-30 pairs in 1986-1987, but no breeding was seen and this population is now probably extirpated (Taylor 2000; Shirihai 2002).

Total population of the species is now likely fewer than 80,000 pairs and declining (BirdLife 2006).

6.   **Threats**

The IUCN and BirdLife International list climate change as the primary threat to this species (BirdLife 2006; Hilton et al. 2006). The significant declines over the past few decades are attributable to changes in the marine environment resulting in less prey (BirdLife 2006). Given the low population abundance and documented declines, any further reduction in food availability caused by changing climate conditions would be catastrophic for the species. A further discussion of global warming and its impacts on penguins can be found in Part II of this Petition.

In addition to the overriding threat of global warming, competition with and bycatch in commercial fisheries, non-native predators, disease, disturbance, and oil spills and pollution are considered threats to the continued existence of the Erect-crested Penguin (Ellis et al. 1998; Taylor 2000; BirdLife 2006). Further discussion of the various threats to this and other penguin species in the context of ESA listing criteria is contained in Part II of this Petition.

F. Macaroni Penguin (*Eudyptes chrysolophus*)

Figure 12: Macaroni Penguin

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Figure 13: Macaroni Penguin Range

The Macaroni Penguin (*Eudyptes chrysolophus*) is the world's most abundant penguin. It is also one of the most widespread, breeding in at least 216 colonies at 50 sites (BirdLife 2006).

Nevertheless, the species is currently is listed as Vulnerable by the IUCN and BirdLife International (BirdLife 2006). Macaroni penguin population have undergone severe declines in several of their best monitored breeding colonies, with populations at South Georgia and Marion having declined by over 50% in the past 20 years (BirdLife 2006). As with all other species in the genus, the declines have been linked to reductions in prey availability linked to changing ocean conditions (Ellis et al. 1998; Shirihai 2002; BirdLife 2006). This Petition seeks listing of the Macaroni Penguin as Threatened under the ESA. If FWS determines that the species as a whole does not warrant listing under the ESA, we request that the agency examine whether the populations at South Georgia and Marion which have suffered the most substantial declines be considered for listing as Distinct Population Segments or as a "significant portion" of the species range.

1. Description

The Macaroni Penguin is the second largest crested penguin. It has an orange crest and black and white plumage. Golden-orange plumes with black streaks cover the upper forehead and reach beyond the eye, drooping there. Body length reaches 71 cm with weight of 3.1-6.6 kg. (Shirihai 2002).

2. Taxonomy

The Macaroni Penguin is currently considered monotypic with no recognized subspecies (Shirihai 2002). The species diverged from other members of the genus within the past 8 million years, and from the closely related Royal Penguin within the past 2 million years following the onset of the Pleistocene glaciations (Baker et al. 2006).

3. Distribution and Habitat

a. Breeding Range

Macaroni Penguins breed in at least 216 colonies at 50 sites, including southern Chile, the Falkland Islands, South Georgia and the South Sandwich Islands, the South Orkney and South Shetland Islands, Bouvet Island, Prince Edward and Marion Islands, Crozet Islands, Kerguelen Islands, Heard and McDonald Islands and very locally on the Antarctic Peninsula. (Woehler 1993; Woehler and Croxall 1997; Shirihai 2002; BirdLife 2006)

b. Foraging Range

The Macaroni Penguin ranges north to the islands off Australia, New Zealand, southern Brazil, Tristan da Cunha, South Africa and regularly reaches north of the Antarctic Convergence during winter (Shirihai 2002).

4. Life History

a. Diet and Feeding Behavior

Macaroni Penguins feed mainly on krill, along with small fish and cephalopods while pursuit diving (Shirihai 2002; Marchant and Higgins 1990). Most foraging dives are less than 20 m, but the species has been recorded as going as deep as 115 m (Shirihai 2002).

b. Breeding Behavior

Macaroni Penguins nests on level to steep ground, often walking hundreds of meters across steep rocky slopes to nest sites (Marchant and Higgins 1990). Breeding areas usually have little or no vegetation due to erosion by birds. Breeding occurs from September through March. Eggs are laid in November in a rudimentary shallow scrape, incubated for 33-37 days, and chicks fledge after 60-70 days (Shirihai 2002).

5. Abundance and Trend

Macaroni Penguins were once much more numerous than they are today. However, few historical population estimates exist for this species making range-wide trends difficult to assertain (Woehler 1993; Woehler et al. 2001). Several authors have documented declines of 50-65% in several populations in the last 30 years (Shirihai 2002; Crawford et al. 2003a; BirdLife 2006).

The current global population estimate is approximately 9 million pairs (Shirihai 2002, BirdLife 2006). Populations at Ile de Pingouins, Iles Crozet, Heard, and McDonald Islands are roughly estimated at one million pairs each (Ellis et al. 1998). Populations at the Willis Islands, South Georgia are roughly estimated at 2.5 million pairs (Ellis et al. 1998). On Marion Island, approximately 4,000 pairs breed, while only 50 pairs breed at the Falkland Islands (Ellis et al. 1998, Bingham 1998).

Some populations have decreased by at least 50% in the last few decades (Shirihai 2002). Study populations at South Georgia decreased by 65% in 12 years (1986-1998) and the overall South Georgia population has probably halved over the last 20 years (BirdLife 2006). SCAR (1992) indicated that South Georgia and Bouvet populations had decreased at a rate of 1 percent per annum since the mid-1970s. Detailed monitoring of colonies at Bird Island, South Georgia indicate that the population there has declined by 50% since 1976-1977, when the population was roughly 70,000 pairs. Thus, the South Georgia population was estimated to be 5.4 million pairs in the mid-1970s, but has declined to only 2.7 million pairs more recently (Ellis et al. 1998). Study populations on Marion Island have also decreased by 50% over 30 years (1979-1998) (BirdLife 2006).

6. Threats

The IUCN and BirdLife International list climate change as a primary threat to this species (BirdLife 2006; Hilton et al. 2006). The significant declines over the past few decades

are attributable to changes in the marine environment resulting in less prey (BirdLife 2006). A further discussion of global warming and its impacts on penguins can be found in Part II of this Petition.

In addition to the overriding threat of global warming, competition with and bycatch in commercial fisheries, non-native predators, disease, disturbance, and oil spills and pollution are considered threats to the species in various portions of its range (Ellis et al. 1998; Shirihai 2002; BirdLife 2006). Further discussion of the various threats to this and other penguin species in the context of ESA listing criteria is contained in Part II of this Petition.

G. Royal Penguin (*Eudyptes schlegeli*)

Figure 14: Royal Penguin

Photo by Peter and Barbara Barham

Figure 15: Royal Penguin Range

The Royal Penguin (*Eudyptes schlegeli*) is another endemic penguin, restricted to Australia's Macquarie Island (BirdLife 2006). The species is currently listed as Vulnerable by the IUCN and BirdLife International (BirdLife 2006). While declines have not yet been documented for the Royal Penguin, other penguin species in the region have shown marked declines in response to changing ocean conditions that are expected to affect this species as well (Ellis et al. 1998; BirdLife 2006). Additionally, the species faces numerous threats from disturbance and non-native predators on its breeding islands, and pollution and fisheries in its oceanic habitat. This Petition seeks listing of the Royal Penguin as Threatened under the ESA.

1. Description

The Royal Penguin is a large, orange-crested black and white penguin, with plumage very similar to Macaroni Penguin. The main distinguishing feature is that the Royal has a variably pale white face, as compared to the black face of the Macaroni Penguin. The massive

bill is reddish orange brown with pink skin at the base. Length 65-75 cm, weight 3.0-8.1 kg.
The female averages smaller in most measurements than the male and tends to have a greyer
lower face (Shirihai 2002).

2. Taxonomy

The Royal Penguin was once considered to be a subspecies of the Macaroni Penguin
(Shirihai 2002). However, the full species status of the Royal Penguin has been confirmed by
morphometric and genetic data that show significant differences from Macaroni Penguin.
According to Baker et al. (2006) the Royal and Macaroni Penguin species diverged within the
last 2 million years, coinciding with the onset of the Pleistocene glaciations.

3. Distribution and Habitat

a. Breeding Range

Royal Penguin breeding is confined to Macquarie Island and nearby Bishop and Clerk
Islands, Australia, giving the species one of the most restricted breeding ranges of any penguin
species (Marchant and Higgins 1990; Shirihai 2002)

b. Foraging Range

During the breeding season, foraging occurs in the polar frontal zone, which changes in location
over the course of the breeding season (Shirihai 2002; Marchant and Higgins 1990). Hull et al.
(1997) tracked breeding Royal Penguins during incubation, guard, and early crèche of the 1994/5
and 1995/6 breeding seasons. Foraging during all stages of the breeding season was offshore, in
deep water (greater than 2000 meters) and in the polar frontal zone (Hull et al. 1997). Foraging
behavior of Royal Penguins is closely linked to the polar frontal zone, their prey, and the
constraints of the breeding season (Hull et al. 1997). During the incubation stage birds can travel
over 600 km from Macquarie Island and back again in three weeks (Ellis et al. 1998).

Royal Penguins are migratory, leaving Macquarie Island after the breeding season.
Where they go is unknown, although there have been sightings from Tasmania to the Antarctic
sector of the Southern Ocean (Shirihai 2002).

4.   Life History

a. Diet and Feeding Behavior

The diet of the Royal Penguin is composed of squid, myctophid fish, euphausiids and
other crustaceans (Shirihai 2002; Marchant and Higgins 1990). The proportions change
marginally throughout the breeding cycle. The diet differs at colonies around the island,
particularly between the east and west coasts, and shows substantial annual differences
(Marchant and Higgins 1990).

b. Breeding Behavior

Royal penguins breed in huge high-density colonies on exposed, rocky or tussac-covered ground (Shirihai 2002). All penguins in the population have a highly synchronized cycle, beginning when the males arrive in late September to claim nest sites. The females arrive in early October and lay their eggs in mid to late October, with the chicks hatching about 30 days later (Marchant and Higgins 1990). Males then guard the chicks for three to four weeks, until the chicks are large enough to join creches. From mid-January onward both parents are free to feed the chick and each adult foraging cycle lasts about two days. The chicks fledge in late February, after which the parents return to sea to fatten for the molt which begins in mid-March. After they molt, the Royal Penguins remain at sea until the next breeding season (Shirihai 2002).

5.   Abundance and Trend

Royal Penguins were heavily exploited in the 19th and early 20th centuries, greatly reducing their populations. Over the course of the 20th Century populations recovered, reaching approximately 850,000 pairs by the mid 1980s (BirdLife 2006). Surveys in 1984-1985 placed the population in 57 colonies ranging from around 60 pairs to more than 160,000 pairs (Woehler 1993; Shirihai 2002). The population is thought to be stable (BirdLife 2006).

6.   Threats

The IUCN and BirdLife International list climate change as a primary threat to this species (BirdLife 2006; Hilton et al. 2006). While declines have not yet been documented for the Royal Penguin, other penguin species in the region have shown marked declines in response to changing ocean conditions that are expected to affect this species as well (Ellis et al. 1998; BirdLife 2006). A further discussion of global warming and its impacts on penguins can be found in Part II of this Petition.

In addition to the overriding threat of global warming, competition with and bycatch in commercial fisheries, non-native predators, disease, disturbance, and oil spills and pollution are considered threats to this species (Ellis et al. 1998; Shirihai 2002; BirdLife 2006). Shirihai summarized the threats as follows.

> The currently stable population is, however, threatened by introduced predators,
> human disturbance, marine and atmospheric pollution, habitat loss and
> degradation, though the effect of climate change on food supply may offer the
> most significant long-term threat.

(Shirihai 2002). Additionally, fishing for Patagonian Toothfish was initiated around Macquarie Island in 1994 and other fisheries will likely be initiated (Ellis et al. 1998). Fishing for euphausiids, squid and myctophid fish could have a substantial impact on this species (Ellis et al.

1998). Further discussion of the various threats to this and other penguin species in the context of ESA listing criteria is contained in Part II of this Petition.

III. GENUS: EUDYPTULA

The genus *Eudyptula* currently contains two species, the Blue or Little Penguin (*Eudyptula minor*) and the White-flippered Penguin (*Eudyptula albosignata*). The White-flippered Penguin was formerly considered a subspecies (*Eudyptula minor albosignata*) of the Little Penguin but genetic data show the two lineages diverged about 2.7 mya, and the two taxa are now recognized as distinct species (Baker et al. 2006). This petition seeks listing of the White-flippered Penguin as Endangered under the ESA.

A. White-flippered Penguin (*Eudyptula albosignata*)

Figure 16: White-flippered Penguins

Photo by Peter and Barbara Barham

Figure 17: White-flippered Penguin Range

The White-flippered Penguin (*Eudyptula albosignata*) is another New Zealand endemic, restricted to the Banks Peninsula and nearby Motunau Island (BirdLife 2006). The species is currently is listed as Endangered by the IUCN and BirdLife International (BirdLife 2006). The species has declined by well over 50% in recent decades and now numbers fewer than 2,500 breeding pairs (Ellis et al. 1998; Taylor 2000; BirdLife 2006).

1. Description

The White-flippered Penguin, along with rest of the Little Penguin complex, is the smallest of the world's penguins. Adults have blue-gray dorsal feathers and white underside. The flipper has broad white trailing and leading edges, and in some males the white may meet in

the center of the flipper (Shirihai 2002). White-flippered Penguins' body length reaches 41cm, with a weight of 1-1.5 kg (Shirihai 2002).

2. Taxonomy

The taxonomy of the White-flippered Penguin remains somewhat unsettled. The taxon has long been recognized as one of six subspecies of the Little Penguin complex (Kinsky and Falla 1976). Banks et al. (2002) examined mitochondrial DNA and determined that the Little Penguin complex consists of two distinct clades which may warrant division into two separate species. The White-flippered Penguin fell within a clade that was comprised of most New Zealand birds, while birds from Australia and the Otago area in New Zealand comprised the other clade (Banks et al. 2002). Within the two clades, maintenance of the existing subspecies was supported (Banks et al. 2002). Baker et al. (2006) conducted a recent genetic analysis of all extant penguin species, and after looking at both nuclear and mitochondrial DNA found the White-flippered Penguin distinct from the rest of the Little Penguins (*E. minor*) and treated it as a full species, *Eudyptula albosignata*. Baker et al. (2006) stated that the two lineages diverged about 2.7 mya. Further genetic analysis of the Little Penguin complex may ultimately lead to additional species being defined and/or subspecies being redefined.

3. Distribution and Habitat

a. Breeding Range

The White-flippered Penguin is endemic to Canterbury, New Zealand breeding in significant numbers only on Banks Peninsula and Motunau Island 65 km north of Christchurch (Taylor 2000; Challies and Burleigh 2004).

b. Foraging Range

Birds disperse locally around eastern South Island (from Otago to Cook Straight). Breeding adults appear to remain close to nesting colonies, with more than 80% of beachcast banded adults found within 100 km of where they nest (Ellis et al. 1998).

4. Life History

a. Diet and Feeding Behavior

Diet and feeding behavior is assumed to be similar to other to the Little Penguin. These species feed on small shoaling fish such as pilchards and anchovies or cephalopods, and less often on crustaceans. Prey is caught by pursuit diving (Marchant and Higgins 1990).

b. Breeding Behavior

Breeding behavior is also similar to Little Penguins. The Little Penguins lay eggs from July to December, peaking in August through November. Eggs are laid in a 0.15-1.9 m-long burrow, lined with plant material, or in hollows under bushes or rocks, in dunes, or on vegetated slopes of coasts and islands, sometimes up to 500 m inland. Eggs are incubated 33-39 days, with the chicks fledging after 50-65 days. The species first breeds at 2-3 years old (Shirihai 2002).

5. Abundance and Trend

White-flippered Penguins have disappeared from much of their range since European settlement, and are in much reduced numbers where they have survived (Challies and Burleigh 2004). Contemporary writings indicate that White-flippered Penguins were very common around Banks Peninsula in the late 1800s (Challies and Burleigh 2004). Since then mammalian predators have had a major impact on their overall numbers and the sizes and distribution of colonies. In the 1950s penguins were still nesting around the heads of most of the bays on the peninsula, albeit usually in small numbers (Challies and Burleigh 2004). Virtually all of these colonies disappeared soon after except for those in Flea and Stony Bays (Challies and Burleigh 2004). During the last 25 years predators have overrun many of the remaining colonies on the sides of the bays. Of four colonies containing >50 nests monitored over this period one was destroyed and the others were reduced by 72 - 77% (Challies and Burleigh 2004). The aggregate number of nests in these colonies declined from 489 to 85 between 1981 and 2000, an overall loss of 83% (Challies and Burleigh 2004). The present colony in Flea Bay provides an example of what White-flippered Penguin numbers and habitat use might have been like prior to declines. Based on the population at Flea Bay, the peninsula-wide population must have comprised tens of thousands of pairs at the time of European settlement (Challies and Burleigh 2004).

Robertson and Bell (1984) estimated that there were 5,000-10,000 pairs of White-flippered Penguins. More recent estimates have been much smaller. Ellis et al (1998) estimated a total population is 2,200 pairs. This was comprised of 1,650 breeding pairs on Motunau Island and about 550 pairs on the Banks Peninsula (Ellis et al. 1998; Taylor 2000). The numbers on Banks Peninsula have declined by at least 60-70% between 1980 and 1993 (Ellis et al. 1998).

6. Threats

The key land-based threats to White-flippered Penguins are predation by ferrets, stoats, and feral cats (Ellis et al. 1998). Ferrets take eggs and chicks and sometimes kill adult penguins. Unrestrained dogs readily attack and kill adult penguins and chicks (Taylor 2000). There is some evidence that stoats, which are good swimmers, are reaching parts of the shoreline and preying on penguins in areas that were previously predator free (Challies and Burleigh 2004).

Cattle and sheep grazing also degrade nesting habitat and trample nests (Taylor 2000). Fires are a potential risk to penguins especially during the molt in December to February, and a few penguins may be killed or injured by cars when crossing roads (Taylor 2000).

At sea, White-flippered Penguins have been frequently caught in near-shore set nets, especially around Motunau Island (Ellis et al. 1998). A large oil spill is a key potential threat because the birds nest in areas with shipping lanes (Taylor 2000). Oil spills in Australia (e.g. *Iron Baron* off Tasmania) have shown that the closely related Little Penguin are a primary victim of oil spills (Hull et al. 1998).

Additionally, as for virtually all penguin species, reduced prey availability due to changing ocean conditions holds the potential to have devastating impacts to this already imperiled species. Further discussion of the various threats to this and other penguin species in the context of ESA listing criteria is contained in Part II of this Petition.

IV. GENUS: MEGADYPTES

The genus *Megadyptes* contains only one species, the Yellow-eyed Penguin (*Megadyptes antipodes*). This Petition seeks listing of the Yellow-eyed Penguin as Endangered under the ESA.

A. Yellow-eyed Penguin (*Megadyptes antipodes*)

The Yellow-eyed Penguin (*Megadyptes antipodes*) is another New Zealand endemic, restricted to the South Island, Aukland Islands, and Campbell Island (Ellis et al. 1998; BirdLife 2006). The species is currently listed as Endangered by the IUCN and BirdLife International (BirdLife 2006). The species has declined by well over 50% in recent decades and now numbers fewer than 2,000 breeding pairs (Ellis et al. 1998; Taylor 2000; BirdLife 2006). This Petition seeks listing of the Yellow-eyed Penguin as Endangered under the ESA.

Figure 18: Yellow-eyed Penguins   **Figure 19: Yellow-eyed Penguin Range**

Photo by Peter and Barbara Barham

1. Description

The Yellow-eyed Penguin is a medium-sized penguin with a pale yellow eye, which gives it a somewhat more fierce appearance than other penguins (Shirihai 2002). The top of the head is capped by yellow, with black-centered feathers bordered by a bright lemon yellow band extending through the eye to around the hindcrown. The Yellow-eyed Penguin is unique in appearance and not likely confused with any other penguin. Body length varies from 56-78 cm, while weight ranges from 3.6-8.9 kg. (Shirihai 2002).

2. Taxonomy

The Yellow-eyed Penguin is considered monotypic with no recognized subspecies (Shirihai 2002). The species diverged from the crested penguins (*Eudyptes*) about 15 million years ago (Baker et al. 2006).

3. Distribution and Habitat

a. *Breeding Range*

The Yellow-eyed Penguin is segregated into three discrete populations: South Island, Auckland Islands, and Campbell Island (Ellis et al. 1998). The species breeds along the south-east coast of South Island as well as the nearby Foveaux Strait and Stewart Islands (Taylor 2000). Historical breeding habitat of this species was primarily in coastal podocarp/hardwood forest and mixed-species scrub on slopes above landing areas (Darby 2003). Very little coastal forest remains on the east coast of the South Island, though it remains the dominant habitat in breeding areas on other islands (BirdLife 2006).

b. *Foraging Range*

Adults are sedentary, but juveniles disperse north as far as the Cook Strait (Marchant and Higgins 1990; Darby 2003). The species forages over the continental shelf (Taylor 2000).

4.   Life History

a. *Diet and Feeding Behavior*

The Yellow-eyed Penguin feeds primarily on red cod, opal fish, sprat and squid (Shirihai 2002; BirdLife 2006).

b. *Breeding Behavior*

Yellow-eyed Penguins usually nests in forest where available, but on the South Island, the species tends to nest in scrub remnants (Marchant and Higgins 1990). The species breeds

from August – March and lays eggs in shallow scrapes of leaves, grass, and twigs. Eggs are incubated 39-51 days and chicks fledge at 106-108 days. Males may not breed until 3-10 years old, though maturity is usually reached earlier for females (Shirihai 2002).

Yellow-eyed Penguin are not a colonial nesters, but instead are secretive and avoid visual contact between pairs at adjacent nest sites during the breeding season. Therefore, nests tend to be some distance apart and well hidden (Marchant and Higgins 1990; Darby 2003). Nests are usually a minimum of 4-6 meters apart in habitats such as New Zealand flax (*Phormium tenax*) that maximize visual barriers between pairs, but more usually 30-50 meters apart in relatively unmodified coastal forest habitat (Darby 2003). Single isolated pairs often nest many kilometers from their nearest neighbors, and some birds nest at least 1 km inland (Darby 2003). Nests must have surrounding vegetation that conceals them from visual contact with conspecifics for successful breeding (Seddon and Davis 1989).

5.   Abundance and Trend

The current population estimate for the species is approximately 2,000 breeding pairs. This is comprised of 600-650 pairs on the South Island's south-east coast, 470-600 pairs on islands in Foveaux Strait and Stewart Islands, 520-570 at Auckland Islands, and 490-600 on the Campbell Islands (BirdLife 2006). However, these numbers are far from stable and the Foveaux Strait and Stewart Islands birds may now number fewer than 150 pairs (Ellis et al. 1998).

Two severe mortality events in 1986 and 1990 each halved the number of South Island Yellow-eyed Penguin pairs (Marchant and Higgins 1990; BirdLife 2006). However, numbers apparently recovered by 1995 (Ellis et al. 1998). The Catlins population may have declined by 75% since the 1940s (Heather and Robertson 1997; Williams 1995). Numbers of individuals on Campbell Island declined between 1987 and 1998 (Moore 1992; Taylor 2000).

Moore et al. (2001) surveyed Campbell Island in winter 1992 and recorded 1034 Yellow-eyed Penguins. From mark–recapture analysis of banded birds at one site, the total population was estimated at 1,347 birds, a decrease of 41% since 1988, when there were 2,277 birds (Moore et al. 2001). In 1992, 140 landing sites were found, 32 fewer sites than in 1988.

6.   Threats

a. Global Warming

The large population fluctuations and periodic population crashes are correlated with warming sea temperatures (Ellis et al. 1998; Taylor 2000; BirdLife 2006). Unlike other penguin species where warming-related declines are caused by a reduction in prey availability, Yellow-eyed penguin die-offs appear to be caused by temperature induced disease outbreaks (Graczyk et al. 1995). Taylor (2000) summarized the issue as follows

The periodic adult deaths appear to be associated with periods of warmer than usual sea and land temperatures. The deaths were initially thought to be associated with temperature related changes such as shortage of prey species, biotoxins caused by algal blooms or increases in land-based viruses such as avian pox. Graczyk et al. (1995) examined the circumstances of these deaths and concluded that they were caused by an outbreak of avian malaria. Avian malaria antibodies were detected from all six yellow-eyed penguin populations from which blood samples were collected. The samples from birds that died had significantly higher absorbances than remaining samples and the circumstances of the deaths conformed with previous outbreaks of avian malaria that have occurred overseas (Graczyk et al. 1995).

(Taylor 2000). Regardless of the mechanism, the correlation of penguin die-offs with warm water episodes does not bode well for the future to the Yellow-eyed Penguin in a greenhouse world.

b. Habitat Loss

Yellow-eyed Penguins have lost much of their forested nesting habitat to logging and land clearing (Seddon and Davis 1989). Even in the remaining areas where the birds continue to breed, nests are often exposed and poorly protected from temperature extremes and predators (Ellis et al. 1998; Taylor 2000).

c. Introduced Predators

Introduced ferrets (*Mustela furo*), stoats (*M. erminea*) and domestic cats are major predators in the South Island (Marchant and Higgins 1990). Predators are also present in all main breeding colonies on the islands, except Campbell Island (Ellis et al. 1998; Taylor 2000).

d. Mortality in Fisheries

Gillnet entanglement is a significant cause of mortality and represents a serious threat to the Yellow-eyed Penguin, particularly near South Island breeding areas (Darby and Dawson 2000; Rance 1995). Of 102 recaptures away from the colonies, 25% were taken from set nets (Marchant & Higgins 1990). This level of bycatch is likely enough to drive population declines. The species also forages over the continental shelf and may therefore also be at risk from trawlers and purse-seiners (Taylor 2000).

e. Human Disturbance

On the Otago Peninsula, South Island, tourists have unregulated access to breeding sites of the Yellow-eyed Penguin (McClung et al. 2004). The presence of people on beaches delays post-foraging landing by penguins, which in turn affects the amount of food delivered by parents to their chicks. This has negative consequences on chick growth, fledging mass, and the

probability of survival (McClung et al. 2004). Further discussion of the various threats to this and other penguin species in the context of ESA listing criteria is contained in Part II of this Petition.

In sum, the Yellow-eyed Penguin is one of the most imperiled penguin species on the planet, with a very small population and restricted breeding range. On its breeding grounds both adults and chicks suffer mortality from introduced predators. At sea, the species suffers higher rates of bycatch relative to population size than probably any other penguin species. Finally, the species is prone to catastrophic die-off in years with unusually warm weather, making it particularly vulnerable to the ever-growing threat of global warming. The species should be promptly listed under the ESA.

V. GENUS: SPHENISCUS

The genus *Spheniscus* includes four species, the African Penguin (*S. demersus*), Humboldt Penguin (*S. humboldti*), Magellanic Penguin (*S. magellanicus*), and Galápagos Penguin (*S. mendiculus*). As previously stated, the Galápagos Penguin is already listed as Endangered under the ESA and is currently the only penguin so protected. The Galápagos Penguin is considered Endangered by the IUCN and BirdLife International, the African and Humboldt penguins are considered Vulnerable, while the Magellanic Penguin is considered Not Threatened (BirdLife 2006). This Petition seeks ESA listing for the African and Humboldt Penguins. We believe both species are appropriately categorized as Endangered under the statute.

A. African Penguin (*Spheniscus demersus*)

Figure 20: African Penguins

Photo by Peter and Barbara Barham

Figure 21: African Penguin Range

The African Penguin (*Spheniscus demersus*) has suffered as dramatic a drop in abundance as any species of penguin. In the early 20th century a single colony contained over 1.4 million adult birds; a century later there are fewer than 180,000 birds globally, split among the 27 remnant colonies (Ellis et al. 1998). The species has suffered every possible insult, from direct persecution and harvest, to massive oil spills, destruction of nesting colonies as a consequence of guano harvesting, and population die-off associated with food shortages caused by industrial fishing fleets and warming oceans (BirdLife 2006). The species clearly warrants the protections of the ESA.

1. Description

The African Penguin is a medium-sized, distinctly patterned, black and white penguin, with a black face and broad band on the chest and sides (Shirihai 2002). Adults have a black forehead to the nape and rest of the upperparts, including the upperside of the flipper, contrasting with white below. The face is black and encircled by a broad white band connected to the white on the chest. The eye is black with a distinctive pink orbital ring which extends to the base of the bill. (Shirihai 2002). The sexes look alike with seasonal variation in feather wear. The voice is a donkey-like braying mainly heard at night (giving the species its alternative name of Jackass Penguin). Body length reaches 60-70 cm, with a of weight 2.1-3.7 kg. Females average smaller in bill size and overall weight but not in flipper length than males (Shirihai 2002).

2. Taxonomy

The African Penguin is considered monotypic with no recognized subspecies (Shirihai 2002). The genus diverged from other penguins about 25 million years ago, although speciation is relatively recent, occurring in the past 4 million years (Baker et al. 2006). While some authors have argued that African, Humboldt and Magellanic Penguins are actually races of a single species, recent genetic data confirms full specific status (Baker et al. 2006).

3. Distribution and Habitat

a. Breeding Range

The African Penguin's breeding range is from Hollams Bird Island, Namibia, to Bird Island, Algoa Bay, South Africa (Whittington et al. 2000). Currently there are 27 breeding colonies: eight islands and one mainland site along the coast of southern Namibia; 10 islands and two mainland sites along the coast of Western Cape Province, South Africa; and six islands in Algoa Bay, Eastern Cape Province, South Africa (Whitington et al. 2000; Crawford et al. 1995; Ellis et al. 1998). Penguins no longer breed at nine locations where they formerly bred: Neglectus, Seal, Penguin, North Long, North Reef, and Albatross Islands in Namibia and Jacob's Reef, Quoin, and Seal (Mossel Bay) Islands in South Africa (Crawford et al. 1995). The total area available for all nesting African Penguins is less than 1,000 hectares (Whittington et al. 2000; Ellis et al. 1998).

b. Foraging Range

African Penguins are usually found within 40 km of the shore, coming onshore to a variety of coastal habitats to breed, molt and rest (Shirihai 2002). Juveniles tend to disperse along the coastline to the west and north (Ellis et al. 1998). Birds regularly reach southern Angola and vagrants have been found off Gabon, Congo and Mozambique (Shirihai 2002).

4. Life History

a. Diet and Feeding Behavior

The African Penguin feeds on pelagic school-fish including sardine (*Sardinops sagax*) and anchovy (*Engraulis capensis*). Petersen et al. (2006) analyzed the role of food availability in limiting African Penguin populations. Foraging effort was significantly greater for mainland breeding penguins than for island breeding birds and this greater foraging effort probably reflects reduced prey availability.

b. Breeding Behavior

African Penguins breed from May through August on rocky ground with little or no vegetation (Shirihai 2002). Nest-burrows are usually dug if conditions allow, with guano being preferred over sand. Females lay two eggs, in March-May in South Africa, and November-December in Namibia. Eggs are incubated for 36-41 days and chicks fledge at 60-130 days. (Shirihai 2002).

5. Abundance and Trend

African Penguin populations are about 10% of what they were at the beginning of the 20th century (Whittington et al. 2000). In 1910, there were probably 1.4 million adult birds in one population alone at Dassen Island (Shannon and Crawford 1999). In the mid-1950s, the overall population was estimated to be about 300,000 adults, including 145,000 at Dassen Island, a 90% reduction since 1910 (Shannon and Crawford 1999). In the late 1970s, there were an estimated 222,000 adult African Penguins, 194,000 in the late 1980s and 179,000 in the early 1990s (Crawford et al. 1995; de Villiers 2002), indicating a mean annual rate of decrease between the late 1970s and early 1990s of 1.3%, and between the late 1980s and the early 1990s of 1.5%. Adult survival is estimated to be about 0.90 per annum which is not sufficient to maintain the population. (Shannon and Crawford 1999, Crawford et al. 1999).

The annual loss of birds has not slowed as the population has decreased (Crawford et al. 1995). If the observed rate of loss continues, Ellis et al. (1998) predicted that extinction in the wild will occur within 70 years.

Of the 27 breeding colonies, seven islands now support 80% of the remaining global population. Only 14 of the 27 breeding colonies contain more than 1,000 adults. (Ellis et al. 1998).

In the 1980s, breeding began at two new mainland sites in South Africa (Boulders and Stony Point). A third site, Robben Island, where African Penguins had been previously extirpated, was re-colonized in the 1980s as well. However, even these new colonies do not come close to offsetting the loss of birds elsewhere. For example, in southern Namibia, penguins at Possession Island declined from 23,000 pairs in 1956 to fewer than 500 pairs in 1987 (Whittington et al. 2000).

Total global population of the species is now likely below 60,000 breeding pairs (Whittington et al. 2000).

6. Threats

The African Penguin faces threats as severe and diverse as any penguin species on the planet. According to the IUCN and BirdLife International, the primary threats to African penguins are: past and ongoing habitat loss/degradation from guano extraction and other sources; invasive alien species directly affecting the species; the continuing direct harvest of individual penguins for subsistence and trade; accidental mortality or bycatch in fisheries; pollution affecting habitat and the species directly, especially oil slicks; natural disasters; changes in native species dynamics; increased competitors and predators; human disturbance through recreation/tourism, and other sources (BirdLife 2006). Additionally, as is the case with virtually every other species of penguin, substantial changes in the distribution and abundance of prey species as a result of warming ocean temperatures has been linked to population declines. Unfortunately for the already imperiled African Penguin, global warming will likely greatly exacerbate this problem, and if not abated, render the species' current extinction trajectory irreversible.

a. Global Warming

As one of the northern most penguins, African Penguins are subject to heat stress, and in more extreme conditions the adults will abandon clutches and broods to take refuge in the sea (Ellis et al. 1998). This results in a higher incidence of predation by Kelp Gulls and other predators. Additionally, occasional heavy rain can flood nests, drowning the small chicks and causing older chicks to die of hypothermia. If ambient temperature and rainfall further increase as a result of global warming, as is predicted by some, African Penguins will suffer ever greater reproductive losses (Whittington et al. 2000; Ellis et al. 1998). Additionally, as discussed in more detail in Section II of this Petition, global warming will continue to change ocean currents in a manner that alters the timing, location, and abundance of fish and other species relied upon by penguins. The African Penguin is no exception, and the order of magnitude declines the species has already suffered may be just a forerunner of the stresses the species will face in the near future. Finally, and also potentially related to global warming, storms of greater frequency

and magnitude have been having a significant affect on adult and chick survival on breeding colonies at certain sites (de Villiers 2002).

b. Fisheries Interactions

Long-term African Penguin population declines have been correlated not just with rising temperatures, but also with the operation of industrial fisheries (Ellis et al. 1998; Whittington et al. 2000). Commercial purse-seine fisheries off South Africa and Namibia catch large quantities of sardine (*Sardinops sagax*) and anchovy (*Engraulis capensis*), important prey for African Penguins. Sardine stocks collapsed in the 1960s off South Africa and in the 1970s off Namibia, contracting to the southeast and north as they did so (Crawford et al. 1987). The subsequent reduction of prey availability was probably the main reason for the large decrease in numbers of penguins from Cape Town to Lüderitz.

From 1989 to 2004, the breeding success of African Penguins at Robben Island, South Africa was significantly related to estimates of the abundance of both anchovy and sardine, and to the combined biomass of these species (Crawford et al. 2006). When the combined spawner biomass of fish prey was less than 2 million tons, pairs fledged an average of 0.46 chicks annually. When it was above 2 million tons, annual breeding success had a mean value of 0.73 chicks per pair (Crawford et al. 2006). Given previously estimated values of survival and age at first breeding, these levels of breeding success are inadequate to sustain the African Penguin population (Crawford et al. 2006).

Whether caused by the overfishing or the changing climate, or most likely, a combination of the two, the collapse of sardine and anchovy stocks off penguin foraging habitats has been disastrous for the species. Absent better regulation of these fisheries, such declines will likely continue (Whittington et al. 2000; Ellis et al. 1998).

c. Oil Pollution / Oil Spills

The African Penguin has been hit more frequently and harder by oil spills than almost any other species of penguin. Five of the world's major 50 oil spills in history have occurred off the coast of South Africa (Whittington et al. 2000). Oil spills have a major impact on African Penguins, especially when the oil washes ashore at breeding areas (Adams 1994; Underhill et al. 1999).

The bulk ore carrier *Apollo Sea* sank near Dassen Island, South Africa, in June 1994, dumping oil into the ocean and trapping penguins. Of the approximately 10,000 African Penguins that were oiled, collected and transported to a rescue centre only 5,213 were released after cleaning (Underhill 1999). Of the 4,076 of the released birds outfitted with flipper bands, only 2,652 had been re-sighted at breeding colonies within two years of their release (Underhill 1999). Overall the oil spill killed nearly 75% of the penguins that were found and treated, but the mortality rate was likely higher for individuals that were not treated (Underhill 1999).

Similarly, on June 23, 2000, the iron ore carrier *MV Treasure* sank between Robben Island and Dassen Island, oiling 19,000 adult penguins at the height of what was otherwise the best breeding season on record for the species. (Nel and Whittington 2003) The oiled birds were brought to Cape Town for rehabilitation. An additional 19,500 un-oiled penguins were removed from Dassen Island before the oil slick reached shore. These birds were released 800 miles up the coast in an effort to keep them away from the spill area before cleanup. Tens of thousands of volunteers helped with the rescue and rehabilitation process, and more than 90% of the treated penguins were rehabilitated and released. Nevertheless, this spill, combined with the 1994 spill likely killed over 30,000 individuals, or as much as 10% of the species (Nel and Whittington 2003).

There have been six major oil incidents since the early 1970s in which many penguins were oiled, as well as a great many more minor oiling events (Whittington et al. 2000). While catastrophic oil spills occur irregularly, there is also is persistent, chronic oiling which accounts for steady, high levels of mortality. For example, of 689 dead penguins found at St. Croix Island over a 10-year period, oil pollution accounted for more deaths (44%) than any other factor (Whittington et al. 2000).

d. Predation and Competition

When a population is severely depleted, the impacts of predation from even native species may preclude recovery or further the decline. Cape fur seals (*Arctocephalus pusillus pusillus*), themselves a protected species, have recovered from previous exploitation and are now abundant off the west coast of southern Africa, with a population size about 1.5–2 million animals. They are important predators of the African Penguin (David et al. 2003). Additionally, competition with expanding seal herds for breeding space may be the reason for cessation of breeding at five African Penguin colonies (Whittington et al. 2000). Besides fur seals, sharks are significant predators of penguins, and Kelp Gull (*Larus dominicanus*) as well as feral cats prey on eggs and chicks at several colonies (Crawford 1998).

e. Other Threats

Guano collection has historically been a major cause of disturbance at many African Penguin colonies and its removal has deprived penguins of nest-burrowing sites, causing heat stress and abandonment of nests, flooding of nests by rain and increased predation (BirdLife 2006). Further discussion of the various threats to this and other penguin species in the context of ESA listing criteria is contained in Part II of this Petition.

B. Humboldt Penguin (*Spheniscus humboldti*)

The Humboldt Penguin (*Spheniscus demersus*) has suffered a similar fate as its congener the African Penguin. In the middle of the 19th century it likely numbered over a million individuals; today it numbers less than 13,000 (Ellis et al. 1998). The species has lost habitat to

Figure 22: Humboldt Penguins   **Figure 23: Humboldt Penguin Range**

Photo by Peter and Barbara Barham

guano harvesting, drowned in fishing nets, been chopped up and killed for fish bait, died in oil slicks, and suffered mass starvation as industrial fishing fleets depleted its foraging areas of the anchoveta upon which it feed. Moreover, El Niño events, apparently increasing in severity and frequency as the world warms, periodically deprive the species of the food it needs to feed it schicks. The species plainly warrants the protections of the ESA.

1. Description

The Humboldt Penguin is a medium-sized, black-and-white penguin with an average length of approximately 65 cm (BirdLife 2006). A black head with white border extends from the eye around ear-coverts and chin, and joins on the throat (BirdLife 2006). Birds have blackish-grey upperparts and whitish underparts with a black breast-band extending down the flanks to the thigh. The bill has a fleshy-pink base. Juveniles have a wholly dark head (greyer on sides and chin) and lack the breast-band (BirdLife 2006). A similar species, the Magellanic Penguin, has broader white stripe on head and has more than one breast-band (BirdLife 2006).

2. Taxonomy

The Humboldt Penguin is considered monotypic with no recognized subspecies. The genus diverged from other penguins about 25 million years ago, although speciation is relatively recent, occurring in the past 4 million years (Baker et al. 2006). While some authors have argued that African, Humboldt and Magellanic Penguins are actually races of a single species, recent genetic data confirms full specific status (Baker et al. 2006).

3. Distribution and Habitat

a. Breeding Range

The Humboldt Penguin is endemic to the Humboldt Current region of South America, restricted to the coasts and islands of Chile and Peru. The species' reproductive range includes Foca Island in Peru through the Pinihuil Islands in Chile (Araya et al. 2000).

b. Foraging Range

Feeding mainly occurs in inshore waters along the coasts of Peru and Chile (Herling et al. 2005). Along the coastline the Humboldt Penguin faces many different ecological and climatic conditions from a dry coastal desert climate and nutrient rich coastal upwelling regions in the north to lush temperate rainforests and poor coastal upwelling in the south (Herling et al. 2005). The coastline of Chile is influenced by the cold, nutrient-rich Humboldt Current, flowing northwards from Antarctica, bringing waters with colder temperatures than typical for the prevailing latitudes. In the north of Chile the cold sea-surface temperatures are being intensified by the coastal upwelling that usually brings up cold, nutrient-rich waters from below the thermocline (Herling et al. 2005). This, in turn, allows high primary productivity resulting in high amounts of fish such as the plankton-eating anchovy (*Engraulis* spp.). There may be an extended migration route of around 700 km from Peru to north Chile, and adult birds regularly disperse up to 170 km in Peru, and occasionally over 600 km (Culik and Luna-Jorquera 1997; Wallace et al. 1999).

4. Life History

a. Diet and Feeding Behavior

Foraging mainly in inshore waters, the Humboldt Penguin primarily takes small fish, especially anchoveta (*Engraulis* spp.) (BirdLife 2006).

b. Breeding Behavior

Humboldt Penguins nest on islands and rocky coastal stretches, burrowing holes in guano and occasionally using scrape nests or caves (Cheney 1998; Ellis et al. 1998), though apparently preferring to breed in higher elevation sites where guano deposits are available for burrow excavations (Paredes and Zavalaga 2001). The choice of a good nest is important for breeding success, as penguins nesting further inland and with better shelter have higher breeding success than those nesting in beaches or sea caves (Paredes and Zavalaga 2001). Burrow nests in the guano deposits of the cliff tops or slopes are considered the best for breeding (Paredes and Zavalaga 1998).

5. Abundance and Trend

Humboldt Penguin populations have declined from levels of perhaps over a million birds in the 19th century to fewer than 12,000 today. Murphy (1936) suggested that Humboldt Penguins were numerous in the Humboldt Current area and there are mid-19th century estimates

of more than one million birds (Araya et al. 2000). By the time Murphy (1936) published his account, the population decline was evident, a trend which Murphy emphasized.

The current population of Humboldt Penguins is estimated to be approximately 7,500 individuals in Chile and less than 5,000 individuals in Peru (Araya et al. 2000; Paredes et al. 2003).

Humboldt Penguins have been declining since the mid-19th century, but the 1982-1983 El Niño Southern Oscillation (ENSO) reduced the population from approximately 20,000 birds to around 5,500 total birds (Ellis et al. 1998; Hays 1984, 1986). By 1995-1996, the population had increased to 10,000-12,000 birds, mainly at Punta San Juan (3,400 birds) and Isla Pachacamac (800) in Peru, and Isla Pan de Azúcar (1,750), Isla de Chañaral (2,500), Isla Pájaros (1,000), Islote Cachagua (2,000) and ex-Islote Pájaro Niño (1,600) in Chile (Cheney 1998). The 1997-1998 ENSO event reduced the population again to 3,300 birds (BirdLife 2006).

In Peru, the number of colonies declined from 17 in 1981 to two in 1996 (Ellis et al. 1998), but had recovered to six by 1999 (BirdLife 2006). Surveys in Peru during 1999-2000 recorded the species at 21 localities, 10-14 of which were considered breeding sites. However, in both years, 78% of the total Peruvian population of 4,425 birds were clustered in just five colonies (Paredes et al. 2003).

The breeding range of penguins in Peru remains the same, from La Foca Island (5°47'S) to Punta Coles (17°42'S), but the size and distribution of colonies have changed during the period 1984-1999 (Paredes et al. 2003). There are now fewer penguins on the central coastal area and proportionally more on the southern coast of Peru (Paredes et al. 2003). These changes may be the result of a combination of migration to more southern locations as a result of ENSO events (Hays 1986; Culik 2000), increasing human presence and activities in the central coastal areas (INEI 1999), or long-term changes in prey distribution (Paredes et al. 2003). Increased human disturbance, and particularly the progressive expansion of local fisheries, is considered by some to be the main cause of decline (Paredes et al. 2003).

Of the Peruvian breeding locations, only Punta San Juan and Pachacamac Island, together comprising 50% of the Peruvian population, are protected as part of a reserve system (Paredes et al. 2003). The remaining 50% of the population exist on sites that are often disturbed by guano miners, fishermen and other human activity (Paredes et al. 2003). The only colonies that have increased in population are those with legal protection where wardens or scientists are permanently present (Paredes et al. 2003).

In Chile, Humboldt Penguins only breed at 10 sites (Ellis et al. 1998).

Researchers working on the Population and Habitat Viability Assessment (PHVA) of Humboldt Penguins predicted a high probability of extinction of Humboldt Penguins based on the current rate of adult mortality and reproduction (Araya et al. 2000).

6. Threats

The Humboldt Penguin is threatened by changing ocean conditions, particularly from ENSO events, fishing activities, human disturbance, loss of habitat from guano exploitation, egg and chick predation by introduced species, and marine pollution (Cheney 1998, Ellis et al. 1998, Paredes et al. 2003).

a. El Niño / Southern Oscillation (ENSO)

The upwelling system of the Humboldt Current is regularly affected by recurrent ENSO events, where the nutrient-rich surface waters are being replaced by warm nutrient-poor waters and fish becomes unavailable to seabirds (Hays 1986; Boersma 1998). The 1997-98 ENSO, the strongest recorded in history, resulted in a marked decline of Humboldt Penguins in Peru (Paredes et al. 2003).

In population censuses of the Humboldt Penguin undertaken before the strong 1982-83 ENSO event, the total number of penguins in Peru and Chile was estimated at 20,000 individuals (Hays 1986; Araya 1988). After the 1982-83 ENSO event, only 3,500 individuals were reported in Peru (Hays 1986) and only 2,800 in Chile (Araya 1988). Only one quarter of the population remained.

ENSO events have also affected local fishermen by reducing the abundance of their main target fish and shellfish species (Paredes et al. 2003). As a result, fishermen switched to other species in fishing grounds that are often around penguin rookeries (Paredes et al. 2003). This has resulted not only in increased penguin mortality due to entanglement in fishing nets (Majluf et al. 2002), but also in disturbance and illegal killing of penguins for food (Paredes et al. 2003). These activities may have led penguins to abandon colonies occupied in 1984 (Punta Corio, La Chira, Morro Sama, Atico, San Fernando) and seek refuge in either marginal areas inaccessible to humans or in protected areas (Paredes et al. 2003).

The relationship between global warming, changing ocean conditions and ENSO events is discussed further in Part II of this Petition.

b. Fisheries Interactions and Mortality

Fisheries adversely affect Humboldt Penguins in at least three ways. First, the species sustains high levels of direct mortalities from entanglement and drowning in fishing gear. Second, large-scale fisheries compete with the penguins by removing large quantities of the anchoveta upon which they feed. Finally, fishermen kill Humboldt Penguins and use their flesh for fish bait (BirdLife 2006).

The entanglement of Humboldt Penguins in gill nets has been reported as one of the main causes of adult mortality in non-El Niño years in Peru (Zavalaga and Paredes 1997; Majluf et al. 2002) and Chile (Simone et al. 1999). In Central Chile, most bycatch occurs in the winter (June

through August) when Humboldt Penguins leave breeding colonies and disperse into zones where nets are set for corvina (*Cilus gilberti*) (Simeone et al. 1999; Luna et al. 2002). In Peru, the cojinova (*Seriorella violacea*) fishery is the primary source of direct mortality for penguins (Luna et al. 2002).

The dependence of Humboldt Penguins on commercially exploited, schooling prey species makes the species particularly susceptible to changes in prey stocks, due to non-sustainable fisheries management (Herling et al. 2005). The commercial fishery of Chile intensively exploits the main prey species of Humboldt Penguins, anchovy, silversides, garfish and herring (Herling et al. 2005). In 1997, the total catch of these species was 2.2 million tons (Herling et al. 2005). The intensive commercial exploitation of the main prey species of the Humboldt penguin likely makes it more difficult for penguins to find the food they need to survive (Herling et al. 2005).

c. Guano Extraction

Historical declines in Humboldt Penguin populations resulted from the exploitation of guano at breeding sites (Williams 1995). In Peru, the Humboldt Penguin was once considered an important guano-producing seabird before the guano exploitation in the middle of the 19th century (Coker 1919; Murphy 1936). Originally seen in "hundreds of thousands," the early drastic decline of penguin numbers has been associated with the destruction of its nesting habitat during guano harvests (Murphy 1936; Hays 1986; Paredes et al. 2003). Murphy (1936) reported more than 100 islands in Peru were periodically allowed to become merely ankle-deep in new guano before harvest swept them clean, rendering these sites much less suitable for nesting and forcing the species to resort to more precarious nesting sites (Murphy 1936; Araya et al. 2000).

The guano serves as a substrate that penguins use for burrowing (Paredes et al. 2003). Recent studies have shown that guano extraction causes reduced penguin breeding success (Paredes and Zavalaga 2001). Paredes and Zavalaga (2001) concluded that penguins breeding on cliff tops and burrows dug in guano deposits had much higher reproductive success than penguins nesting on beaches or sea caves. Reproductive failure was mostly due to nest flooding during strong ocean swells (Paredes and Zavalaga 2001). On cliff tops, where the main guano deposits are located, burrows were the most successful nests with 1.41 fledglings/nest (Paredes and Zavalaga 2001). Halting guano extraction around the main breeding areas will increase the availability of burrowing substrates and breeding success (Paredes and Zavalaga 2001). Furthermore, as sea levels rise, Humboldt Penguins will lose more low lying nesting areas, making the limited cliffs and guano deposits all the more important.

Unfortunately, guano is still harvested in Peru, and likely limits the availability of preferred nesting habitat (Paredes and Zavalaga 2001). About half of the remaining Humboldt Penguin in Peru nest in areas managed as guano reserves. While guano harvest has not occurred at the important Punta San Juan reserve for over a decade, other occupied reserves are still harvested (Paredes et al. 2003). Although guano bird reserves provide some refuge for penguins, during guano harvests workers often collect eggs and chicks (Paredes et al. 2003). In addition,

the removal of guano leaves penguins without a substrate for burrow construction and forces them to nest in the open, where they are exposed to predators and heat stress. Thus, guano harvesting not only results in direct penguin mortality, but also significantly hinders the birds' reproductive success (Paredes and Zavalaga 2001; Paredes et al. 2003).

d. Human Disturbance

Over the last decade Humboldt Penguins have become a focus for ecotourism (Ellenberg et al. 2006). Ellenberg et al. (2006) measured the breeding success of penguins on the islands of Damas, Choros, and Chanaral, which together make up the Humboldt Penguin National Reserve in Chile. Humboldt penguins are extremely sensitive to human presence. Ellenberg et al. (2006) found that breeding success was significantly reduced at sites frequently visited by tourists and that Humboldt Penguins respond more strongly to human presence than do any other penguin species thus far studied (Ellenberg et al. 2006). On Damas Island, which receives over 10,000 annual visitors, reproductive success was around 0.5 chicks per pair; on Choros Island, which receives about 1,000 annual visitors, reproductive success was roughly one chick per pair; on Chanaral Island, which receives only 100 tourist visits annually, reproductive success was 1.34 chicks per pair (Ellenberg et al. 2006).

Further discussion of the various threats to this and other penguin species in the context of ESA listing criteria is contained in Part II of this Petition.

PART TWO: ANALYSIS OF ENDANGERED SPECIES ACT LISTING FACTORS

I.   Criteria for Listing Species as Endangered or Threatened under the Endangered Species Act

Under the ESA, 16 U.S.C. § 1533(a)(1), FWS 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.[1] In making such a determination, FWS 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;

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[1] In making this determination, the FWS must rely "solely on the best scientific and commercial data available." 16 U.S.C. § 1533(b)(1)(A). Regrettably, political considerations are routinely inserted by political appointees at the Department of Interior into determinations that should be entirely science-based (Union of Concerned Scientists 2005, 2004a-d). Petitioner urges the FWS to consider only the best scientific information available in its determination on this Petition.

(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).

A species is "endangered" if it is "in danger of extinction throughout all or a significant portion of its range" due to one or more of the five listing factors. 16 U.S.C. § 1531(6). A species is "threatened" if it is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. § 1531(20).

Under the ESA, a "species" includes any species, subspecies or "distinct population segment" of a vertebrate species. 16 U.S.C. § 1532(16). As explained in the individual species accounts above, each of the petitioned taxa is recognized as a distinct species or subspecies, and therefore each qualifies as a "species" under the ESA.

While the ESA does not define the "foreseeable future," the FWS must use a definition that is reasonable, that ensures protection of the petitioned species, and that gives the benefit of the doubt regarding any scientific uncertainty to the species.

The minimum time period that meets these criteria is 100 years. There is ample precedent for use of a timeframe of 100 years or longer as the "foreseeable future," and no support for using a timeframe of less than 100 years. Because global warming is one of the foremost threats to the petitioned species, the FWS should consider the timeframes used in climate modeling. Predictions of impacts in the next 100 years or more are routine in the climate literature, demonstrating that impacts within this timeframe are inherently "foreseeable." Climate scientists routinely look at much longer time periods, and therefore a time horizon of 1000 years or more with regard to this threat would be eminently reasonable.

The IUCN threatened species classification system, described below, also uses a timeframe of 100 years. Moreover, in planning for species recovery, the FWS (as well as its sister agency, the National Marine Fisheries Service) routinely considers a 75-200 year foreseeable future threshold (Suckling 2006). For example, the Alaska Region has previously stated in the Steller's Eider Recovery Plan:

> The Alaska-breeding population will be considered for delisting from threatened status when: The Alaska-breeding populations has <1% probability of extinction in the next 100 years; AND Subpopulations in each of the northern and western subpopulations have <10% probability of extinction in 100 years and are stable or increasing.
> The Alaska-breeding population will be considered for reclassification from Threatened to Endangered when: The populations has > 20% probability of extinction in the next 100 years for 3 consecutive years; OR The population has >

20% probability of extinction in the next 100 years and is decreasing in abundance (USFWS 2002 (emphasis added)).

With regard to the Mount Graham red squirrel, the FWS stated "At least 10 years will be needed to stabilize the Mt. Graham red squirrel population and <u>at least 100 to 300 years will be needed to restore Mt. Graham red squirrel habitat</u>" (Suckling 2006 (emphasis added). With regard to the Utah prairie dog, the Service defined the delisting criteria as "[t]o establish and maintain the species as a self-sustaining, viable unit with retention of 90 percent of its genetic diversity <u>for 200 years</u>" (Sucking 2006 (emphasis added)). The National Marine Fisheries Service stated of the Northern right whale: "[g]iven the small size of the North Atlantic population, downlisting to threatened <u>may take 150 years</u> even in good conditions" (Suckling 2006 (emphasis added)).

Perhaps most importantly, the time period the FWS uses in its listing decision must be long enough so that actions can be taken to ameliorate the threats to the petitioned species and prevent extinction. Slowing and reversing impacts from anthropogenic greenhouse gas emissions, a primary threat to all of the petitioned penguin species, will be a long-term process for a number of reasons, including the long lived nature of carbon dioxide and other greenhouse gases and the lag time between emissions and climate changes. The FWS must include these considerations in its listing decision.

For all these reasons, Petitioner suggests a minimum of <u>200 years</u> as the "foreseeable future" for analyzing the threats to the continued survival of the petitioned penguin species. The use of less than 100 years as the "foreseeable future" in this rulemaking would be clearly be unreasonable, frustrate the intent of Congress to have imperiled species protected promptly and proactively, and fail to give the benefit of the doubt to the species as required by law.

As detailed throughout, neither anthropogenic greenhouse gas emissions nor any of the other threats to the petitioned penguin species are speculative or too far in the future to understand or address. Tragically, these new and modern threats are already here, and the impacts are already manifesting in penguin populations. Urgent action, including listing under the ESA and dramatic cuts in greenhouse gas emissions levels, is needed now to ensure that these species do not become extinct in the foreseeable future. As described below, each of the petitioned penguin species qualifies for listing under the ESA.

II. IUCN Status of Petitioned Penguin Species

The World Conservation Union, formerly the International Union for the Conservation of Nature ("IUCN") is the world's foremost authority on the status of threatened species. The IUCN Redlist classification system is widely regarded as the most authoritative list of globally threatened spcies (Akçakaya et al. 2006; IUCN 2001). It is intended to be an easily and widely understood system for classifying species at high risk of global extinction (IUCN 2001). The general aim of the system is to provide an explicit, objective framework for the classification of the broadest range of species according to their extinction risk (IUCN 2001). The current system

("Version 3.1") is the result of a comprehensive and continuing process of drafting, consultation and validation (IUCN 2001). For all birds, including the petitioned penguin species, IUCN status determinations are made by BirdLife International, a global partnership of conservation organizations and researchers that operates in over one hundred countries and territories worldwide. (BirdLife 2006).

Figure 24 depicts the IUCN classification system graphically, and Table 1 provides the definitions for each category. A reviewer categorizing a species considers each category in turn and places the species in the highest category of threat for which it meets any one of the IUCN's criteria (some criteria may never be applicable to some species, no matter how likely they are to become extinct) (IUCN 2001). Table 2 provides the criteria for the Endangered and Vulnerable categories. A species is classified as Endangered or Vulnerable if it meets any one of criteria A through E shown in Table 2. All of the petitioned penguin species, with the exception of the Emperor penguin, are currently classified as either Endangered or Vulnerable by the IUCN.

Figure 24: IUCN Species Classification System
Source: IUCN (2001).
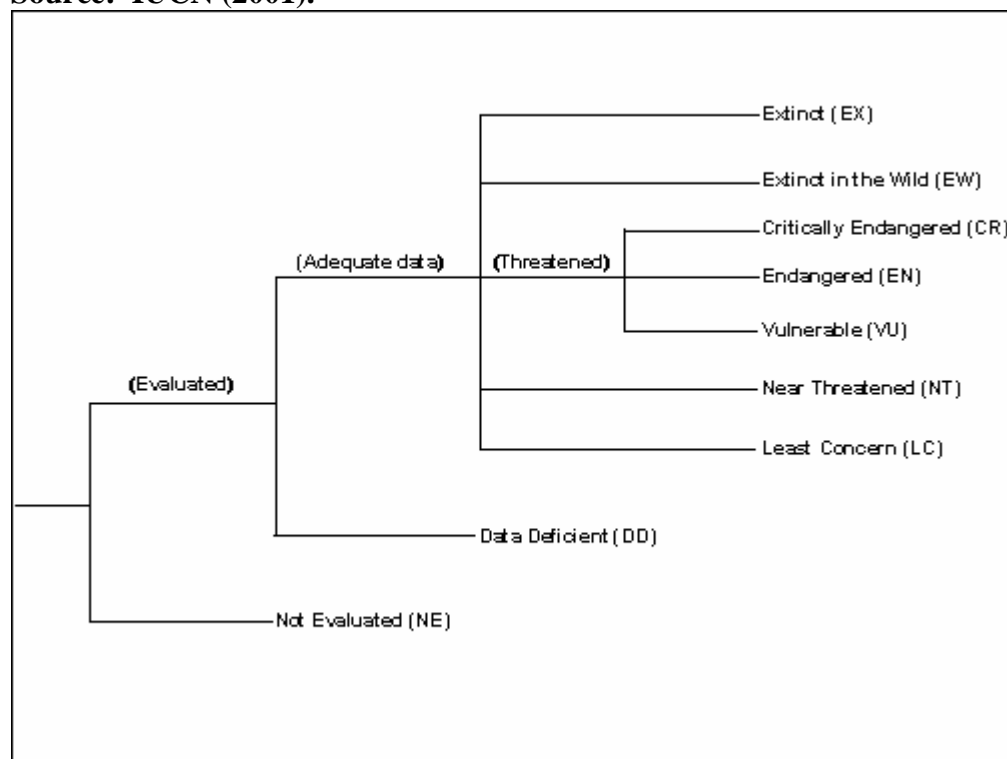
Table 1: IUCN Categories and Definitions
Source: IUCN (2001)

CATEGORY	DEFINITION
EXTINCT (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at

CATEGORY	DEFINITION
	appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
EXTINCT IN THE WILD (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
CRITICALLY ENDANGERED (CR)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
ENDANGERED (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.
VULNERABLE (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.
NEAR THREATENED (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
LEAST CONCERN (LC)	A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
DATA DEFICIENT (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.
NOT EVALUATED (NE)	A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Table 2: Quantitative Criteria for Endangered and Vulnerable Listings
Source: IUCN (2001)

	ENDANGERED	**THREATENED**
A. DECLINING TOTAL POPULATION – Reduction in population size based on any of the following 4 options and specifying a-e as appropriate		
	≥ 70 %	≥ 50 %
	(1) population size reduction that is observed, estimated, inferred, or suspected in the past 10 years or 3 generations, whichever is longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any combination of a-e below.	
	≥ 50 %	≥ 30 %

	ENDANGERED	THREATENED
(2) population size reduction that is observed, estimated, inferred, or suspected in the past 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any combination of a-e below.		
(3) population size reduction that is projected or suspected to be met within in the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years), based on (and specifying) and combination of b-e below.		
(4) population size reduction that is observed, estimated, inferred, projected or suspected over any 10 year or 3 generation period, whichever is longer (up to a maximum of 100 years), where the time period includes both the past and the future, AND where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any combination of a-e below.		
a) direct observation b) an index of abundance appropriate for the taxon c) a decline in area of occupancy, extent of occurrence and/or quality of habitat d) actual or potential levels of exploitation e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors, or parasites		

B. SMALL DISTRIBUTION, AND DECLINE OR FLUCTUATION

	ENDANGERED	THREATENED
1. Extent of occurrence	< 5,000 km²	< 20,000 km²
OR		
2. Area of occupancy	< 500 km²	< 2,000 km²
For either of the above, specify at least two of a-c:		
(a) either severely fragmented or known to exist at # locations	≤ 5	≤ 10
(b) continuing decline observed, inferred or projected in any of the following:		
	i) extent of occurrence ii) area of occupancy iii) area, extent and/or quality of habitat iv) number of locations or populations v) number of mature animals	
(c) extreme fluctuations in any of the following:	> 1 order of magnitude	> 1 order of magnitude
	i) extent of occurrence ii) area of occupancy iii) number of locations or populations iv) number of mature animals	

C. SMALL TOTAL POPULATION SIZE AND DECLINE

	ENDANGERED	THREATENED
Number of mature individuals	< 2,500	< 10,000
And 1 of the following 2:		
(1) an estimate of continuing decline at a rate of at least:	20% in 5 years or 2 generations (up to a maximum of 100 years in the future)	10% in 10 years or 3 generations (up to a maximum of 100 years in the future)
(2) continuing decline, observed, projected or inferred, in numbers of mature individuals and at least one of the following (a-b):		
(a) fragmentation – population structure in the form of one of the following:	(i) no population estimated to contain >250 mature individuals	(i) no population estimated to contain >1,000 mature individuals

	ENDANGERED	THREATENED
	(ii) at least 95% of mature individuals in one population	(ii) all mature individuals are in one population
(b) extreme fluctuations in the number of mature individuals		
D. VERY SMALL POPULATION OR RESTRICTED DISTRIBUTION		
(1) Number of mature individuals	< 250	< 1,000
(2) Applies only to threatened: Population with a very restricted area of occupancy or number of locations such that is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and thus is capable of becoming highly endangered or even extinct in a very short time period.		
	(not applicable)	Area of occupancy typically < 20 km² or number of locations ≤ 5
E. QUANTITATIVE ANALYSIS		
Indicating the probability of extinction in the wild to be at least:	20 % in 20 years or 5 generations, whichever is longer (up to a maximum of 100 years)	10 % in 100 years

As discussed in the species accounts above, the current IUCN classification of each of the petitioned penguin species is as follows:

Table 3: IUCN Listing Status of Petitioned Penguin Species
Sources: BirdLife (2006); Ellis et al. (1998).

SPECIES	IUCN STATUS
Emperor Penguin (*A. forsteri*)	Least Concern
Southern Rockhopper Penguin (*E. c. chrysocome*)	Vulnerable
Eastern Rockhopper Penguin (*E. c. filholi*)	Vulnerable
Northern Rockhopper Penguin (*E. moseleyi*)	Vulnerable
Fiordland Crested Penguin (*E. pachyrhynchus*)	Vulnerable
Snares Crested Penguin (*E. robustus*)	Vulnerable
Erect-crested Penguin (*E. sclateri*)	Endangered
Macaroni Penguin (*E. chrysolophus*)	Vulnerable
Royal Penguin (*E. schlegeli*)	Vulnerable
White-flippered Penguin (*E. m. albosignata*)	Endangered
Yellow-eyed Penguin (*M. antipodes*)	Endangered
African Penguin (*S. demersus*)	Vulnerable
Humboldt Penguin (*S. humboldti*)	Vulnerable

The IUCN status listings are based on evaluations conducted by BirdLife International in 2004. While the IUCN Listing affords no actual regulatory protection to any species, such a listing is an unequivocal statement from scientists that the species is imperiled and warrants protection. These classifications are prima facie evidence that the petitioned species warrant protection under the ESA. Certainly, an IUCN listing is sufficient to meet the "may be warranted" threshold for initiating a status review as required by 16 U.S.C. § 1533(b)(3)(B).

However, the current IUCN classifications may actually understate the threat to many of these species for several reasons. First, the data utilized for the last major evaluation came primarily from a collaborative workshop, the Penguin Conservation Assessment and Management Plan (CAMP), held in September 1996 in Cape Town, South Africa. Thus, while IUCN and BirdLife International have made some updates in recent years, a thorough evaluation of these species populations has not been performed since the 1996 CAMP workshop.

As detailed below, scientific understanding of global warming and scientists' ability to predict future impacts from anthropogenic greenhouse gas emissions have advanced very rapidly in recent years, and in particular, over the past five years. We now know that greenhouse gas emissions, global warming, and ocean acidification pose a much greater and more urgent threat to organisms like the petitioned penguin species than previously understood. Today's information on the threat to these species from anthropogenic greenhouse gas emissions was simply not available in 1996, and therefore the previous evaluations are almost certainly underestimates of the threats faced by these species.

In addition, the current IUCN Redlist classification system was not designed to explicitly evaluate the widespread and pervasive threat posed by global warming and ocean acidification, and therefore, may not be the best tool for assessing these threats, especially when they operate on long time horizons (Akçakaya et al. 2006). Applying the IUCN Redlist criteria may result in an underestimate of the threat faced by species impacted by climate change. For example, the restriction of consideration to a time frame of 3 generations or 10 years, whichever is longer, under Factor A3 would prevent the listing of a species expected to suffer large scale declines in more than 3 generations' time (or 10 years) from global warming (Akçakaya et al. 2006). Because of the lag time in the climate system, a species may already be committed to declines that will not manifest themselves for many decades. Factor E may be used to classify species based on the probability of extinction over longer time periods, but the problem here is that for most species available data are not sufficient for building models to estimate this probability (Akçakaya et al. 2006). This is a further reason why the IUCN classifications for each petitioned penguin species must be considered a minimum estimate of its current degree of imperilment.

As discussed above, the most recent Emperor Penguin assessment relied upon del Hoyo et al. (1992) for the proposition that the species appears to be stable (BirdLife 2006). As discussed throughout, our understanding of the status and threats to the Emperor Penguin has improved dramatically in recent years, precipitous declines have been documented in several populations, and it is clear that the Emperor Penguin qualifies, at a minimum, as Threatened under the ESA.

III. The Survival of Each of the Petitioned Penguin Species is Threatened by One or More of the Endangered Species Act Listing Factors

A. The Present or Threatened Destruction, Modification or Curtailment of Their Habitat or Range

Worldwide, habitat loss or degradation is the primary cause of species extinction (Primack 2001). This is particularly true for birds (Pimm et al. 2006). Direct habitat loss threatens all of the petitioned penguin species, as detailed in the species accounts above. Penguin breeding colonies are being lost in many areas due to human encroachment, erosion, deforestation, mining and agriculture, and other human modifications of the landscape (Williams 1995). In addition to these more traditional threats, however, the marine environment upon which penguins rely is now under on severe and pervasive threat from anthropogenic greenhouse gas emissions, which are resulting in global warming, increased ocean temperatures, and ocean acidification. Many of the petitioned penguin species are already manifesting adverse impacts from these factors. All are severely threatened in the future from this new and deadly assault upon their habitat.

1. Anthropogenic Greenhouse Gas Emissions and Current Climate Science

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 (Albritton et al. 2001). The earth's climate is the result of a state in which the amount of incoming and outgoing radiation are approximately in balance (Albritton et al. 2001). 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 (Albritton et al. 2001). A change in the net radiative energy available to the global Earth-atmosphere system is called "radiative forcing" (Albritton et al. 2001). 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 manmade factors (Albritton et al. 2001; ACIA 2004). The level of scientific understanding of these different forcings varies widely, and the forcings themselves and interactions between them are complex (Albritton et al. 2001). 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 (Albritton et al. 2001; IPCC 2001a; ACIA 2004). 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 (Albritton et al. 2001; ACIA 2004; Figure 25). The higher the level of greenhouse gas concentrations, the larger the degree of warming experienced.

Figure 25: The Enhanced Greenhouse Effect
Source: ACIA (2004).
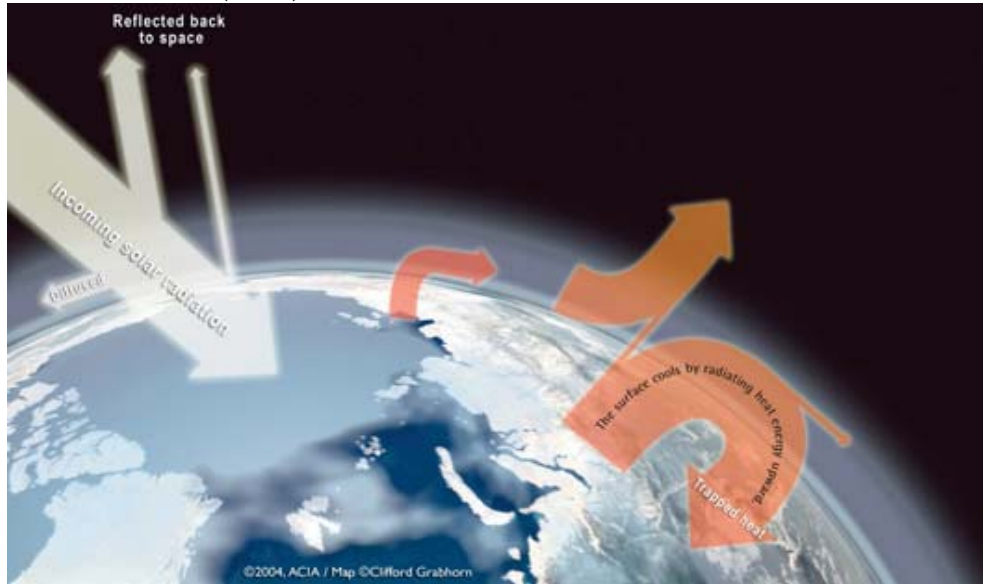
By the time of the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2001[2], the atmospheric concentration of carbon dioxide had increased by 31% since 1750, to a level that has not been exceeded during the past 420,000 years and likely not during the past 20 million years (IPCC 2001a). The current rate of increase is unprecedented during at least the past 20 million years (IPCC 2001a). 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 (IPCC 2001a). Carbon dioxide is considered the most important greenhouse gas overall because the volumes emitted dwarf those of all the other greenhouse gases combined. As of March, 2006, the atmospheric carbon dioxide concentration was 381 ppm, and rising at over 2 ppm per year (Shukman 2006).

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[2] The IPCC was established by the World Meteorological Organization and the United Nations Environment Programme in 1988 (IPCC 2001a). The IPCCs 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 2001a). 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 2001a). The IPCC's comprehensive Assessment Reports are produced approximately every seven years and build upon and expand past IPCC products. The *Fourth Assessment Report* is scheduled for release beginning in February, 2007, and should be available for FWS's use in its full status review for the petitioned penguin species. This Petition cites from the *Third Assessment Report* and from many more recent individual peer reviewed publications.

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 420,000 years (IPCC 2001a). About half of current methane emissions are manmade, and there is also evidence that current carbon monoxide (CO) emissions are a cause of increasing methane concentrations (IPCC 2001a). 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 17% since 1750, continues to increase, and has not been exceeded during at least the last 1000 years (IPCC 2001a). About a third of current nitrous oxide concentrations are manmade. 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).

By 2001, the global average temperature has risen by approximately 0.6° C ± 0.2° C (1.0° F ± 0.36° F) during the 20th Century (IPCC 2001a). Important advances in the detection and attribution of global warming have demonstrated, beyond any legitimate scientific debate, that a significant portion of this observed warming is due to anthropogenic greenhouse gas emissions (Barnett et al. 2005, IPCC 2001a; LLNL 2006).

Past anthropogenic greenhouse gas emissions have altered the energy balance of the earth by 0.85 ± 0.15 watts per square meter (Hansen et al. 2005). Due to the lag time in the climate system, this energy imbalance commits the earth to <u>additional</u> warming of .6° C (1° F) of warming that is already "in the pipeline," even absent additional greenhouse gas emissions (Hansen et al. 2005).

Because greenhouse gas emissions are continuing to increase, warming is projected to accelerate. Based on differing scenarios of future greenhouse gas emissions and the world's leading climate models, the IPCC has projected between 1.4° and 5.8°C (2.5° -10.4° F) of additional warming by the end of this century. The higher the level of greenhouse gas emissions, the more the world will warm.

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. 2006a,b). 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. 2006a,b). 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.[3]

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. 2006a,b; Hansen and Sato 2004). 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 (Hansen 2006; Hansen et al. 2006a,b). 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 (Hansen 2006; Hansen et al. 2006a,b). The alternative scenario would limit global warming to less than an additional 1°C in this century (Hansen 2006; Hansen et al. 2006a,b).

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 2006; Hansen et al. 2006a,b). This rate of increase itself appears to be increasing (Black 2006). 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. 2006a,b). 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. 2006a,b). 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. 2006a,b).

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).

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. Global Warming in Antarctica and the Southern Ocean

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[3] This limit may increase slightly to 475 ppm carbon dioxide if other quantities of other greenhouse gases such as methane and nitrous oxide are reduced (Hansen 2006; Hansen et al. 2006a,b).

The Antarctic, like the Arctic, plays an important role in the regulation of the global climate, and changes due to the climate forcings of anthropogenic greenhouse gas emissions are expected to be more pronounced in both polar regions than in other areas of the world (Clarke and Harris 2002). The earth's climate system is extremely complex, and discussion of global average temperatures masks significant regional variation and variability. Because the Antarctic is the most remote, harsh, and unpopulated region of the planet, data to explicate climate trends are sparse. Few Antarctic stations have climate records extending back further than 40 years, making it difficult to determine whether the observed temperature changes in Antarctica reflect the global trends (Clarke and Harris 2002). An additional problem is that temperature records from Antarctica have a particularly high level of interannual variability, which makes the determination of trends from short records very problematic (Clarke and Harris 2002).

Despite these limitations, however, observations can be made from available data. The Antarctic Peninsula, and in particular the central and southern portions of its western coast, is one of the most rapidly warming areas on the planet, and the sub- and maritime Antarctic islands also show consistent warming (Clarke and Harris 2002; Chapin III 2005). In the past 50 years the annual mean temperature has increased in this region by about 2° C (3.6° F) (Chapin III 2005), and by 2.5° C (4.5° F) for the Antarctic Peninsula alone (NSIDC 2002). The climate of the Antarctic Peninsula area is highly sensitive due to complex interactions between atmosphere, oceans, and sea ice, and is strongly influenced by climate variations in the subtropical and tropical Pacific Ocean (Clarke and Harris 2002). As discussed further below, this warming has caused the loss of seven ice shelves during the past 50 years. By contrast, over much of Antarctica, warming trends have been very small, with a very small amount of cooling recorded over the South Pole (Clarke and Harris 2002).

Based on available data, the Southern Ocean appears to be warming at a rate greater than the global average. Global average temperatures in the upper 1000m of the oceans increased by about 0.1° C (0.18° F) between 1955 and 1995 (Levitus et al. 2000; Clarke and Harris 2002). Gille (2002) used data from autonomous Lagrangian Circulation Explorer floats to infer a warming in the Antarctic Circumpolar Current (ACC) of about 0.17° C (0.30° F) between the 1950s and 1980s at depths of 700-1000 m (Gille 2002; Clarke and Harris 2002). The data and conclusions of Gille (2002) imply that the Southern Ocean is warming faster than the global average, and at rates comparable with the observed atmospheric warming in the Southern Ocean (Gille 2002; Clarke and Harris 2002).

Recent increases in Antarctic precipitation have also caused a freshening of surface layers in the Southern oceans that weakens bottom-water formation (Clarke and Harris 2002; Anisimov et al. 2001). The surface and shelf waters in the Ross Sea have warmed and become less saline over the past 40 years. Ocean measurements in the Ross Sea over the past four decades, one of the longest records near Antarctica, reveal marked decreases in shelf water salinity and the surface salinity within the Ross Gyre due to a combination of increased precipitation, a reduction of sea-ice production, and increased melting of the West Antarctic ice sheet (Jacobs et al. 2002; Chapin III 2005). These changes have been accompanied by atmospheric warming on Ross

Island, ocean warming at depths of approximately 300 meters north of the continental shelf, a more negative Southern Oscillation Index, and thinning of southeast Pacific ice shelves (Jacobs et al. 2002).

The Southern Ocean also plays a critical role in global climate. With no continental barriers, it serves as a conduit to transmit climatic signals between the Pacific, Atlantic, and Indian Oceans. The predominant current of the Southern Ocean, the fast-flowing ACC, brings mid-depth water into contact with the ocean surface and serves as a barrier to southward transport, possibly helping to isolate the Antarctic continent from mid-latitude climate variability (Rintoul et al. 2001). Because warm water can hold less dissolved gas than cold water, the observed warming indicates that the carbon dioxide storage capacity of the Southern Ocean has decreased since the 1950s, further influencing global climate (Gille 2002).

The Southern Ocean is covered by an expanse of sea ice that varies seasonally from 3 million to 20 million square kilometers, an area about the size of North America (Chapin IIII 2005). Scientists believe that sea ice is a sensitive indicator of climate change, but tracking sea-ice extent changes has only been possible since the advent of the satellite record in the early 1970s (Clarke and Harris 2002). From ice cores and 22 years of satellite-derived sea-ice extent data, Curran et al. (2003) determined that there has been a 20% decline in sea-ice extent from 1950 to 1995 in the 80°E to 140°E sector of Antarctica. In contrast to the Arctic, thus far regional sea-ice declines in some parts of the Antarctic have been balanced by increases in other areas (Clarke and Harris 2002).

The IPCC has estimated future precipitation and warming in Antarctica and over the Southern Ocean using four different emissions scenarios and a range of the world's leading climate models (Anisimov et al. 2001). Precipitation is projected to increase between 1-28% over land and between 2-17% over the ocean in the summer, and between 4-32% over land and between 5-20% over the ocean in the winter by 2080. Temperatures are projected to increase between 1.0-4.8° C (1.8-8.6° F) over land and between 0.0-2.8° C (0.0-5.04° F) over the ocean in summer and between 1.0-5.0° C (1.8°-9.0° F) over land and between 0.5-5.0° C (0.9-9.0° F) over the ocean in the winter (Anisimov 2001:813). A doubling of pre-industrial concentrations of carbon dioxide has been projected to result in a reduction of Antarctic sea ice volume of 25% or more, with sea ice retreating fairly evenly around the continent (Anisimov 2001; Gordon and O'Farrell 1997).

3. The Impact of Global Warming on Penguins

Several penguin species are already experiencing population declines and other adverse impacts from the warming and consequent ecosystem changes experienced to date from past greenhouse gas emissions. Because a doubling of the warming experienced to date is "in the pipeline," (Hansen et al. 2005), and because anthropogenic greenhouse gases are continuing to grow unabated, global warming must be considered one of the leading threats to the petitioned penguin species. Perhaps even more importantly, however, these penguin species, like many

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others, are intensely threatened by the cumulative and synergistic impact of global warming, fisheries, introduced predators, human disturbance, pollution, and other threats.

Long-term or drastic alterations to the marine environment may exceed the capability of penguins to adapt to changes in environmental conditions. Their large body size makes penguins dependent on oceanic areas of high productivity, typically around upwelling and convergence zones (Williams 1995). Thus, although penguins are adaptable to a changing environment, long-term deterioration or shifts in environmental conditions that favor penguins will cause a decline in populations and potentially extinction. In addition, the strong fidelity that penguins show to their breeding colonies and nest-sites also make them more vulnerable to the loss of favorable environmental conditions.

The fossil record indicates that penguins are a less diverse group today than they once were (Williams 1995). Many larger species died out during the Miocene Period (10-20 MYA) during which marked environmental changes occurred, with complex cycles of climatic warming and cooling. Those lineages that survived to modern times tended to be smaller and lighter, perhaps because larger penguins may have been especially dependent on areas of high marine productivity. The loss of many large penguin species during a time of climatic change might indicate that their demise was due to changing oceanic conditions, leading scientists to conclude that future climate change may also cause penguin extinctions (Williams 1995).

Global warming is threatening penguins through a variety of processes, including the impacts on the marine ecosystem, and in particular impacts on krill species, impacts on the El Niño Southern Oscillation (ENSO), and impacts to Antarctic ice shelves and sea-ice extent. Each of these complex phenomena is discussed below.

a. Effects on the Marine Ecosystem

The Southern Ocean is one of the last refuges for marine megafauna, but it is now threatened not only by continued exploitation, but also by the effects of global warming on the sea-ice environment (Smetacek and Nicol 2005). As discussed above, the Southern Ocean appears to be warming more rapidly than the global average, with a temperature increase of approximately 0.17° C (0.3° F) observed between the 1950s and 1980s (Gille 2002; Chapin III 2005). A warming Southern Ocean has broader implications as the water that is ventilated in the region around Antarctica spreads gradually around the globe. Impacts on the marine ecosystem are manifested through a variety of processes.

First, rising global temperatures are reducing the sea-ice extent surrounding some areas of the Antarctic continent, particularly in the region of the Antarctic Peninsula (Ainley 2002). In turn, this reduction is affecting the base of the food chain, phytoplankton and krill (Atkinson et al. 2004). The increase of air temperature, decrease of sea-ice and subsequent reduced productivity has been affecting penguin populations over the past half century (Barbraud and Weimerskirch 2001; Wilson et al. 2001; Croxall et al. 2002). Some penguin species and populations fare better than others as result of reduced sea-ice. Adélie Penguins are decreasing

in the Antarctic Peninsula area and increasing in East Antarctica and the Ross Sea area (Woehler et al. 2001; Croxall et al. 2002, Ainley 2002). Records of Emperor Penguin breeding in Adelie Land, show that the population there was stable from the 1950s to the mid-1970s, followed by a rapid decline in the late 1970s (Barbraud and Weimerskirch 2001). All of these changes have been correlated with changes in global and regional temperature and sea-ice extent.

Second, even in areas outside of the Antarctic sea-ice region, global warming is causing reduced productivity in prey species while also causing prey to move further from shore, where penguins mainly forage. Increasing water and air temperatures drive prey species further away from land and into deeper water (Ainley et al. 2005). In addition, changes in water temperature can cause ocean currents to stall or change course with catastrophic impacts to marine organisms, particularly top predators like penguins. On Marion Island, for example, there have been long-term decreases in the breeding populations of three penguins: Gentoo Penguin (*Pygoscelis papua*), Eastern Rockhopper Penguin (*Eudyptes chrysocome filholi*) and Macaroni Penguin (*Eudyptes chrysolophus*) (Crawford et al. 2003a, 2003b). All three species feed relatively close to the island and therefore are sensitive to changes in prey availability. Sea surface temperature at Marion Island increased by 1.4º C (2.5° F) between 1949 and 1998, and mean surface air temperature increased by 1.2º C (2.15° F) between 1949 and 1999 (Smith 2002). During the period 1994/95-2002/03, reproductive success for all three species was inadequate to maintain their populations and there was a low mass at fledging of Rockhopper Penguin chicks. Clearly, the affect of warming has been to reduce the prey to the point that penguins are starving to death. This pattern has been seen throughout the Southern Hemisphere and has affected all species of penguin (Cunningham and Moors 1994; Vargas et al. 2006; Whittington et al. 2000, Araya et al. 2000)

Several studies have documented the sensitivity of penguin populations to small-scale changes in sea temperature. The breeding population of Rockhopper Penguins at Campbell Island was approximately 1.7 million in the 1940s and decreased to around 105,000 by the 1990s, a decline of 94 percent (Williams 1995). The most rapid decline occurred during the 1950s, a period of increased sea temperature in the area around Campbell Island, and these warmer seas have been identified as the principle cause for the population decline. In a study of range wide Rockhopper Penguin populations, Hilton et al. (2006) shows that penguins are especially sensitive to climate changes that affect the marine environment and prey abundance. Increases in Chinstrap Penguin populations along the Antarctic Peninsula during the last four decades have been attributed to a gradual warming that has decreased the extent of winter sea-ice cover (Fraser et al. 1992). Conversely, further south in the Ross Sea area of the Antarctic Continent, increases in sea-ice are thought to be the cause of increases in Adélie Penguin populations over the last 10-20 years (Taylor et al. 1990). Local effects of climate change, as indicated by local changes in temperature, precipitation or other weather factors have also been implicated in changes in penguin populations. The Emperor Penguin colony at Point Geologie, Adélie Land decreased from 6,000 to 3,000 pairs over a ten year period during which the Astrolabe Glacier retreated, exposing the breeding colony to more persistent inclement weather (Croxall 1987).

Barbraud and Weimerskirch (2006) reported that over a 55-year period for the entire community of Antarctic seabirds in East Antarctica, species now arrive at their colonies 9.1 days later, on average, and lay eggs an average of 2.1 days later than in the early 1950s. The tendency toward later arrival and breeding are unexpected, and completely opposite to trends observed in the northern hemisphere. Furthermore, these delays are linked to a decrease in sea ice extent that has occurred in eastern Antarctica over the last several decades. This is contrasted with effects on similar trophic levels in the northern hemisphere and the Arctic where breeding now commences earlier.

Jenouvrier et al. (2005a) examined long-term data of populations and breeding success of three Antarctic seabirds (Southern Fulmar, Snow Petrel, Emperor Penguin) of colonies breeding in Terre Adelie. The study was designed to measure the effects of climate fluctuations on Antarctic marine ecosystems by using upper level predators as indicators. Over the past 40 years, populations and demographic parameters of the three species fluctuate with a periodicity of 3-5 years, coinciding with detected changes in Antarctic and sub-Antarctic sea-ice extent and the Southern Oscillation Index (Jenouvrier et al. 2005a). The authors detected an important change of correlation occurring between the end of the 1970s and the beginning of the 1980s. These results suggest that a regime shift has probably occurred during this period, significantly affecting the Antarctic ecosystem (Jenouvrier et al. 2005a).

Recently reported declines in other vertebrate marine predators in the sub-Antarctic support the idea of a general decrease in carrying capacity that would be consistent with a decrease in primary productivity. At Campbell Island, there has been an unexplained decline in the Grey-headed Albatross (*Thalassarche chrysostoma*) population of 82–88% between the 1940s and the 1990s, and concurrent with Rockhopper Penguin declines of 90% (Cunningham and Moors 1994). Additionally, southern elephant seal (*Mirounga leonina*) numbers at Campbell Island declined by approximately 97% between the 1940s and 1980s (Taylor and Taylor 1989). Similarly, populations of several seabird species and southern elephant seal have decreased at all Indian Ocean islands (Marion, Kerguelen, Macquarie and Amsterdam islands) since the 1960s (Weimerskirch et al. 2003). Similarly, at South Georgia, the world's largest population of the closely related Macaroni Penguin (*Eudyptes chrysolophus*), which tends to replace the Rockhopper Penguin south of the Antarctic Polar Front, is thought to have decreased from approximately 5.4 to 2.7 million pairs between the mid-1970s and mid-1990s (Trathan et al. 1998).

There is evidence of declining chlorophyll and zooplankton concentrations from the southern Indian Ocean since the 1970s, which suggests a drop in primary productivity (Hunt et al. 2001). This, coupled with the simultaneous decline of seabird and seal populations, led Weimerskirch et al. (2003) to suggest that a system shift has taken place in the southern Indian Ocean.

b. Effects on Krill

Antarctic krill (*Euphausia superba*) is central in the Antarctic food chain. The different components of the Antarctic marine ecosystem are made up of predators that rely, directly or indirectly, upon the health of the krill populations. Antarctic krill has a circumpolar distribution and has been very abundant in the Southern Ocean. Areas of highest krill concentration are often close to the land-based breeding colonies of krill-eating birds and seals (Alonzo et al. 2003). These predators depend on krill being within reach of their colonies in order to feed and rear their offspring during the Antarctic summer. For example, there are clear links between krill abundance and the reproduction and survival of penguins in Antarctica (Alonzo et al. 2003). Having a limited foraging range and foraging depth, penguins and other seabirds are particularly sensitive to changes in abundance of their prey (Crawford 1987).

In the Southern Ocean, seabirds are long-lived, upper-trophic-level predators that integrate environmental variability over large spatial and temporal scales (Smith et al. 1999). Sea surface temperature and sea ice extent have been shown to affect the population dynamics of seabirds through effects on demographic traits such as productivity and adult survival (Barbraud and Weimerskirch 2001, Ainley 2002). Several authors have emphasized the important role of krill in the Antarctic food web in explaining the link between sea ice and the population dynamics of top predators (Tynan 1998, Nicol et al. 2000, Croxall et al. 2002), particularly seabirds (Fraser et al. 1992, Smith et al. 1999, Barbraud et al. 2000, Barbraud and Weimerskirch 2001). The proposed mechanism is an effect of sea surface temperature and sea ice anomalies on food availability. For example, reduced sea ice extent and warm sea surface temperature negatively affect the abundance of krill (Pakhomov and McQuaid 1996, Loeb et al. 1997, Brierley et al. 2002) and, as a consequence, the demographic parameters of krill predators. These environmental variables have contrasting effects on populations and species: a decrease in sea ice extent may have a positive impact on some species and a negative impact on others (Croxall et al. 2002).

Global warming is affecting the ocean currents in the Antarctic and the changes in the physical environment of the Southern Ocean affects features that are known to be critical to the life history of krill: sea-ice extent and concentration, water temperatures, and circulation patterns (Atkinson et al. 2004; Hofman and Murphy 2004). The combined effects of all these changes on the circumpolar population of krill are difficult to predict (Smetacek and Nicol 2005), but changes in distribution and abundance of krill have been observed (Atkinson et al. 2004). Overall, researchers predict that global warming will reduce krill populations.

Antarctic krill and salps (mainly *Salpa thompsoni*) are major grazers of plankton in the Southern Ocean. Atkinson et al. 2004 examined spatial and temporal changes over larger scales by combining all available scientific net sampling data from 1926 to 2003. This analysis showed that the productive southwest Atlantic sector contains more than 50% of Southern Ocean krill stocks, but that their density has declined since the 1970s (Atkinson et al. 2004). Spatially summer krill density correlates positively with chlorophyll concentrations and temporally, summer krill densities correlate positively with sea-ice extent the previous winter (Atkinson et al. 2004). Summer food and the extent of winter sea ice are thus key factors in the high krill densities observed in the southwest Atlantic Ocean (Loeb et al. 1997; Atkinson et al. 2004).

Krill need the summer phytoplankton blooms of this sector, where winters of extensive sea ice mean plentiful winter food from ice algae, promoting larval recruitment and replenishing the stock. Salps, by contrast, occupy the extensive lower-productivity regions of the Southern Ocean and tolerate warmer water than krill. As krill densities decreased last century, salps appear to have increased in the southern part of their range (Atkinson et al. 2004). These changes have had profound effects within the Southern Ocean food web. If salps become the more dominant grazer of plankton in the Southern Oceans as a result of global warming, krill stocks will be drastically reduced. Under this scenario, krill will no longer be able to support penguin populations, and the Southern Ocean will lose many top predator species.

Continued anthropogenic greenhouse emissions pose a major threat to penguin populations as mediated by impacts on krill species. As summarized by Chapin III (2005:728):

> This tight but complex linkage of krill population dynamics to sea ice suggests that any future changes in timing, duration, or extent of sea ice will strongly affect the community composition of phytoplankton, krill, and their predators. Because advection of biological material is important in maintaining Southern Ocean ecosystems, the potential impacts of regional changes may extend well to the north of the main sea-ice-covered regions.

As detailed in the Emperor Penguin species account, declines in krill have already manifested themselves in declines in penguin numbers. If current krill-decline trends continue, effects on the Emperor and other species of penguin will be catastrophic.

c. Calving and Collapse of Antarctic Ice Shelves

An ice shelf is a thick slab of ice fed by glacier flow that attaches to land along a coastline, and floats on the ocean (NSIDC 2006). The ice shelves fringing Antarctica range in thickness from about 100 to 600 meters, and some shelves last for thousands of years or longer (NSIDC 2006). Because they are exposed to both warming air above and warming ocean below, ice shelves respond more quickly than ice sheets or glaciers to rising temperatures (NSIDC 2006). The rapid warming of the western Antarctic Peninsula has resulted in the retreat of seven major ice shelves during the past 50 years (Clarke and Harris 2002), totaling approximately 13,500 km^2 (NSIDC 2006). Ice shelves that have been lost include the Wordie Ice Shelf, Müller Ice Shelf, George VI Ice Shelf, and Wilkins Ice Shelf on the west coast, and the Prince Gustav Ice Shelf, and Larsen Inlet Ice Shelf, and northern part of the Larsen Ice Shelf, on the east coast (Anisimov 2001).

Ice sheets retreat via two different processes: calving and collapse (NSIDC 2006). Calving of huge, tabular icebergs is a natural process unique to Antarctica, and the process can take a decade or longer (NSIDC 2006). Calving can take the form of a large crack along the ice shelf edge that resembles a loose tooth (NSIDC 2006). The icebergs often drift around the continent, and as long as they remain in cold water, they can survive a long time (NSIDC 2006). If they drift northward into warmer waters, however, the icebergs melt and break apart (NSIDC

2006). Ice sheet calving is a natural event that occurs under a wide range of climatic conditions, so the calving of major icebergs is not necessarily an indicator of global warming (NSIDC 2006).

Ice shelf collapse via disintegration, on the other hand, is a new phenomenon that scientists believe is driven by global warming (NSIDC 2006). Scientists believe that the collapse is governed by processes explained by the "Melt Pond Theory," which posits that warm summer temperatures and an impermeable surface that prevents water from being absorbed lead to melt ponds on the shelf (NSIDC 2006). This meltwater can later fill small surface cracks, and depending on the amount of water and the depth of a crack, the water can deepen the crack and eventually wedge through the ice shelf (NSIDC 2006). The formation of melt ponds depends most upon summer temperatures, and will require a series of warm summers for permeable snow to be transformed into impermeable ice, allowing melt ponds to form during subsequent warm summers (NSIDC 2006). Glaciers can also respond to summer warming (NSIDC 2006). Even when the temperature of interior glacial ice remains below freezing, meltwater can percolate through the glacier to its base and decrease friction between the glacial ice and the underlying rock (NSIDC 2006). This is a seasonal phenomenon, and with a stable ice shelf in place, glacier acceleration ends with the warm summer temperatures (NSIDC 2006).

When an ice shelf shatters, however, the ice shelf's ability to support the glacier is reduced, and as a result, glacier flows can greatly accelerate (NSIDC 2006). In the 18 months following the Larsen Ice Shelf disintegration, glaciers feeding that ice shelf accelerated between three- to eight-fold (NSIDC 2006).

Over the past several decades as the Antarctic Peninsula has warmed, the northernmost ice shelves on the peninsula have retreated dramatically (NSIDC 2006). Since 1974, seven ice shelves have retreated by a total of approximately 13,500 square kilometers (NSIDC 2006). The most pronounced ice shelf retreat has occurred on the Larsen Ice Shelf, located on the eastern side of the Antarctic Peninsula's northern tip (NSIDC 2006). The shelf is divided into three regions from north to south: A, B, and C.

In January 1995, two events took place on the Larsen ice shelf: the calving of a 70- by 25-kilometer iceberg from the Larsen B; and the disintegration of the remainder of the Larsen A, which began retreating in the 1980s (NSIDC 2006). The breakup pattern in the Larsen A, in which 2,000 square kilometers disintegrated into small icebergs, was at that time an unprecedented observation. In 2002, the disintegration of an even larger area took place (NSIDC 2006). Between 31 January and 5 March 2002, approximately 3,250 square kilometers of the Larsen B shattered, releasing 720 billion tons of ice into the Weddell Sea, the largest single disintegration event in 30 years of ice shelf monitoring (NSIDC 2006). Preliminary studies of sediment cores suggest that it may have been this ice shelf's first collapse in 12,000 years (NSIDC 2006).

Rignot et al. (2005) provide further observation and conclusions from a study of satellite radar data from 1995 to 2004 and airborne ice thickness data from 2002. This study reveals that the glaciers flowing into the former Wordie Ice Shelf, West Antarctic Peninsula, discharge 6.8 ±

0.3 km^3/yr of ice, which is 84% ± 30% larger than a snow accumulation of 3.7 ± 0.8 km^3/yr over a 6,300 km^2 drainage basin (Rignot et al. 2005). Airborne and ICES laser altimetry elevation data reveal glacier thinning at rates up to 2 m/yr. Fifty km from its ice front, Fleming Glacier flows 50 percent faster than it did in 1974 prior to the main collapse of Wordie Ice Shelf (Rignot et al. 2005). Rignot et al. (2005) conclude that the glaciers accelerated following ice shelf removal, and have been thinning and losing mass to the ocean over the last decade. This and other observations suggest that the mass loss from the northern part of the Peninsula is substantial (Rignot et al. 2005).

While scientists cannot predict with certainty the impact of this unprecedented ice sheet collapse on the marine ecosystem and penguins, a recent study of iceberg calving strongly suggests that it may reduce marine productivity and severely and negatively impact penguin populations. Arrigo et al. (2002) studied the impact of the large, 10,000 square kilometer, B-15 iceberg, which calved off the Ross Ice Shelf in March, 2000. Nine months after calving, the pieces of B-15 were still in the southwestern Ross Sea, forming a barrier that greatly restricted the typical northwest drift of the pack ice (Arrigo et al. 2002). As a result, the entire Ross sea experienced unusually heavy ice conditions during 2000-2001 (Arrigo et al. 2002). The extensive geographic and temporal ice cover reduced both the area suitable for phytoplankton growth and the length of the algal growing season (Arrigo et al. 2002). As a result, primary productivity throughout the region was more than 40% below normal, with more locally severe impacts in areas of particularly heavy ice cover (Arrigo et al. 2002). Arrigo et al. (2002:8-3) stated "[m]odification of the temporal bloom dynamics and primary production caused by B-15 on such a large scale is almost certain to impact the entire pelagic ecosystem of the Ross Sea." Emperor and Adélie penguin reproduction is timed such that the chicks fledge in early summer, during the time of maximum food availability (Arrigo et al. 2002). These species may be particularly vulnerable, therefore, to changes in the timing of food availability, in addition to reductions in overall productivity (Arrigo et al. 2002). Adélie penguin diet did indeed appear to be altered after the calving of the B-15 (Arrigo et al. 2002). Emperor and Adélie penguins were further impacted by the calving of B-15, because a large piece of the iceberg blocked the entrance to Cape Crozier and the breeding grounds of these species (Arrigo et al. 2002).

Global warming, therefore, will likely continue to adversely impact penguin species, particularly the Emperor, via increased calving and collapse of the Antarctic ice sheets.

d. El Niño Southern Oscillation (ENSO)

Penguins may be severely impacted by the El Niño Southern Oscillation (ENSO), which can produce changes in much of the near shore and offshore marine communities, including a reduction in upwelling of cold, nutrient-rich waters. When this upwelling is reduced, overall productivity and seabird prey decline. As a result, many seabirds forgo reproduction, leave the area, and/or die of starvation. During past severe ENSO events, tens of thousands of seabirds have died, and some populations do not recover for decades (Tovar and Cabrera 1995). During the 1982 ENSO event, the populations of seabirds along the Peruvian coast was estimated to

have declined from about 6 million birds in March 1982 to 300,000 birds in May 1983 (Williams 1995).

Penguins are likely to be affected to a greater degree than most seabirds by changes in ocean currents because of their large body size, inability to forage over large distances quickly and their dependence on areas of high productivity (Williams 1995). Vargas et al. (2006) examined the impacts of ENSO activity from 1965 to 2004 on the Galápagos penguin. The two strong ENSO events of 1982–1983 and 1997–1998 were followed by crashes of 77% and 65% of the penguin population, respectively (Vargas et al. 2006). The 2004 penguin population is estimated to be at less than 50% of that prior to the strong 1982–1983 ENSO event (Vargas et al. 2006). Vargas et al. (2006) conclude that strong ENSO years cause Galápagos penguin crashes, likely through starvation, and that weak ENSO years impede recovery.

The Humboldt Penguin has also been reduced significantly in both distribution and abundance due to the effects of ENSO events (Paredes et al. 2003, Ellis et al. 1998). As stated by the International Penguin Conservation Work Group (2006):

> The coastline along which the Humboldt penguin is found is particularly susceptible to the influences of El Niño Southern Oscillation (ENSO) events, which occasionally bring seasons of extreme food shortage. During such years, cool nutrient rich waters which normally flow northwards along the coast of Chile and Peru, become displaced by warmer nutrient poor waters flowing from the central Pacific. This loss of nutrients results in a slowing down of primary production by phytoplankton, which in turn affects the entire marine food chain. Being top predators within the marine ecosystem, penguins are amongst the worst affected species, and often face complete abandonment of breeding, and even possible starvation. The Humboldt Penguins are particularly dependent on the availability of fish, which are forced to move further offshore in search of cooler currents. Such events are often accompanied by severe weather patterns, which can bring heavy rain and flooding to areas that normally receive little or no rain. Under such conditions, Humboldt penguin breeding sites may be completely washed out, as happened along the coast of Peru and Chile during the ENSO of 1997/98.

ENSO years now appear to occur 2-7 times more frequently than they did 7,000-15,000 years ago, and this recent apparent increase in the frequency (and also severity) of ENSO events poses a threat to penguins (Vargas et al. 2006). The 1983 and 1998 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. 2006a).

While atmospheric science theory does not provide a clear answer on the effect of global warming on ENSO, most climate models yield either a tendency towards a more ENSO-like state or no clear change (Hansen et al. 2006a). Ravelo et al. (2004) 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. 2006a). Leading climate scientists believe that near-term global warming will lead to an increased likelihood of strong ENSO events (Hansen et al. 2006a).

Anthropogenic warming, therefore, also has the potential to harm penguins via increases in the intensity (and possibly in the frequency) of ENSO events. Regardless of the impact of anthropogenic greenhouse gas emission on their frequency and/or intensity, ENSO events are clearly a threat to penguin species. Of the petitioned species, the Humboldt Penguin is most directly threatened by ENSO events.

e. Sea Level Rise

In 2001 the IPCC projected that global sea level will likely rise between 10-90 cm in this century (Albritton et al. 2001). 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 Kanagaratnam 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 (Hansen 2006). The IPCC projection of 10-90 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. 2006a). 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. 2006b). The forcing from continued unabated greenhouse gas emissions in this century could yield sea level rise of more than 1 m or more and a dynamically changing ice sheet that is out of our control (Hansen et al. 2006b).

Even sea level rise in line with the past underestimate from the IPCC would still inundate substantial areas of the coast and have far-reaching consequences for many species of penguins. Yet 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). This would not only threaten the nesting and breeding habitat of nearly all penguin species, but could flood vast areas and displace millions of people, with horrifying consequences.

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 (2001). 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. 2006a,b). For these reasons, sea level rise must be considered a very important future threat to the petitioned penguin species.

4. 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 Wicket 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; Ruttimann 2006). The pH of the ocean is currently changing rapidly at a rate 100 times anything seen in hundreds of millennia, and may drop to 7.9 by the end of this century (Ruttimann 2006). If carbon dioxide emissions continue unabated, resulting changes in ocean acidity could exceed anything experienced in the past 300 million years (Caldeira & 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 also reduces the availability of calcium carbonate needed by marine life to build shells and skeletons (Ruttimann 2006). 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). Already the ocean surface layer has lost 10% of its carbonate compared to preindustrial levels (WBGU 2006). Continuing carbon dioxide emissions could result in calcification rates

decreasing by up to 60% by the end of this century (Ruttimann 2006). Acidic waters also dissolve existing protective carbonate skeletons and shells. Increased acidity may also harm larvae of sea organisms (Ruttimann 2006).

Because carbonate concentrations are highest in the tropics and lowest in the Southern Ocean, marine organisms in the Southern Ocean are the first to be threatened by ocean acidification, and in particular by the decreasing availability of aragonite, a type of carbonate. One of the most prominent components of Southern Ocean, a type of plankton called the pteropod, is unable to maintain shells in waters that lack aragonite (Orr et al. 2005). Scientists project that unabated carbon dioxide emissions and ocean acidification would begin to eliminate available aragonite in the Southern Ocean within the next 50 years (Orr et al. 2005). Within decades, then, these pteropods may be unable to grow their calcium carbonate exoskeletons (Orr et al. 2005). The aragonite-dependent pteropods form the basis of the diet for many other zooplankton and fish. Penguins, in turn, prey on krill, fish, squid and other marine organisms, all of which directly rely on plankton.

Pteropod populations are high in polar regions, but only a few species inhabit the highest latitudes (Orr et al. 2005). These species have only one or two generations per year and are vital to the polar food web (Orr et al. 2005). Pteropods in the Ross Sea are so important to the food chain that they are considered an indicator of the health of the ecosystem (Orr et al. 2005). Yet changes in seawater chemistry that will occur by the end of the century if carbon dioxide emissions are not greatly reduced may doom these organisms and threaten the diversity and abundance of marine life the polar regions (Orr et a. 2005). Penguins, near the top of the polar food chain, are at grave risk from this phenomenon if carbon dioxide emissions are not reduced.

Other planktonic organisms, coccolithophores and foraminiferans, also demonstrated decreased calcification when calcite, another carbonate, is unavailable (Feely et al. 2004). Increased carbon dioxide concentrations resulted in malformed shells of coccolithophorids (Riebesell et al. 2000). Coccolithophores reflect light and contribute to cloud formation over the oceans, and thus a decline in coccolithophores may cause the climate to warm even more quickly (Ruttimann 2006).

Severe impacts to penguins could begin from ocean acidification in as little as a few decades. By the close of this century, the acidification of the ocean will almost certainly have a significant impact on calcifying organisms and the species, such as penguins, that rely upon them, if greenhouse gas emissions are not abated (WBGU 2006).

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

As described in the individual species accounts, direct harvest still occurs for several penguin species, including the African, Humboldt, and Northern Rockhopper species.

Additionally, historic harvest severely depleted the Royal Penguin as well as local populations of numerous other species. Such harvest clearly constitutes "overutilization."

More recently, a different form of "overutilization" has arisen to threatened penguins—tourism. While well-managed tourism is likely compatible with all penguin species, current rates of growth call into question whether it is in fact well-managed.

Antarctic tourism is a rapidly growing industry. From 1958 until 1987, an average of fewer than 1000 tourists visited Antarctica each season (Enzenbacher 1992). Since then, the number of tourists has increased exponentially to reach over 26,000 in the 2006 season (IAATO 2006). This trend is likely to continue as much larger ships enter the market and tour operators continue to acquire more aircraft. So called "ecotourism" generally remains largely unregulated and can have negative consequences for native species (Jaffe 2006).

For example, at the penguin colony at Punta Tombo, Argentina tourism has increased from several dozen people per year in the 1960s to more than 50,000 per year in the 1990s (Boersma and Stokes 1995). These numbers are of particular concern because most visitors are concentrated in the small areas of critical penguin breeding habitat.

The use of helicopters is of particular concern for species that breed in remote areas and are not accustomed to disturbance. Harris (2005) examined the potential of aircraft operations to disturb penguins. The authors concluded that disturbance is likely to lead to impacts on the health, breeding performance and survival of individual birds, and perhaps bird colonies (Harris 2005). While guidelines for the operation of aircraft in Antarctica have been adopted, the interactions between aircraft and birds in Antarctica, and the consequent impacts on individual birds and on bird populations are still so poorly understood that aircraft should be considered a potential threat to penguins (Harris 2005). In addition, enforcing such guidelines on tour operators given the vast expanse of the Antarctic will likely prove difficult if not impossible.

C. Disease and Predation

1. Disease

As discussed in the individual species accounts, disease outbreaks have been linked to penguin die-offs for several species, including for the highly endangered Yellow-eyed Penguin. The possible introduction of disease represents an ever-growing threat to all species of penguins, particularly when combined with a warming climate rendering penguin colonies more hospitable to disease and increasing human visitation to colonies.

Penguins originated in cool southern regions with their evolution coinciding with modern Southern Ocean circulation patterns (Fordyce and Jones 1990; Baker et al 2006). Therefore, as a group they were relatively isolated from exposure to the diversity of avian parasites at lower latitudes (Jones and Shellam 1999). As such they remain particularly vulnerable to any disease introduction.

Global warming may enable the range or density of invertebrate vectors of diseases to be increased (Epstein and Mills 2005). This may be particularly relevant where penguins breed on large land masses on which arthropod vectors occur at lower latitudes, and which with little climate amelioration could increase their range southwards without the necessity of crossing a sea barrier (Jones and Shellam 1999). Colonies of penguins which breed on the South American and African mainlands may be at particular risk in this respect. There is also the concomitant risk of their parasites' range increasing, since these organisms, like the parasites themselves, reproduce more rapidly at higher temperatures.

Increasing exposure of penguins to environmental pollutants may compromise their immune systems and make them more susceptible to disease (Luebke et al. 1997). Food availability may be reduced by El Niño Southern Oscillation events (Schreiber and Schreiber 1984), by more intense commercial fishing in their feeding grounds (Woehler 1995) or by global warming (Atkinson et al. 2004) and hence decrease resistance to disease.

Increasing disturbance of their breeding habitats, whether by tourists or by aircraft (Cooper et al. 1994), engenders stress which may increase susceptibility to disease if the pathogens are present. If a penguin has subpatent *Plasmodium* infection, stress is probably a potent factor in increasing parasitaemia and hence pathogenicity in penguins soon after capture (Brossy 1992). There is ample evidence of the effects of infection with *Plasmodium* spp. on captive penguins (Fix et al. 1988).

Relatively little is known about the prevalence of disease in penguins (Clarke and Kerry 1993). Antibodies for avian malaria have been detected in the blood of many penguin species (Graczyk et al. 1995b, Graczyk et al. 1995c). Antibodies for infectious bursal disease virus, a pathogen of domestic chickens, have been found in Adélie and Emperor Penguins in the Antarctic; the likely source of such pathogens was chicken imported to Antarctica for human consumption (Gardner et al. 1997).

Gottdenker et al. (2005) analyzed the potential spread of disease from poultry production on the inhabited islands of the Galápagos Archipelago, the home of the Galápagos Penguin. With increased poultry production there is an increased risk of disease transfer from chickens to native Galápagos bird species that may have little resistance to introduced pathogens (Wikelski et al. 2004). Pathogens identified in domestic chicken populations that are of immediate avian conservation concern are Newcastle disease, *Mycoplasma gallisepticum*, and the proventricular parasite *Dispharynx* spp.

The threat of disease transmission to penguins in more southerly ranges increases as global warming makes environmental conditions more suitable for vectors. In addition, the increase in human disturbance and exploration in areas inhabited by penguins makes the spread of deadly disease more likely.

The introduction of alien vertebrates and invertebrates may also introduce novel diseases or increase disease transmission rates. Ticks, fleas or lice from alien mammal, bird or invertebrate species can result in the spread of such diseases as avian malaria, Newcastle disease virus, and fowl pox virus (Williams 1995). These diseases have already affected some penguin populations (Morgan et al. 1985). Introduced rats increase the spread of ticks that can transmit *Pasteurella multocida*, a viral disease which can kill penguin adults and young (de Lisle et al. 1990). The continuing introduction of alien animals and plants as human activity increases in the Antarctic and the Southern Ocean will most certainly be damaging to penguin populations.

2. Introduced Predators

As detailed in the species accounts, with the exception of the Emperor Penguin, all the petitioned species face current or potential threats from non-native predators. Penguins breed primarily on remote islands and along expanses of desert and Antarctic coastline where there are relatively few natural predators. Predation by introduced species contributes to the decline of both mainland and island populations of many species (Dann 1992, Stahel and Gales 1987, Croxall 1987, Boersma 1976). Introduced mammalian predators decrease reproductive success and lower adult and juvenile survival (Ellis et al. 1998). In New Zealand, predation by stoats (*Mustela erminea*), ferrets (*M. putorius*), dogs and cats has contributed to the decline of the Yellow-eyed Penguin (Darby and Seddon 1990). Increased travel to and settlement in remote areas is increasing the threat of alien species introductions.

D. Other Natural and Anthropogenic Factors

1. Fisheries Interactions

Other than global warming, fisheries probably represent the greatest threat to penguins worldwide. Impacts range from the intentional, such as fishermen using African, Humboldt and Northern Rockhopper Penguins as bait, to the unintentional, but direct impact of species such as Yellow-eyed, White-flippered, and other species getting entangled and drowning in nets, to the less direct (but probably most significant) impact of intensive harvest of penguin prey such as sardines and anchoveta causing wholesale population crashes of Southern Rockhopper and other species of penguin. Each of these forms of impact is addressed, as appropriate, in the preceding separate species accounts. More general information about trends and causal mechanisms follows.

a. Direct Mortality from Fishing Operations

The recent and rapid increase in commercial fishing in the oceans of the Southern Hemisphere is the source of several threats to penguins. Increased mortality from capture in fishing nets is a growing problem (Boersma et al. 1990). Penguins often drown in set nets and are maimed or killed in seine nets (Majluf et al. 2002). Entanglement of penguins in trawl nets, especially in shrimp fisheries, is increasing (Gandini et al. 1999) and these and other inshore

feeding species are doubtless at risk in various other net and trawl fisheries (Croxall and Wood 2002).

b. *Competition for Limited Marine Resources*

Commercial fisheries have changed and continue to change the structure of marine communities through over-harvest of selected species (Crawford 1987). These changes have been observed in the significant declines of penguin populations along the coasts of Peru and western South Africa in the last twenty years (Ellis et al. 1998). These penguin populations appear unlikely to recover because the changes in the structure of the marine communities do not appear to be readily reversible (Boersma and Stokes 1995).

Competition with commercial fisheries is a problem likely to exacerbate in the future, particularly as the fishing industry harvests smaller fish (Boersma and Stokes 1995). Competitive interactions between seabirds and commercial fisheries have been documented in many of the world's oceans (Schaefer 1970, Crawford and Shelton 1978, Crawford and Shelton 1981, Furness 1984, Croxall and Lishman 1987), and potential competition with commercial fisheries has been identified as a problem for many penguin species (Burger and Cooper 1984, Boersma et al. 1990, Norman et al. 1992).

Changes in prey abundance in prey abundance attributable to commercial fishing are mainly local but competition for remaining prey species is likely to become increasingly important and widespread (Boersma and Stokes 1995). Humans currently use more than 40% of all the net terrestrial primary productivity (Vitousek et al. 1986). As humans harvest more fish, exploit new species of marine life, and discard more by-catch and offal into the ocean, humans affect seabird population composition and abundance (Boersma and Stokes 1995). Human use of marine habitats is likely to have an increasingly harmful effect on penguins over time (Ellis et al. 1998).

The Antarctic krill fishery has been the largest fishery in the CCAMLR area since the late 1970s (Croxall and Nicol 2004). In most recent years, almost all krill fishing vessels have been operating in coastal areas of the South West Atlantic region, where the catch rate has historically been higher. This fishery is the largest crustacean fishery in the world and, if fully exploited, it has prospects for becoming the largest global fishery (Nicol & Endo 1997). There is potential for a rapid expansion of the fishery in future years, as krill-processing technology develops and demand for krill products increases. This raises concerns about the future of the vulnerable and still little understood Antarctic marine ecosystem.

Krill harvest is poised to become the latest chapter in the history of serial over-exploitation of marine species in the Southern Ocean. This pattern has included seals in the 19th century, the great whales in the middle of the 20th century, the marbled rockcod (*Notothenia rosii*) in the early 1970s and, most recently, some populations of Patagonian toothfish (*Dissostichus eleginoides*).

Globally, humans impact environments and ecosystems faster than they become aware of their effects (Verity et al. 2002). Humans have proven capable of assuming the role of top carnivore in pelagic ecosystems where living resources are attractive and financially amenable to exploitation, and that overexploitation is the rule under such circumstances (Verity et al. 2002). Other anthropogenic activities associated with changes in various marine pelagic ecosystems, such as increased diseases, mortalities, extinctions, habitat invasions, and species replacements, function as sentinels and indicate that portions of the pelagic ecosystem are under considerable stress, and these problems can be expected to worsen up to the year 2025 and beyond (Verity et al. 2002).

The history of exploitation, management and protection of Antarctic marine organisms differs little from marine systems elsewhere. The successional stages of prospecting, exploitation, over-exploitation, reactive management, precautionary management are evidenced by the harvesting of seals, whales, fin fish and krill in the Southern Ocean (Croxall and Nicol 2004). Southern Ocean fishery management systems remain vulnerable to rapid shifts in worldwide fishery economics that could result in the over-exploitation of critical penguin prey species (Croxall and Nicol 2004).

Worm et al. (2006) document the consequences of the historical and ongoing erosion of marine biodiversity that is accelerating on a global scale. This trend is of serious concern. Based on the projections of human exploitation of marine species, Worm et al. (2006) project the global collapse of all taxa currently fished by the mid–21st century. Furthermore, the elimination of locally adapted populations and species not only impairs the ability of marine ecosystems to support top predators and human fisheries but also sabotages the stability and recovery potential of marine ecosystems in a rapidly changing marine environment. The impacts of global warming to marine systems will likely compound the damage.

Although krill catches in the Southern Ocean are currently well below catch limits set by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), there is a risk of localized, excessive fishing effort that might impact on species that depend on krill for food, particularly during the breeding season. Considerable overlap exists between the krill fishery and breeding areas for penguins and seals in the South Atlantic Ocean (Constable and Nicol 2002). According to the information currently available, the Antarctic krill fishery occurs almost entirely within the foraging ranges of land-based krill predators such as penguins and seals (Constable and Nicol 2002).

The impact of high krill catches taken in a small area, close to land-based predator colonies, also needs to be considered in relation to breeding times. Concentrated fishing may have its maximum impact on predator breeding success, when fishing takes place on the immediate foraging area and at the critical breeding time. For example, in the Antarctic Peninsula, the summer fishery takes place at the same time and in the same areas where penguins and seals are foraging to rear their young.

Furthermore, projected increases in krill harvesting could result in the krill fishery becoming a globally important supplier of aquaculture meal, which in turn could have significant ecological impacts if not managed carefully (Atkinson et al. 2004).

There are strong indications that interest in the Antarctic krill fishery is rapidly increasing, as the market for krill products expands. The perceived massive abundance of krill stocks in the Southern Ocean and increasing restrictions on access to krill fisheries in the Northern Hemisphere are elements that may intensify pressure on Southern Ocean krill stocks in the short term (Nicol & Foster 2003).

Finally, as discussed elsewhere in this Petition, krill stocks in substantial portions of the Southern Ocean have declined by as much as 80% (Atkinson et al. 2004). When an expanded fishery is superimposed on top of this climate-related decline in krill abundance, krill harvest may accelerate the decline of already imperiled penguin species.

2. Marine Pollution

a. Oil Pollution

As the species accounts demonstrate, particularly for the African Penguin, oil spills and oil pollution can have population-level effects of penguins. Oil is toxic to penguins when ingested and it also clogs their feathers, destroying the insulating and waterproofing properties. Oiled penguins swam at slower speeds and had increased heart rates and metabolic rates compared with un-oiled penguins (Culik et al. 1991). Oiled penguins taken into captivity may be more susceptible to disease (Graczyk et al. 1995a, Carrasco et al. 2001).

Oil pollution from chronic tanker discharge and accidental spills is a cause of mortality for nearly all temperate penguin species and has been implicated in the decline of African Penguins (Crawford et al. 1995a) as well as the annual death of 40,000 Magellanic Penguins along the southern coast of Argentina (Gandini et al. 1994). The toxic effects of oil are also responsible for the deaths of Little Penguins (Harrigan 1992), with a single oil spill in northern Tasmania resulting in 10,000 – 20,000 estimated mortalities (Goldsworthy 2000). Even penguins in the Antarctic are vulnerable to oil spills (Reid 1995). As oil is developed in more remote locations and transported greater distances, penguins will be at greater risk (Boersma and Stokes 1995).

The 1989 oil spill from the tourist boat *Bahia Paraiso* in Antarctica demonstrated that remoteness is becoming less effective in protecting the penguins' marine environment from humans (Ellis et al. 1998).

b. Chemical Contaminants

Many chemical by-products of human activities such as pesticides, heavy metals and plastics eventually reach the ocean and result in harm to penguins (Ellis et al. 1998, Frost et al.

1976, Berruti et al. 1989). Since penguins are typically high on the food chain, materials that tend to bio-accumulate (e.g. lead, mercury, pesticides) are especially problematic as the marine environment becomes increasingly polluted (Ellis et al. 1998).

Chiuchiolo et al. (2004) measured various organochlorine pesticides and brominated diphenyl ethers (BDE-47, -99, and -100) in sea-ice algae, water column plankton, and juvenile and adult krill collected in the Palmer Long-Term Ecological Research (LTER) region west of the Antarctic Peninsula during late austral winter and midsummer, 2001-2002. BDEs were 100-1000 times higher in ice algae and 2-10 times higher in phytoplankton than the most abundant organochlorine pesticide, hexachlorobenzene (HCB), reflecting the current production and use of BDEs versus organochlorine pesticides (Chiuchiolo et al. 2004). The high concentrations of BDEs and HCB in ice algae and associated juvenile krill illustrate that sea ice is a vector for entry of POPs into the Antarctic marine ecosystem (Chiuchiolo et al. 2004). Once these contaminants enter the food chain, they accumulate in prey species and eventually concentrate in top predators like penguins. Goerke et al. (2004) analyzed representatives of the Antarctic food web (krill, cephalopod, fish, penguin, and seal) of the area around Elephant Island and from the Weddell Sea for the most recalcitrant organochlorine compounds, and found biomagnification of these pollutants in penguins and seals (Goerke et al. 2004).

c. Marine Debris

Production of plastics in the U.S. increased from 3 million tons in 1960 to nearly 48 million tons in 1995, reflecting a larger worldwide trend. (Tickell 2000). Floating plastic on all oceans has increased accordingly, including raw plastic, and the fragmented, weathered remains of manufactured items like bottles, disposable cigarette lighters, toothbrushes, and children's toys. Such plastic pollution can have lethal and sublethal effects on penguins. While ingestion of plastic is well-documented as a significant problem and source of mortality for albatross (Tickell 2000) it has also been documented for penguins (Laist 1997). Likely more significant however, is the problem of marine entanglement. At least six species of penguins have been documented as entangled in plastic, including six-pack rings and fishing line (Laist 1997). The amount of floating and beachcast plastic debris in the Southern Ocean has increased dramatically in recent year (Tickell 2000). As such, the threat to penguins has grown concomitantly.

E. The Inadequacy of Existing Regulatory Mechanisms

Existing regulatory mechanisms are inadequate to ensure the continued existence of the petitioned penguin species. The primary evidence of the inadequacy of these mechanisms, is that most of the penguin species either have experience or are experiencing significant population declines. This section reviews regulatory mechanisms directed at the protection of birds and Antarctic resources, as well as regulatory mechanism directed at the control of anthropogenic greenhouse gas emissions.

1. Regulatory Mechanisms for the Protection of Birds and Antarctic Resources Provide Inadequate Protection to the Petitioned Species

a. Migratory Bird Treaty Act of 1918

The Migratory Bird Treaty Act ("MBTA") of 1918 fails to protect penguins. First, no penguins are on the current list of species covered by the act. See 71 Fed. Reg. 50194. Second, the National Marine Fisheries Service currently takes the position that the MBTA does not apply beyond the territorial sea of the U.S. Currently, U.S. flagged krill harvesting vessels operate within the forage range of several of the petitioned species. Listing the species in this petition under the ESA is necessary to reduce the threats these vessels pose.

b. Antarctic Treaty

Human activities in Antarctica are governed by the Antarctic Treaty of 1959 and closely associated agreements, known collectively as the Antarctic Treaty System. While the treaty may be effective at what it sets out to do, it does not apparently directly address climate change, the primary threats to the only petitioned species fully associated with Antarctica, the Emperor Penguin.

c. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) came into being in 1980 and is the first international body to adopt an ecosystem approach to management. The goals of the CCAMLR are to conserve Antarctic marine living resources by taking an ecosystem approach to management and exploitation. CCAMLR sets the harvest levels for all commercially important fisheries in the Antarctic Treaty Area. In particular, CCAMLR places catch limits on penguin prey species, including krill.

While CCAMLR is more precautionary than most Regional Fishery Management Organizations ("RFMOs"), current management of krill is likely not at the spatial and temporal scale necessary to protect essential penguin foraging areas (Marris 2004). Additionally, the current CCAMLR quota setting system fails to take into account the effects of climate change on krill stocks (Marris 2004). Finally, even if CCAMLR adequately managed krill harvest, it can do nothing to address the climate-related declines of krill that are underway.

d. U.S. Legislation Specific to Antarctica

The primary U.S. statute relevant to penguin conservation in Antarctica and the Southern Ocean is the Antarctic Marine Living Resources Convention Act of 1984 ("AMLRCA")(16 U.S.C.§ 2431 et seq.). The U.S. implements its CCAMLR treaty obligations through AMLRCA. Under AMLRCA, it is unlawful for any person subject to United States jurisdiction to "engage in harvesting or other associated activities in violation of the provisions of the Convention or in

violation of a conservation measure in force with respect to the United States pursuant to article IX of the Convention" or to "to violate any regulation promulgated under [AMLRCA]. 16 U.S.C.§ 2435(1) & (2). Under the regulations implementing AMLRCA, "every vessel subject to the jurisdiction of the United States that attempts to reduce or reduces any AMLR [Antarctic Marine Living Resource] to possession must have a harvesting permit authorizing the attempt or reduction." 50 C.F.R. § 300.112. Unfortunately, to date, the National Marine Fisheries Service, the federal agency changed with implementing AMLRCA, has issued krill harvesting permits to U.S. flagged vessels to operate in the CCAMLR area, without conducting any environmental review of the potential impacts of the harvest on krill and the penguin and other species dependant upon krill.

The Antarctic Conservation Act of 1978, 16 U.S.C. §§ 2401-12 regulates U.S activities on the Antarctic continent. The 1978 Act directed the National Science Foundation (NSF) to perform the monitoring function of the United States and to ensure protection of the native flora and fauna and preservation of the ecosystem; and to develop and issue regulations to control pollution in the Antarctic.

The Antarctic Science, Tourism, and Conservation Act of 1996 (ASTCA), 16 U.S.C. §§ 2461-66, was passed to deal with the potential for environmental harm in Antarctica due to increased tourism and the effects of mineral exploitation on the Antarctic environment.

While these laws may help avoid direct effects to Emperor Penguin colonies, none of these laws address the primary threats to the species, global warming.

2. Regulatory Mechanisms for the Control of Anthropogenic Greenhouse Gas Emissions are Inadequate to Protect the Petitioned Species

Avoiding the many severe and adverse consequences discussed above to the petitioned penguin species from anthropogenic greenhouse gas emissions will almost certainly require limiting additional climate warming to 1.8° F (1° C) by limiting atmospheric carbon dioxide concentrations to 450-475 ppm. While equity and fairness demand that this stabilization target be reached through deep reductions from the developed nations of the world that have been responsible for the bulk of past emissions, it could be achieved by any one of a virtually unlimited number of possible emissions trajectories from the nations of the world. One thing is clear, however: achieving this target will be extraordinarily challenging and will not occur without additional regulatory mechanisms at the international and national levels.

An additional important and highly relevant conclusion in the literature is that "overshooting" the 450-475 ppm stabilization target (i.e., exceeding the target but compensating afterwards with greater emissions reductions), significantly increases the chances of experiencing additional warming and exceeding the 1° F threshold (Mastandrea and Schneider 2005; Meinhausen 2005). Even if the stabilization target is obtained, more rapid carbon dioxide concentrations early on will also increase the chances of additional warming (Mastandrea and Schneider 2005). Further delays in emissions reductions mean that steeper (and more

challenging) reductions will be required later (Doniger et al. 2006). All of this reinforces the point that we have already lost much from years of inaction, and that sharp reductions must begin immediately.

Most importantly, we now know that even just ten more years of continued emissions trajectories will render it difficult if not impossible to meet the 450-475 ppm stabilization target (Hansen 2006; Hansen et al. 2006a,b). As discussed below, existing regulatory mechanisms are horribly inadequate to ensure that society follows the recommendations of its top scientists. Existing regulatory mechanisms are, therefore, inadequate to ensure that the petitioned penguin species are protected from global warming and acidification of the oceans from anthropogenic greenhouse gas emissions. Tragically, even if other threats, such as unsustainable fisheries interactions, are eliminated, this success would still be meaningless if greenhouse gas emissions continue unabated.

a. The United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change ("UNFCCC") was adopted in May 1992 at the first Earth Summit held in Rio de Janeiro, Brazil, and entered into force in March 1994 (EIA 2004). The stated objective of the UNFCCC is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (EIA 2004). Due to the complexity of climate issues and the widely divergent political positions of the world's nation states, the UNFCCC itself was unable to set emissions targets or limitations, but instead created a framework that set the stage for a range of subsequent actions (UNFCCC 2004). The UNFCCC covers greenhouse gases not otherwise controlled by the Montreal Protocol on ozone-depleting substances (UNFCCC 2004).

The UNFCCC assigns differing responsibilities to its 189 parties, based on their differing levels of economic development (UNFCCC 2004). Annex I parties include 41 mostly developed countries. Annex I countries set a goal (but not a requirement) of returning their emissions by 2000 to 1990 levels (UNFCCC 2004). They are required to make regular reports on implementation, including reporting on levels of greenhouse gas emissions and policies and measures to reduce them (UNFCCC 2004). Annex II is a subset of Annex I countries which includes the 23 highly developed countries which are required to financially and otherwise support the efforts of the developing countries (UNFCCC 2004). Countries with economies in transition ("EITs") include 14 countries in Eastern and Central Europe and the former Soviet Union which are listed in Annex I but do not have the additional responsibilities of the other Annex I countries. Non-Annex I parties include all parties not included in one of the former categories, and are mostly developing countries (UNFCCC 2004). Non-Annex I parties have general commitments to respond to climate change but have fewer obligations and are expected to rely upon external support.

The UNFCCC has not effectively controlled greenhouse gas emissions. The year 2000 has come and gone without the UNFCCC's goal of reducing greenhouse gas emissions from

Annex I countries to 1990 levels being met. More than ten years after the UNFCCC came into force, "dangerous anthropogenic interference with the climate system" remains undefined by the UNFCCC (International Climate Change Taskforce 2005). There is a growing body of evidence, however, that anthropogenic greenhouse gas emissions have already caused "dangerous" climate change. See, e.g., Stott et al. (2004:613)("it is difficult to avoid the conclusion that potentially dangerous anthropogenic interference in the climate system is already underway"); Epstein and Mills (2005). Moreover, we have only ten years to reduce emissions trajectories and avoid a commitment to an amount of climate change that would be not only "dangerous," but truly catastrophic (Hansen 2006a,b).

The UNFCCC on its own simply does not provide for the mechanism for the enforceable emissions reductions commitments that are necessary.

b. The Kyoto Protocol

In 1997 the Kyoto Protocol became the first additional agreement added to the UNFCCC to set emissions targets. The Kyoto Protocol set goals for developed countries only to reduce their emissions to at least 5% below their 1990 levels (UNFCCC 2004). The Kyoto Protocol required ratification by a minimum of 55 countries, encompassing at least 55% of the carbon dioxide emissions of Annex I countries before it would enter into force. Over seven years passed before this occurred. The Kyoto Protocol entered into force on February 16, 2005, 90 days after it was ratified by Russia (UNFCCC 2005).

Despite its long-awaited ratification, the Kyoto Protocol is inadequate to prevent significant climate change, and the threat to the petitioned penguin species. First, the Protocol's overall emissions targets are highly unlikely to be met, due in large part to the refusal of the United States to ratify the agreement. Second, even if the Kyoto targets were met, they are far too modest to impact greenhouse gas concentrations and global warming sufficiently to ensure stabilization of carbon dioxide concentrations at below 475 ppm. Each of these issues is addressed in turn below.

The refusal of the United States to ratify the Kyoto Protocol, announced by the Bush Administration in 2001, is a major reason why Kyoto targets are unlikely to be met. Because the United States is responsible for approximately 24% of worldwide carbon dioxide emissions (EIA 2004), it is highly unlikely that overall targets can be met without US participation. The Kyoto target for the US was a 7% reduction in greenhouse gas emissions levels from 1990 levels by 2012 (EIA 2004). Between 1990 and 2001, United States emissions have in fact increased by 13%. Total United States emissions are projected to grow a staggering additional 43.5% through the period 2025 (GAO 2003a).

In addition to the outright intransigence of the United States, the overall and many country- specific Kyoto targets are unlikely to be met based on current progress and data. While some Annex I countries have achieved their Kyoto targets or at least some reductions, many other Annex I countries have seen their emissions increase substantially (Figure 26 (next page)).

Emissions also increased in many of the developing nations between 1990 and 2000 (UNFCCC 2004). In addition, although emissions of the EIT countries decreased significantly from 1990-2000 as a result of economic contraction in these countries, they increased from 2000 to 2001 and are projected to continue to do so (EIA 2004). Overall, the EIA estimates that worldwide carbon emissions in 2025 will exceed 1990 levels by 72% (EIA 2004).[4]

Figure 26: Changes in Greenhouse Gas Emissions by Annex I Countries, 1990-2001
Source: UNFCC (2004:25).
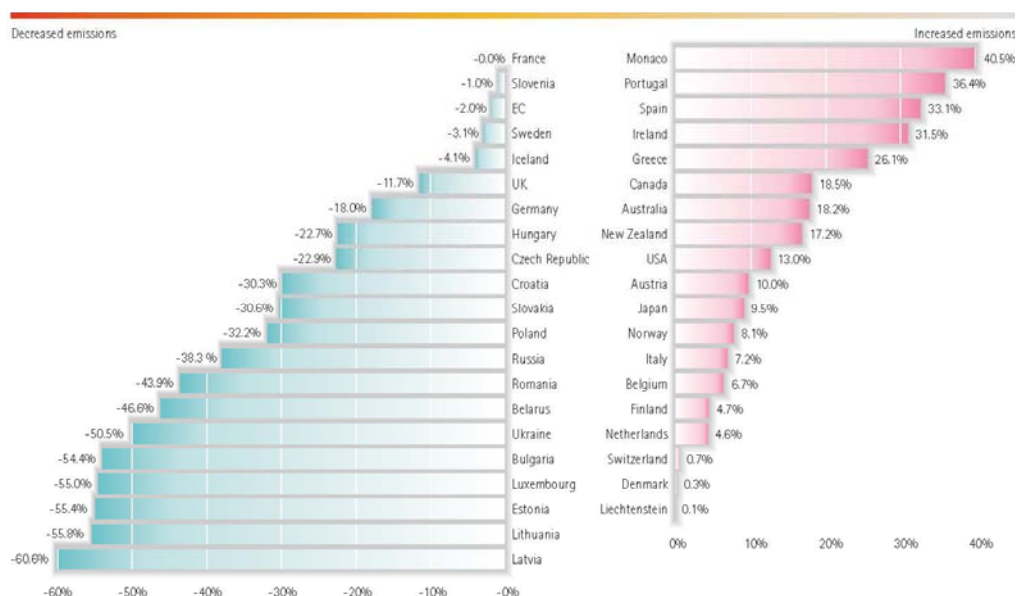
There are other problems with implementation of the Kyoto Protocol as well. For example, accurate, consistent, and internationally comparable information that is essential for sound policymaking is still lacking in many areas (UNFCCC 2004). Many countries have yet to build a sound institutional framework and a number have yet to even report on their institutional arrangements or have pointed out that their systems are weak (UNFCCC 2004). The Protocol will only succeed at meeting its modest goals if the parties fulfill their commitments, yet mechanisms for enforcement have not yet been tested and are likely ineffective. There are no financial penalties or automatic consequences for failing to meet Kyoto targets (UNFCCC 2004).

Even in the unlikely event that overall Kyoto targets were fully met by the year 2012, the reductions are far too small to ensure that carbon dioxide concentrations will not exceed 475 ppm. Implementation of the Kyoto Protocol would only slightly reduce the rate of growth of emissions – it would not stabilize them (Williams 2002). Carbon dioxide levels currently stand

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[4] EIA 2004 projections do not reflect the potential impacts of the Kyoto treaty, because it had not yet come into force when the projections were prepared (EIA 2004). Compliance with Kyoto or other measures to reduce greenhouse gases could cause actual emissions to differ from the projections (EIA 2004), however, as discussed above, compliance with overall Kyoto targets is unlikely.

at 380 ppm, from pre-industrial levels of 280 ppm, and are increasing at more than 2 ppm per year (International Climate Change Taskforce 2005; Black 2006). Stabilizing carbon dioxide concentrations below 475 ppm would require global emissions to drop below 1990 levels within a few decades, with emissions eventually declining to a very small fraction of current levels, despite growing populations and an expanding world economy. These cuts will not be achieved simply by compliance with Kyoto (Williams 2002). The IPCC SRES scenarios predict carbon dioxide concentrations of between 490 and 1260 ppm by 2100 (Albritton et 2001), and these scenarios all assume significant reductions in the rate of greenhouse gas emissions (Nakićenović et al. 2000).

Additionally, Kyoto only sets targets for action by 2012. There is no current regulatory mechanism governing greenhouse gas emissions in the years beyond 2012. Discussions for targets for the second compliance period from 2012-2016 have been blocked vigorously by the Bush Administration's negotiating team at every Conference of the Parties since 2003.

c. United States Climate Initiatives are Ineffective

Because the United States is responsible for approximately 24% of worldwide carbon dioxide emissions, regulation of United States greenhouse gas emissions is essential. Unfortunately, despite the nature and magnitude of the risks, and a variety of actions by Congress and the Executive Branch, there is still no regulation of greenhouse gas emissions on the national level in the United States.

Beginning in 1978, Congress established a "national climate program" to improve understanding of global climate change through research, data collection, assessments, information dissemination, and international cooperation. National Climate Program Act of 1978, 15 U.S.C. §§ 2901 *et seq.* Two years later, in the Energy Security Act, Congress directed the Office of Science and Technology Policy to engage the National Academy of Sciences in a study of the "projected impact, on the level of carbon dioxide in the atmosphere, of fossil fuel combustion, coal-conversion and related synthetic fuels activities" authorized by the Energy Security Act. Pub. L. No. 96-294, tit. VII, § 711, 94 Stat. 611, 774-75 (1980). In 1990, Congress enacted the Global Change Research Act, 15 U.S.C. §§ 2931-2938, which established a 10-year research program for global climate issues, directed the President to establish a research program to improve understanding of global change, and provided for scientific assessments every four years that analyze current trends in global change. *Id.* at §§ 2932, 2933, 2936(3). Congress also established a program to research agricultural issues related to global climate change. Pub. L. No. 101-24, tit. XXIV, § 2402, 104 Stat. 4058, 4058-59 (1990). Finally, two years later, in the Energy Policy Act of 1992, Congress directed the Secretary of Energy to conduct several assessments related to greenhouse gases and report to Congress. Pub. L. No. 102-486, § 1604, 106 Stat. 2776, 3002.

The Global Climate Protection Act of 1987 directed the Secretary of State to coordinate U.S. negotiations concerning global climate change. 15 U.S.C. § 2901 note; § 2952(a).

Following those negotiations, President George H.W. Bush signed, and the Senate approved, the UNFCCC, which, as discussed above, has yet to effectively control greenhouse gas emissions.

The United States Clean Air Act ("CAA") also fails to regulate carbon dioxide emissions, focusing instead on research and monitoring. Section 103(g) directs the Environmental Protection Agency ("EPA") to establish a "basic engineering research and technology program to develop, evaluate, and demonstrate nonregulatory strategies and technologies for air pollution prevention" that would address substances including carbon dioxide. 42 U.S.C. § 7403(g). The CAA also states that nothing in Section 103(g) "shall be construed to authorize the imposition on any person of air pollution control requirements." *Id.*

The Supreme Court will hear a challenge on November 29, 2006 to a 2003 decision by the EPA to reject a petition urging it to regulate greenhouse gas emissions from automobiles, stating as follows:

> After careful consideration of petitioners' arguments and the public comments, EPA concludes that it cannot and should not regulate [greenhouse gas] emissions from U.S. motor vehicles under the CAA. Based on a thorough review of the CAA, its legislative history, other congressional action and Supreme Court precedent, EPA believes that the CAA does not authorize regulation to address global climate change. Moreover, even if [carbon dioxide] were an air pollutant generally subject to regulation under the CAA, Congress has not authorized the Agency to regulate [carbon dioxide] emissions from motor vehicles to the extent such standards would effectively regulate car and light truck fuel economy, which is governed by a comprehensive statute administered by DOT.

> In any event, EPA believes that setting [greenhouse gas] emission standards for motor vehicles is not appropriate at this time. President Bush has established a comprehensive global climate change policy designed to (1) answer questions about the causes, extent, timing and effects of global climate change that are critical to the formulation of an effective, efficient long-term policy, (2) encourage the development of advanced technologies that will enable dramatic reductions in [greenhouse gas] emissions, if needed, in the future, and (3) take sensible steps in the interim to reduce the risk of global climate change. The international nature of global climate change also has implications for foreign policy, which the President directs. In view of EPA's lack of CAA regulatory authority to address global climate change, DOT's authority to regulate fuel economy, the President's policy, and the potential foreign policy implications, EPA declines the petitioners' request to regulate [greenhouse gas] emissions from motor vehicles. 68 Fed. Reg. 52922, 52925 (footnote omitted).

The Bush Administration's climate initiative referenced in the EPA notice above, and revealed after the Administration renounced the Kyoto Protocol, plainly fails to effectively address global warming. This initiative is based entirely on voluntary measures which are

incapable of effectively controlling greenhouse gas emissions. This climate plan, termed the Global Climate Change Initiative, also focuses only on reducing the amount of greenhouse gas emissions per unit of energy produced ("emissions intensity"), not the overall level of emissions (GAO 2003a). In the absence of new climate initiatives, United States emissions intensity is expected to decrease by 14% by 2012, while total emissions continue to increase (GAO 2003a). The Bush plan, if fully implemented and successful, would decrease emissions intensity by a mere additional 4%, for an overall reduction of 18%, but total emissions would still continue to increase. Even according to the Bush Administration's own arithmetic, full implementation and success of the plan will result in US greenhouse gas emissions in 2012 that are 30% higher than 1990 emissions, as opposed to the 7% reduction called for by the Kyoto Protocol (Holdren 2003). Cumulative emissions between 2002-2012 will continue to grow and would be a mere 2% less with the plan than without it (GAO 2003a).

Moreover, the US Government Accounting Office ("GAO") found that the Bush plan does not explain how even the modest 4% claimed reduction in energy intensity will be met. The Bush plan fails to provide any emissions savings estimates at all for 19 of the 30 plan elements (GAO 2003b). Of those 19, at least two seem unlikely to yield any emissions savings at all by 2012 (GAO 2003b). Of 11 initiatives for which savings estimates were provided, at least eight were not clearly attributable to the Bush plan, and there were problems with others as well (GAO 2003b). Overall, the GAO could confirm that emissions savings would be realized from only three of the Bush plan elements (GAO 2003b), an extremely inauspicious finding for the ultimate success (and the good faith intentions) of the already modest proposal.

For all the reasons discussed above, existing regulatory mechanisms relating to global warming are inadequate to address the threat of anthropogenic greenhouse gas emissions to the petitioned penguin species. Protecting these penguins under the Endangered Species Act will bring attention to their plight and encourage both voluntary and regulatory action to address greenhouse gas emissions.

CONCLUSION

As demonstrated in this Petition, each of the 12 petitioned penguin species faces threats to its continued existence. FWS must promptly make a positive 90-day finding on this Petition, initiate a status review, and expeditiously proceed toward listing and protecting these species. We look forward to the official response as required by the ESA.

LITERATURE CITED

Copies of many of the references cited will be sent on compact disk under separate cover. Please consider these references along with the Petition, and include them in the administrative record for the 90-Day Finding on the Petition.

ACIA. 2004. *Impacts of a Warming Climate: Arctic Climate Impact Assessment*. Cambridge University Press. *Available at*: http://amap.no/acia/.

Adams, N.J. 1994. Patterns and impacts of oiling African Penguins *Spheniscus demersus*: 1981 – 1991. *Biological Conservation* 68: 35-41.

Agnew, D.J. 1997. The CCAMLR Ecosystem Monitoring Programme. *Antarctic Science* 9(3): 235-242.

Agnew, D.J. and G. Phegan. 1996. A fine scale model of the overlap between penguin foraging demands and the krill fishery in the South Shetland Islands and Antarctic Peninsula. *CCAMLR Science* 2: 99-110.

Akçakaya, H.R., S.H.M. Butchart, G.M. Mace, S.N. Stuart, and C. Hilton-Taylor. 2006. Use and misuse of the IUCN Red List Criteria in projecting climate change impacts on biodiversity *Global Change Biology* 12: 2037-2043, doi: 10.1111/j.1365-2486.2006.01253.x.

Ainley, D.G. 2002. *The Adelie Penguin: bellwether of climate change*. Columbia University Press, New York.

Ainley, D.G., E.F. O'Conner and R.J. Boekleheide. 1984. *The Marine Ecology of Birds in the Ross Sea, Antarctica*. Washington, D.C., American Ornithologists Union.

Ainley, D.G., E.D. Clarke, K. Arrigo, W.R. Fraser, A. Kato, K.J Barton and P.R. Wilson. 2005. Decadal-scale changes in the climate and biota of the Pacific sector of the Southern Ocean, 1950s to the 1990s. *Antarctic Science* 17: 171-182.

Albritton, D.L., L.G. Meira Filho, U. Cubasch, X. Dai, Y. Ding, D.J. Griggs, B. Hweitson, J.T. Houghton, I. Isaksen, T. Karl, M. McFarland, V.P. Meleshko, J.F.B. Mitchell, M. Noguer, B.S. Nyenzi, M. Oppenheimer, J.E. Penner, S. Pollonais, T. Stocker and K.E. Trenberth. 2001. Technical Summary. Pp. 21-83 *In*: *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 881 pp. Available at http://www.ipcc.ch/.

Alonzo, S.H., P.V. Switzer and M. Mangel. 2003. An ecosystem-based approach to management: using individual behaviour to predict the indirect effects of Antarctic krill fisheries on penguin foraging. *Journal of Applied Ecology* 40(4): 692-702, doi: 10.1046/j.1365-2664.2003.00830.x

Ancel, A., G. L. Kooyman, P. J. Ponganis, J.-P. Gendner, J. Lignon, X. Mestre, N. Huin, P. H. Thorson, P. Robisson and Y. Le Maho. 1992. Foraging behaviour of emperor penguins as a

resource detector in winter and summer. *Nature* 360, 336 - 339 (26 November 1992); doi:10.1038/360336a0.

Anisimov, O., B. Fitzharris, J.O. Hagen, R. Jefferies, H. Marchant, F. Nelson, T. Prowse, and D.G. Vaughan. 2001. Polar Regions (Arctic and Antarctic). Pp 803-841 *In*: *Climate Change 2001: Impacts, Adaption, and Vulnerability* [McCarthy, J.J., Canziani, O.F, Leary, N.A., Dokken, D.J., White, K.S. (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available at http://www.ipcc.ch/.

Araya B. 1988. Status of the Humboldt Penguin in Chile following the 1982-83 El Niño. *Spheniscus Penguin Newsletter* 1: 8-10.

Araya, B. and M. Bernal. 1995. In: Simonetti, J.A., M.T.K. Arroyo, A.E. Spotorno and E. Lozada (Eds.). *Diversidad Biologica de Chile*. CONICYT, Chile. Pp. 350-360.

Araya, B., D. Garland, G. Espinoza, A. Sanheusa, A. Simeone, A. Teare, C. Zavalaga, R. Lacy, and S. Ellis (eds.). 2000. Population and Habitat Viability Assessment for the Humboldt Penguin (*Spheniscus humboldti*). Olmue, Chile 28 Sept. – 1 Oct. 1998. Final report. IUCN/SSC Conservation Breeding Specialist Group: Apple Valley, Minnesota.

Arrigo, K.R., van Dijken, G.L., Ainley, D.G., Fahnestock, M. 2002. Ecological impact of a large Antarctic iceberg. *Geophysical Research Letters* 29: 7.

Atkinson A, Siegel V, Pakhomov E and Rothery P. 2004. Long-term decline in krill stock and increase in salps within the Southern Ocean. *Nature* 432: 100-103.

Bailey, A.M., and Sorensen, J.H. 1962. Subantarctic Campbell Island. *Denver Museum of Natural History Proceedings* 10: 1-305.

Bailey, E.P. 1992. Red foxes, *Vulpes vulpes*, as biological control agents for introduced arctic foxes, *Alopex lagopus*, on Alaskan Islands. *Canadian Field Naturalist*, 106, 200 205.

Baker, A.J., S.L. Pereira, O.P. Haddrath and K.A. Edge. 2006. Multiple gene evidence for the expansion of extant penguins out of Antarctica due to global cooling. *Proceedings of the Royal Society Biology* 273: 11-17.

Banks, J.C., A.D. Mitchell, J.R. Waas and A.M. Paterson. 2002. An unexpected pattern of molecular divergence within the blue penguin (*Eudyptula minor*) complex. *Notornis* 49: 29-38.

Barbraud, C., H. Weimerskirch, C. Guinet, and P. Jouventin. 2000. Effect of sea-ice extent on adult survival of an Antarctic top predator: the snow petrel *Pagodroma nivea*. *Oecologia* 125:483-488.

Barbraud, C. and H. Weimerskirch. 2001. Emperor penguins and climate change. *Nature* 411: 183-186.

Barbraud, C. and H. Weimerskirch. 2003. Climate and density shape population dynamics of a marine top predator. *Proc. R. Soc. Lond. Biology* 270: 2111–2116.

Barbraud, C. and H. Weimerskirch. 2006. Antarctic birds breed later in response to climate change. *Proceedings of the National Academy of Sciences* 103(16): 6248-6251.

Barnes, K. N. (ed.). 2000. *The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland*. Johannesburg: BirdLife South Africa.

Barnett, T.P. et al. 2005. Penetration of human-induced warming into the world's oceans. *Science* 309:284-287.

Bell, B.D. 1975. Report on the birds of the Auckland Islands Expedition 1972-73. *In*: Preliminary results of the Auckland Islands Expedition 1972-1973. Yaldwin, J.C. (ed.), *Reserves Series* No. 1975/3, Department of Lands and Survey, Wellington, pp 136-142.

Bennett, A.G. 1933. *The penguin population of the Falklands Islands in 1932-33*. Government Press, Falkland Islands. 4 pp.

Berruti, A., N.J. Adams and S. Jackson. 1989. The Benguela ecosystem Part VI: seabirds. *Oceanography and Marine Biology Annual Review* 27: 273-335.

Bingham, M. 1996. Falkland Islands Penguin Census, 1995/96. Falklands Conservation, Stanley. *Available at:* http://www.seabirds.org/research.htm#bookmark2

Bingham, M. 1998. The Penguins of South America and the Falkland Islands. *Penguin Conservation* 11(1): 10-15. *Available at:* http://www.seabirds.org/research.htm#bookmark3

Bingham, M. 2002. The decline of Falkland Islands penguins in the presence of a commercial fishing industry. Revista Chilena de Historia Natural 75: 805-818. *Available at:* http://www.seabirds.org/resume.htm#bookmark1

BirdLife International. 2000. *Threatened Birds of the World*. Lynx Edicions and BirdLife International, Barcelona, Spain and Cambridge, U.K.

BirdLife International. 2004. *Threatened Birds of the World 2004*. CD-ROM. BirdLife International, Cambridge, U.K.

BirdLife International (BirdLife). 2006. *In*: IUCN 2006. *2006 IUCN Red List of Threatened Species.* Available at: www.iucnredlist.org.

CENTER FOR BIOLOGICAL DIVERSITY

Black, R. 2006. Carbon emissions show sharp rise. BBC News, available at http://news.bbc.co.uk/2/hi/science/nature/6189600.stm.

Boersma, P.D. 1976. An ecological and behavioral study of the Galapagos penguin. *Living Bird* 15: 43-93.

Boersma, P.D. 1998. Population trends of the Galapagos penguin: Impacts of El Nino and La Nina. *Condor* 100, 245–253.

Boersma, P.D. and M.J. Groom. 1993. Conservation of storm-petrels in the North Pacific. *In* (K. Vermeer, K.T. Briggs, K.H. Morgan and D. Siegel-Causey) *The status, ecology and conservation of marine birds in the North Pacific*. Canadian Wildlife Services Special Publications, Ottawa. Pp. 112-121.

Boersma, P.D. and D.L. Stokes. 1995. Mortality patterns, hatching asynchrony, and size asymmetry in Magellanic penguin (*Spheniscus magellanicus*) chicks. *In* (P. Dann and P. Reilley, eds.) *Penguin Biology 2*. Sureey Beatty and Sons, NSW.

Boersma, P.D., D.L. Stokes and P.M. Yorio. 1990. Reproductive variability and historical change of Magellanic penguins (*Spheniscus magellanicus*) at Punta Tombo, Argentina. *In* (L.S. Davis and J.T Darby, eds.) *Penguin Biology*. Academic Press, San Diego. Pp.15-43.

Bousquet, P., P. Ciais, J.B. Miller, E.J. Dlugokencky, D.A. Hauglustaine, C. Prigent, G.R. Van der Werf, P. Peylin, E.G. Brunke, C. Carouge, R.L. Langenfelds, J. Lathière, F. Papa, M. Ramonet, M. Schmidt, L.P Steele, S.C. Tyler and J. White. 2006. Contribution of anthropogenic and natural sources to atmospheric methane variability. *Nature* 443: 439-443.

Brierley, A.S. and D.N. Thomas. 2002. Ecology of southern ocean pack ice. *Adv Mar Biol.* 43: 171-276.

Brierley, A.S., P.G. Fernandes, M.A. Brandon, F. Armstrong, N.W. Millard, S.D. McPhail, P. Stevenson, M. Pebody, J. Perrett, M. Squires, D.G. Bone, and A.M. Griffiths. 2002. Antarctic krill under sea ice: elevated abundance in a narrow band just south of ice edge. *Science* 295: 1890–1892.

Brooke, M. de L. 2004. The food consumption of the world's seabirds. *Proceedings of the Royal Society of London B*, 271 (Suppl.), S246–S248.

Brossy, J.J. 1992. Malaria in wild and captive Jackass Penguins *Spheniscus demersus* along the southern African coast. *Ostrich* 63: 10-12.

Burger, A.E. and J. Cooper. 1984. The effects of fisheries on seabirds in South Africa and Namibia. *In* (D.N. Nettleship, D.A. Sanger and D.F. Springer, eds.) *Marine seabirds: their*

feeding ecology and commercial fisheries relationships. Canadian Wildlife Services Special Publications, Ottawa. Pp. 150-60.

CCAMLR. 2004. Report of the Twenty-Third Meeting of the Commission, Hobart, Australia, 25 October- 5 November 2004.

Caldeira, K. and M.E. Wicket. 2003. Anthropogenic carbon and ocean pH., *Nature* 425: 365.

Capurro, A., E. Frere, M. Gandini, P. Fandini, T. Holik, V. Lichtschein and C. Gregorio. 1986. Radioactividad o hambre. *Propuesta Patagonica* 4: 16-18.

Carrasco, L., J.S. Lima, D.C. Halfen, F.J. Salguero, P. Sánchez-Cordón and G. Becker. 2001. Systemic aspergillosis in an oiled magallanic penguin (*Spheniscus magellanicus*). *Journal of Veterinary Medicine*, Series B Vol. 48 P. 551, September 2001, doi:10.1046/j.1439-0450.2001.00456.x

Challies, C.N. and R.R. Burleigh. 2004. Abundance and breeding distribution of the white-flippered penguin (*Eudyptula minor albosignata*) on Banks Peninsula, New Zealand. *Notornis* 51(1): 1-6

Chambers, L.E., L. Hughes and M.A. Weston. 2005. Climate change and its impact of Australia's avifauna. *Emu* 105, 1-20.

Chapin, F.S. III. 2005. Chapter 25: Polar Systems. *In*: *Millenium Ecosystem Assessment Vol.1: Ecosystems and human well-being: current state and trends: findings of the Condition and Trends Working Group*. [R. Hassan, R. Scholes, N. Ash (eds.)]. Island Press. Available at: http://www.maweb.org//en/products.global.condition.aspx

Cheney, C. 1998. The current situation of the Humboldt Penguin in Chile and Peru: a report from the population and habitat viability analysis meeting, part 1. *Penguin Conservation* 11: 4-9.

Chiuchiolo A.L., R.M. Dickhut, M.A. Cochran and H.W. Ducklow. 2004. Persistent organic pollutants at the base of the Antarctic marine food web. *Environ Sci. Technol.* 38(13): 3551-3557.

Christidis, L. and W.E. Boles. 1994. *The taxonomy and species of birds of Australia and its territories*. Melbourne: Royal Australasian Ornithologists' Union (RAOU Monogr 2).

Clarke, A. and C.M. Harris. 2003. Polar marine ecosystems: major threats and future change. *Environmental Conservation* 30(1). DOI:10.1017/S0376892903000018.

Clarke, J.R. and K.R. Kerry. 1993. Diseases and parasites of penguins. *Korean Journal of Polar Research* 4, 79–86.

Coker, R.E. 1919. Habits and economic relations of the guano birds of Peru. *Proceedings of the United States National Museum* 56: 449-511.

Collar, N.J. and P. Andrew. 1988. *Birds to Watch. The ICBP World Checklist of Threatened Birds.* ICBP Technical Publication No. 8. Page Bros. (Norwich) Ltd, Norfolk, England.

Collar, N.J., M.J. Crosby and A.J Stattersfield. 1994. *Birds to Watch 2. The World List of Threatened Birds* BirdLife International. Page Bros (Norwich) Ltd, U.K.

CONAF. 1988. *Libro Rojo de los Vertebrados Terrestres de Chile*. Glade, A. (Ed.) Corporacion Nacional Forestal, Santiago de Chile. 68 p.

Constable, A.J. and S. Nicol. 2002. Defining smaller-scale management units to further develop the ecosystem approach in managing large-scale pelagic krill fisheries in Antarctica. *CCAMLR Science* 9: 117-131.

Cooper, J. 1992. Rockhopper penguins at the Auckland Islands. *Notornis* 39: 66-67.

Cooper, W.J., C.M Miskelly, K. Morrison and R.J. Peacock. 1986. Birds of the Solander Islands. *Notornis* 33: 77-89.

Cooper, J., N.L. Avenant and P.W. Lafite. 1994. Airdrops and King Penguins: a potential conservation problem at sub-Antarctic Marion Island. *Polar Record* 30: 277-282.

Coria, N.R. and D. Montalti. 2000. A Newly Discovered Breeding Colony of Emperor Penguins *Aptenodytes forsteri*. *Marine Ornithology* 28: 119-120.

Crawford, R.J.M. 1987. Food and population variability in five regions supporting large stocks of anchovy, sardine and horse mackerel. *South African Journal of Marine Science* 5: 735-757.

Crawford, R. 1998. Revised Red Data Book. *Bird Numbers* 7: 8-9. Available at: http://web.uct.ac.za/depts/stats/adu/bn7_2_07.htm

Crawford, R.J.M. and P.A. Shelton. 1978. Pelagic fish and seabird interrelationships off the coasts of South West and South Africa. *Biological Conservation* 14: 85-109.

Crawford, R.J.M. and P.A. Shelton. 1981. Population trends for some South African seabirds related to fish availability. *In* (J. Cooper, ed.) *Proceedings of the symposium on birds of the sea and shore*. Pp. 15-41. African Seabird Group, Cape Town.

Crawford, R.J.M., L.V. Shannon and D.E. Pollock. 1987. The Benguela ecosystem. 4. The major fish and invertebrate resources. *In* Barnes, M. (ed.) *Oceanography and Marine Biology: an annual review 25*. Aberdeen University Press: 353-505.

Crawford, R.J.M., L.G. Underhill, C.M. Raubenheimer, B.M. Dyer and J. Martin. 1992. Top predators in the Benguela ecosystem – implications of their trophic position. *South African Journal of Marine Science* 12: 675-687.

Crawford, R.J.M., A.J. Williams, J.H. Hofmeyr, N.T.W. Klages, R.M. Randall, J. Cooper, B.M. Dyer and Y. Chesselet. 1995. Trends in African Penguin *Spheniscus demersus* populations in the 20th century. *South African Journal of Marine Science* 15: 269-272.

Crawford, R.J.M., L.J. Shannon and P.A. Whittington. 1999. Population dynamics of the African Penguin *Spheniscus demersus* at Robben Island, South Africa. *Marine Ornithology* 27: 139–147.

Crawford, R.J.M., J. Cooper and B.M. Dyer. 2003a. Population of the Macaroni Penguins *Eudyptes chrysolophus* at Marion Island, 1994/95-2002/03, with observations on breeding and diet. *African Journal of Marine Science* 25: 475-486.

Crawford, R.J.M., J. Cooper, B.M. Dyer, M.D. Greyling, N.T.W. Klages, D.C. Nel, J.L. Nel, S.L. Petersen and A.C. Wolfaardt. 2003b. Decrease in Numbers of the Eastern Rockhopper Penguin *Eudyptes Chrysocome Filholi* at Marion Island, 1994/95–2002/03. *African Journal of Marine Science* 25: 487–498

Crawford, R.J.M., P.J. Barham, L.G. Underhill, L.J. Shannon, J.C. Coetzee, B.M. Dyer, T.M. Leshoro and L. Upfold. 2006. The influence of food availability on breeding success of African penguins *Spheniscus demersus* at Robben Island, South Africa. *Biological Conservation* 132: 119-125.

Crick, H.P.Q. 2004. The impact of climate change on birds. *Ibis* 146 (Suppl.1): 48-56.

Croxall, J.P. 1987. The status and conservation of Antarctic seals and seabirds: a review. *Environment International* 13: 55-70.

Croxall, J. P. 1998. *Eudyptes chrysocome filholi.* In: *Penguin conservation assessment and management plan*. (Report from workshop held 8-9 September 1996, Cape Town, South Africa.) Ellis, S., Croxall, J. P. & Cooper, J. (eds), IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, USA, pp 48-51.

Croxall, J.P., C. Ricketts and P.A. Prince. 1984. Impact of seabirds on marine resources, especially krill, of South Georgia waters. *In* Whittow, G.C. and Rahn, H., (eds.) *Seabird energetics*. New YorkL Plenum Publishing Corp. 285-318.

Croxall, J.P. and G.S. Lishman. 1987. The food and feeding of penguins. *In* (J.P. Croxall, ed.) *Seabirds: feeding ecology and role in marine ecosystems*. Cambridge University Press. Pp. 101-133.

Croxall, J.P., P.A. Prince and K. Reid. 1999. Diet, provisioning and productivity responses of marine top predators to differences in availability of Antarctic krill. *Marine Ecology Progress Series* 177: 115-131.

Croxall, J.P. and A.G. Wood. 2002. The importance of the Patagonian Shelf for top predator species breeding at South Georgia. *Aquatic Conserv: Mar. Freshw. Ecosyst.* 12: 101–118.

Croxall, J.P., P.N. Trathan and E.J. Murphy. 2002. Environmental change and Antarctic seabird populations. *Science* 297: 1510-1514.

Croxall, J.P. and S. Nicol. 2004. Management of Southern Ocean fisheries: global forces and future sustainability. *Antarctic Science* 16(4): 569-584.

Culik, B.M. 2001. Finding food in the open ocean: foraging strategies in Humboldt Penguins. *Zoology* 104: 327-338.

Culik, B. M. and G. Luna-Jorquera. 1997a. Satellite tracking of Humboldt penguins (*Spheniscus humboldti*) in northern Chile. *Marine Biol.* 128: 547-556.

Culik, B.M. and G. Luna-Jorquera. 1997b. The Humboldt Penguin (*Spheniscus humboldti*): a migratory bird? *Journal für Ornithologie* 138: 325-330.

Culik, B.M., R.P. Wilson, R. Dannfield, D. Adelung, H.J. Spairani and N.R. Coria. 1991. Pygoscelid penguins in a swim canal. *Polar Biology* 11: 277-282.

Cunningham, D.M. and P.J. Moors. 1994. The decline of Rockhopper Penguins *Eudyptes chrysocome* at Campbell Island, Southern Ocean and the influence of rising sea temperatures. *Emu* 94: 27-36.

Curran, M.A.J., T.D. van Ommen, V.I. Morgan, K.L. Phillips and A.S. Palmer. (2003). Ice Core Evidence for Antarctic Sea Ice Decline since the 1950s. *Science* 302: 1203-1206.

Cuthbert, R. and E.S. Sommer. 2004. Population size and trends of four globally threatened seabirds at Gough Island, South Atlantic Ocean. *Marine Ornithology* 32: 97-103.

Dann, P. 1992. Distribution, population trends and factors influenceing the population size of little penguins *Eudyptula minor* on Phillip Island. *Emu* 91: 263-272.

Darby, J.T. 2003. The yellow-eyed penguin (Megadyptes antipodes) on Stewart and Codfish Islands. *Notornis* 50(3): 148-154.

Darby, J.T. and S.M. Dawson. 2000. Bycatch of yellow-eyed penguins (*Megadyptes antipodes*) in gillnets in New Zealand waters 1979–1997. *Biological Conservation* 93: 327-332.

Darby, J.T. and P. Seddon. 1990. Breeding biology of Yellow-eyed penguins (*Megadyptes antipodes*). *In* (L.S. Davis and J.T Darby, eds.) *Penguin Biology*. Academic Press, San Diego. Pp. 45-62.

David, J.H.M., P. Cury, R.J.M. Crawford, R.M. Randall, L.G. Underhill and M.A. Meÿer. 2003. Assessing conservation priorities in the Benguela ecosystem, South Africa: analysing predation by seals on threatened seabirds. *Biological Conservation* 114: 289-292.

Demer, A.D. and S.G. Conti. 2005. New target-strength model indicates more krill in the Southern Ocean. *ICES Journal of Marine Science* 62: 25-32.

Doniger, D.D., A.V. Herzog, and D.A. Lashof. 2006. An ambitious, centrist approach to global warming legislation. *Science* 314:764-765.

Dowsett, R. J. and A.D. Forbes-Watson. 1993. *Checklist of birds of the Afrotropical and Malagasy regions*. Liège, Belgium: Tauraco Press.

Duffy, D.C. and W.R. Siegfried. 1987. Historical variation in food consumption by breeding seabirds of the Humboldt and Benguela upwelling regions. In *Seabirds: feeding ecology and role in marine ecosystems*, (ed. J.P. Croxall), pp. 327-346. Cambridge University Press, Cambridge.

Du Toit, M., G.C. Boere, J. Cooper, M.S. de Villiers, J. Kemper, B. Lenten, S.L. Petersen, R.E. Simmons, L.G. Underhill, P.A. Whittington and O. Byers (Eds). 2003. Conservation Assessment and Management Plan for Southern African Seabirds. Cape Town: Avian Demography Unit & Apple Valley: IUCN/SSC Conservation Breeding Specialist Group.

Ellenberg, U., T. Mattern, P.J. Seddon and G. Luna-Jorquera. 2006. Physiological and reproductive consequences of human disturbance in Humboldt penguins: The need for species-specific visitor management. *Biological Conservation* 133: 95-106.

Ellis, S. 1999. The Penguin Conservation Assessment and Management Plan: a description of the process. *Marine Ornithology* 27: 163–169.

Ellis, S., J.P. Croxall and J. Cooper (eds.). 1998. *Penguin conservation assessment and management plan: Report from the workshop held 8-9 September 1996, Cape Town, South Africa*. Apple Valley, USA: IUCN/SSC Breeding Specialist Group.

Energy Information Administration ("EIA"). 2004. *International Energy Outlook 2004*. Energy Information Administration, U.S. Department of Energy, Washington, DC, USA. xi + 244 pp. Available at http://www.eia.doe.gov/oiaf/ieo/index.html.

Enfield, D.B. 1992. Historical and prehistorical overview of El Nino/Southern Oscillation. In *El Nino*, (eds. H.F. Diaz and V. Markgraf), pp. 95-117. Cambridge University Press, Cambridge.

Enzenbacher, D.J. 1992. Tourists in Antarctica: Numbers and Trends. *Polar Record* 28: 17.

Epstein, P.R. and E. Mills (eds.). 2005. Climate change futures health, ecological, and economic dimensions. The Center for Health and the Global Environment, Harvard Medical School. Cambridge, Massachusets, USA.

Everson, I. 2000. Role of krill in marine food webs, the Southern Ocean. In: *Krill: Biology, Ecology and Fisheries* – (I. Everson, ed.) Fish and Aquatic Resources, Series 6. Blackwell Science, Oxford: 194-201.

Feely, R.A. et al. 2004. Impact of anthropogenic CO_2 on the $CaCO_3$ system in the oceans. *Science* 305:362-366.

Fraser, W.R. and E.E. Hofmann. 2003. A predator's perspective on causal links between climate change, physical forcing and ecosystem response. *Marine Ecology Progress Series*, 265, 1-15.

Fraser, W.R., W.Z. Trivelpiece, D.G. Ainley and S.G. Trivelpiece, S.G. 1992. Increases in Antarctic penguin populations: reduced competition with whales or a loss of sea ice due to environmental warming? *Polar Biology* 11(8): 525-531. DOI 10.1007/BF00237945.

Frere, E., M. Gandini, P. Gandini, T. Holik, V. Lichschein and M. Day. 1993. Variacion annual en el numbero de adultos reproductivos en la nueva colonia de pinguino de panache amarillo *Eudyptes crestatus* (Spheniscidae) en Isla Pinguino (Santa Cruz, Argentina). *Hornero* 13: 293.

Fix, A.S., C. Waterhouse, E.C. Greiner and M.K. Stoskopf. 1988. *Plasmodium relictum* as a cause of avian malaria in wild-caught Magellanic Penguins (*Spheniscus magellanicus*). *Journal of Wildlife Diseases* 24: 610–619.

Fordyce, R.E. and C.M. Jones. 1990. Penguin history and new fossil material from New Zealand. In: Davis, L.S. & Darby, J.T. (Eds). *Penguin biology*. London: Academic Press. pp. 417–446.

Frost, P.G.H., W.R. Siegfried and J. Cooper. 1976. The conservation of the jackass penguin (*Spheniscus demersus*). *Biological Conservation* 9: 79-99.

Furness, R.W. 1984. Seabird-fisheries relationships in the northeast Atlantic and North Sea. *In* (D.N. Nettleship, G.A. Sanger and P.F. Springer, eds.) *Marine Birds: Their Feeding Ecology and Commercial Fisheries Relationships*. Canadian Wildlife Service Special Publication, Dartmouth, Nova Scotia.

Gandini, P.A., P.D. Boersma, E. Frere, M. Gandini, T. Holik and V. Lichtschein. 1994. Magellanic penguins (*Spheniscus magellanicus*) affected by chronic petroleum pollution along coast of Chubut, Argentina. *Auk* 111: 20-27.

Gandini, P.A., E. Frere, A.D. Pettovello and P.V. Cedrola. 1999. Interaction between Magellanic penguins and shrimp fisheries in Patagonia, Argentina. *Condor* 101: 783–789.

García-Borboroglu, P., P.D. Boersma, V. Ruoppolo, L. Reyes, G.A. Rebstock, K. Griot, S. Rodrigues Heredia, A. Corrado Adornes, and R. Pinho da Silva 2006. Chronic oil pollution harms Magellanic penguins in the Southwest Atlantic. *Marine Pollution Bulletin* 52: 193–198.

Gardner, H., K. Kerry, M. Riddle, S. Brouwer and L. Gleeson. 1997. Poultry virus infection in Antarctic penguins. *Nature* 387: 245.

General Accounting Office ("GAO"). 2003a. *Climate Change: Trends in Greenhouse Gas Emissions and Emissions Intensity in the United States and Other High-Emitting Nations*. GAO-04-146R, October 28, 2003. United States General Accounting Office, Washington, DC, USA. 8 pp. Available at http://www.gao.gov/docsearch/repandtest.html.

GAO. 2003b. *Preliminary Observations on the Administration's February 2002 Climate Initiative*. GAO-04-131T, October 1, 2003. US General Accounting Office, Washington, DC, USA. 9 pp. Available at http://www.gao.gov/docsearch/repandtest.html.

Garnett, S.T. and G.M. Crowley. 2000. *The Action Plan for Australian Birds 2000*. Canberra: Environment Australia. Available at:
http://www.deh.gov.au/biodiversity/threatened/publications/action/birds2000/index.html.

Giese, M. and M. Riddle. 1999. Disturbance of emperor penguin Aptenodytes forsteri chicks by helicopters. *Polar Biology* 22: 366-371.

Gille, S.T. 2002. Warming of the Southern Ocean since the 1950s. *Science* 295: 1275-1277.

Goerke, H., K. Weber, H. Bornemann, S. Ramdohr, J. Plotz. 2004. Increasing levels and biomagnification of persistent organic pollutants (POPs) in Antarctic biota. *Marine Pollution Bulletin* 48: 295-302.

Goldsworthy S.D., R.P. Gales, M. Giese and N. Brothers. 2000. Effects of the *Iron Baron* oil spill on little penguins (*Eudyptula minor*): Estimates of mortality. *Wildlife Research* 27(6) 559-571.

Gonzalez-Zevallos, D. and P. Yorio. 2006. Seabird use of discards and incidental captures at the Argentine hake trawl fishery in the Golfo San Jorge, Argentina. *Marine Ecology Progress Series* 316: 175-183.

Gordon, H.B. and S.P. O'Farrell. 1997. Transient climate change in the CSIRO coupled model with dynamic sea ice. *Monthly Weather Review* 125: 875-907.

Gottdenker, N.L, T. Walsh, H. Vargas, J. Merkel, G.U. Jiménez, R.E. Miller, M. Dailey and P.G. Parker. 2005. Assessing the risks of introduced chickens and their pathogens to native birds in the Galápagos Archipelago. *Biological Conservation* 126: 429-439.

Graczyk, T.K., J.F. Cockrem, M.R. Cranfield, J.T Darby and P. Moore. 1995. Avian malaria seroprevalence in wild New Zealand penguins. *Parasite* 2: 401-405.

Guinard, E., H. Weimerskirch and P. Jouventin. 1998. Population changes and demography of the northern Rockhopper Penguin on Amsterdam and Saint Paul Islands. *Colonial Waterbirds* 21: 222-228.

Guinet, C., Y. Cherel, V. Ridoux and P. Jouventin. 1996. Consumption of marine resources by seabirds and seals in Crozet and Kerguelen waters, changes in relation to consumer biomass 1962–85. *Antarctic Science* 8: 23-30.

Hansen, J. 2006. Expert report submitted to the United States District Court, District of Vermont in regard to Case No. 2:05-CV-302 and 2:05-CV-304, <ins>Green Mountain Chrysler-Plymouth-Dodge-Jeep et al. v. Thomas W. Torti, Secretary of Vermont Agency of Natural Resources, et al.</ins>

Hansen, J., M. Sato, R. Ruedy, K. Lo, D.W. Lea and M. Medina-Elizade. 2006a. Global temperature change. *Proc. Natl. Acad. Sci.* 103(39): 14288-14293, doi10.1073/pnas.0606291103.

Hansen, J. et al. 2006b. Dangerous human-made interference with climate: A GISS modelE study. 13 October 2006 Draft. Available at http://arxiv.org/abs/physics/0610115.

Hansen, J. et al. 2005. Earth's Energy Imbalance: Confirmation and Implications. *Science* 308: 1431-1435.

Harper, P.C., G.A Knox, E.B. Spurr, R.H. Taylor, G.J. Wilson and E.C. Young. 1984. The status and conservation of birds in the Ross Sea sector of Antarctica. *ICBP Tech. Publ.* No. 2: 593–608.

Harrigan, K.E. 1992. Causes of mortality of little penguins *Eudyptula minor* in Victoria. *Emu* 91: 273-277.

Harris, C.M. 2005. Aircraft operations near concentrations of birds in Antarctica: The development of practical guidelines. *Biological Conservation* 125: 309-322.

Harrison, J.A., D.G. Allan, L.G. Underhill, M. Herremans, A.J. Tree, V. Parker and C.J. Brown (eds.). 1997. *The atlas of southern African birds*, 1: Non-passerines. Johannesburg: BirdLife South Africa.

Hays, C. 1984. The Humboldt Penguin in Peru. *Oryx* 18: 92-95.

Hays, C. 1986. Effects of the 1982-83 El Niño on Humboldt Penguin colonies in Peru. *Biological Conservation* 36: 169-180.

Heather, B. D. and H.A. Robertson. 1997. *The field guide to the birds of New Zealand*. Oxford, UK: Oxford University Press.

Herling, C., B.M. Culik and J.C. Hennicke. 2005. Diet of the Humboldt penguin (*Spheniscus humboldti*) in northern and southern Chile. *Marine Biology* 147: 13–25.

Hewitt, R.P., G. Watters, P.N. Trathan, J.P. Croxall, M.E. Goebel, D. Ramm, K. Reid, W.Z. Trivelpiece, W.Z. and J.L. Watkins. 2004. Options for allocating the precautionary catch limit of krill among small-scale management units in the Scotia Sea. *CCAMLR Science* 11: 81-97.

Hilton, G.M., D.R. Thompson, P. Sagar, R.J. Cuthbert, Y. Cherel and S.J. Bury. 2006. A stable isotopic investigation into the causes of decline in a sub-Antarctic predator, the Rockhopper Penguin *Eudyptes chrysocome*. *Global Change Biology* 12(4): 611-625.

Hindell, M.A. 1988. The diet of the Royal Penguin *Eudyptes schlegeli* at Macquarie Island. *Emu* 88: 219-226.

Hirons, A.C., D.M. Schell and B.P. Finney. 2001. Temporal records of $d^{13}C$ and $d^{15}N$ in North Pacific pinnipeds: inferences regarding environmental change and diet. *Oecologia* 129(4): 591-601. DOI 10.1007/s004420100756.

Hitchmough, R. 2002. New Zealand Threat Classification System lists 2002. *Threatened Species Occasional Publication 23*. New Zealand Department of Conservation, Wellington. 210 pp. *Available at*: http://www.doc.govt.nz/Conservation/001~Plants-and-Animals/006~Threatened-species/index.asp

Hoffman, E.E. and E.J. Murphy. 2004. Advection, krill and Antarctic marine ecosystems. *Antarctic Science* 16: 487-499.

Holmes, N., M. Giese and L.K. Kriwoken. 2005. Testing the minimum approach distance guidelines for incubating Royal penguins *Eudyptes schlegeli*. *Biological Conservation* 126: 339-350.

del Hoyo, J., A. Elliot and J. Sargatal (eds.). 1992. *Handbook of the birds of the world*, 1. Barcelona, Spain: Lynx Edicions.

Hull, C.L. 2000. Comparative diving behaviour and segregation of the marine habitat by breeding Royal Penguins, *Eudyptes schlegeli*, and eastern Rockhopper Penguins, *Eudyptes chrysocome filholi*, at Macquarie Island. *Canadian Journal of Zoology* 78(3): 333–345.

Hull, C.L., M.A. Hindell and K. Michael. 1997. Foraging zones of royal penguins during the breeding season, and their association with oceanographic features. *Marine Ecology Press Series* 153: 217-228.

Hull, C.L., M.A. Hindell, R.P. Gales, R.A. Meggs, D.I. Moyle and N.P. Brothers. 1998. The efficacy of translocating little penguins *Eudyptula minor* during an oil spill. *Biological Conservation* 86: 393-400.

Hunt, B.P.V., E.A. Pakhomov and C.D. McQuaid. 2001. Short-term variation and long term changes in the oceanographic environment and zooplankton community in the vicinity of a sub-Antarctic archipelago. *Marine Biology* 138: 369-381.

Ichii, T. 2000. Krill harvesting. In: *Krill: Biology, Ecology and Fisheries.* (I. Everson, eds.) Fish and Aquatic Resources, Series 6. Blackwell Science, Oxford: 228-262.

Intergovernmental Panel on Climate Change (IPCC). (2001a). *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 881 pp. Available at http://www.ipcc.ch/.

IPCC. (2001b). *Climate Change 2001: Impacts, Adaption, and Vulnerability (Summary for Policymakers).* [McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J., White, K.S. (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 10 pp. Available at http://www.ipcc.ch/.

IPCC. (2001c). *Climate Change 2001: Synthesis Report (Summary for Policymakers).* Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 34 pp. Available at http://www.ipcc.ch/.

International Association of Antarctic Tour Operators (IAATO). 2006. Statistics: Trends 1992-2007. *Available at*: http://www.iaato.org/tourism_stats.html

International Climate Change Taskforce. 2005. *Meeting the Climate Challenge Recommendations of the International Climate Change Task Force*. The Institute for Public Policy Research, London, UK. ix + 26 pp. Available at http://www.americanprogress.org/site/pp.asp?c=biJRJ8OVF&b=306503.

International Penguin Conservation Work Group. 2006. Humboldt Penguin. Available at http://www.penguins.cl/humboldt-penguins.htm (Downloaded on November 26, 2006).

International Union for the Conservation of Nature and Natural Resources (IUCN). 1990. *1990 IUCN Red List of Threatened Animals.* IUCN, Gland, Switzerland and Cambridge, UK.

IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1.* IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii + 30 pp. Available at http://www.redlist.org/info/categories_criteria2001.html.

Jackson, S. and R.P. Wilson. 2002. The potential costs of flipper-bands to penguins. *Functional Ecology* 16: 141-148.

Jacobs, S.S., C.F. Giulivi, P.A. Mele. 2002. Freshening of the Ross Sea during the late 20th century. *Science* 297(5580): 386-89.

Jaffe, E. 2006. Good Gone Wild: Sometimes, ecotourism hurts what it sets out to help. *Science News* 170(14): 218; available at: http://www.sciencenews.org/articles/20060930/bob9.asp

Jaramillo, A., P. Burke and D. Beadle. 2003. *Birds of Chile*. Princeton, N.J., Princeton University Press.

Jenouvrier, S., C. Barbraud and H. Weimerskirch. 2003. Effects of climate variability on the temporal population dynamics of southern fulmars. *Journal of Animal Ecology*, 72, 576–587.

Jenouvrier, S., H. Weimerskirch, C. Barbraud, Y.H. Park and B. Cazelles. 2005a. Evidence of a shift in the cyclicity of Antarctic seabird dynamics linked to climate. *Proc. of the Royal Society: Biol. Sci.* 272: 887-95.

Jenouvrier, S., C. Barbraud, B. Cazelles and H. Weimerskirch. 2005b. Modelling population dynamics of seabirds: importance of the effects of climate fluctuations on breeding proportions. *Oikos* 108: 511-522.

Jenouvrier, S., C. Barbraud and H. Weimerskirch. 2005c. Long-term contrasted responses to climate of two Antarctic seabird species. *Ecology* 86(11): 2889-2903.

Jones, H.I. and G.R. Shellam. 1999. Blood parasites in penguins, and their potential impact on conservation. *Marine Ornithology* 27: 181-184.

Jones, A.G., S.L. Chown P.G. Ryan, N.J.M. Gremmen and K.J. Gaston. 2003. A review of conservation threats on Gough Island: a case study for terrestrial conservation in the Southern Oceans. *Biological Conservation* 113(1): 75-87.

Jouventin, P. 1982. *Visual and Vocal Signals in Penguins, Their Evolution and Adaptive Characters*. Advances in Ethology, supplements to Journal of Comparative Ethology. Verlag Paul Parey, Berlin und Hamburg.

Jouventin, P., J.C. Stahl, H. Weimerskirch and J.L. Mougin. 1984. The seabirds of the French subantarctic islands and Adélie Land, their status and conservation. Pp. 609-625 in J. P. Croxall, P. G. H. Evans and R. W. Schreiber, eds. *Status and conservation of the world's seabirds*. Cambridge, U.K.: International Council for Bird Preservation (Techn. Publ. 2).

Jouventin, P., R.J. Cuthbert and R. Ottvall. 2006. Genetic isolation and divergence in sexual traits: evidence for the northern rockhopper penguin (Eudyptes moseleyi) being a sibling species. *Molecular Ecology Notes* 15(11): 3413.

Kato, A., K. Watanabe and Y. Naito. 2004. Population changes of Adelie and Emperor Penguins along the Prince Olav Coast and on the Riiser-Larsen Peninsula. *Polar Bioscience* 17: 117-122.

Keymer, I.F. 1988. An investigation of Rockhopper Penguin mortality in the Falklands during the 1985-86 breeding season. *Falkland Islands Foundation Project Report*.

Kinsky, F.C. and R.A. Falla. 1976. A subspecific revision of the Australian Blue Penguin (Eudyptula minor) in the New Zealand Area. *Records of the National Museum of New Zealand* 1: 105-126.

Kirkwood, R. and G. Robertson. 1997. The foraging ecology of female Emperor Penguins in winter. *Ecological Monographs* 67: 155-176.

Kooyman, G.L. 1993. Breeding habitats of emperor penguins in the western Ross Sea. *Antarctic Science* 5(2): 143-148.

Kooyman, G.L. 2002. Evolutionary and ecological aspects of some Antarctic and sub-Antarctic penguin distributions. *Oecologia* 130(4): 485-495.

Kooyman, G.L and J.L. Mullins. 1990. Ross Sea emperor penguin breeding populations estimated by aerial photography. *In* (Kerry, K.R. and Hempel, G. eds.) *Antarctic ecosystems: ecological change and conservation, Proceedings of the Fifth SCAR Symposium on Antarctic Biology*. Berlin: Springer-Verlag, 169-176.

Kooyman, G.L., T.G. Kooyman, M. Horning and C.A. Kooyman, C.A. 1996. Penguin dispersal after fledging. *Nature* 383: 397.

Kooyman, G.L., D.B. Siniff, I. Stirling, J.L. Bengtson. 2004. Moult habitat, pre- and post-moult diet and post-moult travel of Ross Sea emperor penguins. *Marine Ecology Progress Series* 267: 281-290.

Laist D.W, 1997. Impacts of marine debris:entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. In: Marine

Debris. Sources, Impacts, Solutions. J.M. Coe and D.B. Rogers (eds.). Springer-Verlag New York, Inc., pp99-140.

Lawrence Livermore National Laboratory (LLNL). 2006. Researchers link human activities to rising ocean temperatures in hurricane formation regions. News Release, September 11, 2006. Available at http://www.llnl.gov/pao/news/news_releases/2006/NR-06-09-02.html.

Lea, M.A. and T. Soper. 2005. Discovery of the first Emperor Penguin *Aptenodytes forsteri* colony in Marie Byrd Land, Antarctica. *Marine Ornithology* 33: 59–60

Lebreton, J.D. and J. Clobert. 1991. In *Bird Population Studies* (eds. Perrins, C.M., Lebreton, J.D., and Hirons, G.J.M.). Oxford Univ. Press, Oxford. 103-125.

Levitus, S., J.L. Antonov, T.P. Boyer and C. Stephens. 2000. Warming of the World Ocean *Science* 287: 2225.

de Lisle, G.W., W.L. Stanislawek and P.J. Moors. 1990. *Pasteurella multocida* infections in Rockhopper penguins (*Eudyptes chrysocome*) from Campbell Island, New Zealand. *Journal of Wildlife Diseases* 26: 283-285.

Loeb, V., V. Siegel, O. Holm-Hansen, R. Hewitt, W. Fraser, W. Trivelpiece and S. Trivelpiece. 1997. Effects of sea-ice extent and krill or salp dominance on the Antarctic food web. *Nature* 387: 897-900.

Luebke, R.W., P.V. Hodson, M. Faisal, P.S. Ross, K. Grasman and J. Zelkoff. 1997. Aquatic pollution and induced immunotoxicity in wildlife species. (35th Annual Meeting of the Society of Toxicology, Anaheim, California). *Fundamental and Applied Toxicology* 37: 1–15.

Luna-Jorquera, G. 1996. Conservation assessment and management plan (CAMP): the Humboldt penguin *Spheniscus humboldti*. In: Croxall J, Cooper J, Ellis S (eds) Penguin conservation assessment and management plan workshop, Cape Town, South Africa. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, Minn., USA

Luna, G.J., R. Hennicke, R. Wallace, A. Wolfaardt, P. Whittington, S. Ellis and M. McGovern (Eds.). 2002. *Spheniscus* Penguin conservation workshop. Universidad Catolica del Norte, Coquimbo, Chile; 9-10 Sept. 2000. Final Report. Apple Valley, MN: IUCN/SSC Conservation Breeding Specialist Group.

Majluf, P., E.A. Babcock, J.C. Riveros, M. Arias Schreiber W. and Alderete. 2002. Catch and bycatch of sea birds and marine mammals in the small-scale fishery of Punta San Juan, Peru. *Conservation Biology* 16: 1333–1343.

Marchant, S. and P.J. Higgins. 1990. *Handbook of Australian, New Zealand and Antarctic Birds*, Vol. 1. Melbourne, Oxford University Press.

Mastrandrea, M.D. and S.H. Schneider. 2006. Chapter 27 Probabilistic Assessment of 'Dangerous' Climate Change and Emissions Scenarios: Stakeholder Metrics and Overshoot Pathways. Pp. 254-264 *In*: *Avoiding Dangerous Climate Change* [Schnellnhuber, H.J., (ed.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 406 pp.

McLean, I.G., and R.B. Russ. 1991. The Fiordland Crested Penguin Survey, Stage I: Doubtful to Milford Sounds. *Notornis* 38: 183-190.

McLean, I.G., B.J.S. Studholme and R.B. Russ. 1993. The Fiordland Crested Penguin Survey, Stage III: Breaksea Island, Chalky and Preservation Inlets. *Notornis* 40: 85-94.

McLean, I.G., M. Abel, C.N. Challies, S. Heppelthwaite, J. Lyall, and R.B. Russ. 1997. The Fiordland Crested Penguin (*Eudyptes pachyrhynchus*) Survey, Stage V: mainland coastline, Bruce Bay to Yates Point. *Notornis* 44: 37–47.

McClung, M.R., P.J. Seddon, M. Massaro and A.N. Setiawan. 2004. Nature-based tourism impacts on yellow-eyed penguins *Megadyptes antipodes*: does unregulated visitor access affect fledging weight and juvenile survival? *Biological Conservation* 119: 279-285.

Mellick, D. and W. Bremmers. 1995. A recently discovered breeding colony of Emperor Penguins (*Aptenodytes forsteri*) on the Budd Coast, Wilkes Land, East Antarctica. *Polar Record* 31: 426-427.

Meinhausen, M. 2006. Chapter 28 What does a 2° target mean for greenhouse gas concentrations? A brief analysis based on multi-gas emission pathways and several climate sensitivity uncertainty estimates. Pp. 265-279 *In*: *Avoiding Dangerous Climate Change* [Schnellnhuber, H.J., (ed.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 406 pp.

Micol, T. and P. Jouventin. 2001. Long-term population trends in seven Antarctic seabirds at Point Geologie, Terre Adelie: Human impact compared with environmental change. *Polar Biology* 24: 175-185.

Montevecchi, W.A., V.L. Birt and D.K. Cairns. 1988. Dietary changes of seabirds associated with local fisheries failures. *Biological Oceanography* 5: 153-159.

Moore, P. J. 1992. Breeding biology of the Yellow-eyed Penguin *Megadyptes antipodes* on Campbell Island. *Emu* 92: 157-162.

Moore, P.J. 1999. Foraging range of the Yellow-eyed Penguin *Megadyptes antipodes*. *Marine Ornithology* 27: 49-58.

Moore, P.J. 2001. Historical records of yellow-eyed penguin (*Megadyptes antipodes*) in southern New Zealand. *Notornis* 48(3): 145-156.

Moore, P.J., D. Fletcher and J. Amey. 2001. Population estimates of Yellow-eyed Penguins, *Megadyptes antipodes*, on Campbell Island, 1987-98. *Emu* 101(3): 225-236.

Moors, P.J. 1986. Decline in numbers of rockhopper penguins at Campbell Island. *Polar Record* 23(142): 69-72.

Morales Sanchez, J. E. 1988. Confirmación de la presencia de *Spheniscus humboldti* Meyen (Aves: Spheniscidae) Para Colombia. *Trianea (Act. Cient. Tecn. INDERENA)* 1: 141-143.

Morgan, I.R., H.A. Westbury and J. Campbell. 1985. Viral infections of little blue penguins (*Eudyptula minor*) along the southern coast of Australia. *Journal of Wildlife Diseases* 21: 193-8.

Murphy, R.C. 1936. *Oceanic Birds of South America*. Vol. 1. The Macmillan Company. New York. 640 p.

Nakićenović, N., J. Alcamo, G. Davis, B. de Vries, J. Fenham, S. Gaffin, K. Gregory, A. Grübler, T.Y. Jung, T. Kram, E.L. La Rovere, L.Michaelis, S. Mori, T. Morita, W. Pepper, H. Pitcher, L. Price, K. Raihi, A. Roehrl, H-H. Rogner, A. Sankovski, M. Schlesigner, P. Shukla, S. Smith, R. Swart, S. van Rooijen, N. Victor, and Z. Dadi. 2000. *IPCC Special Report on Emissions Scenarios*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 599 pp. Available at http://www.ipcc.ch/

National Snow and Ice Data Center (NSIDC). 1998. January 1995 Events in the Northern Larsen Ice Shelf and Their Importance. *Available at:* http://nsidc.org/iceshelves/larsen1995/

NSIDC. 1999. Antarctic ice shelves breaking up due to decades of higher temperatures. April 7, 1999. *Available at:* http://www.colorado.edu/PublicRelations/NewsReleases/1999/35.html

NSIDC. 2002. Antarctic Ice Shelf Collapses. March 18, 2002. *Available at:* http://www.nsidc.org/iceshelves/larsenb2002/index.html

NSIDC. 2006. Ice Shelves. August 16, 2006. *Available at*: http://nsidc.org/sotc/iceshelves.html.

Nel, D.C. and P.A. Whittington. 2003. Rehabilitation of oiled African Penguins: a conservation success story. Cape Town: BirdLife South Africa and Avian Demography Unit.

Nicol S. and Y. Endo. 1997. Krill fisheries of the world. *FAO Fisheries Technical Paper.* No. 367. Food and Agriculture Organization of the United Nations, Rome. 100p. Available at: http://www.fao.org/DOCREP/003/W5911E/W5911E00.HTM

Nicol, S., T. Pauly, N.L. Bindoff, S. Wright, D. Thiele, G.W. Hosie, P.G. Strutton and E. Woehler. 2000. Ocean circulation off east Antarctica affects ecosystem structure and sea-ice extent. *Nature* 406: 504-507.

Nicol, S. and J. Foster. 2003. Recent trends in the fishery for Antarctic krill, *Aquatic Living Resources* 16: 42-45, *Available at:* http://www.edpsciences.org/articles/alr/abs/2003/01/alr3065/alr3065.html

Norman, F.I., P.B. Du Guesclin and P. Dann. 1992. The 1986 wreck of little penguins *Eudyptula minor* in Western Victoria. *Emu* 91: 369-76.

Oliver, W.R.B. 1955. *New Zealand Birds*. A.H. & A.W. Reid, Wellington.

O'Reilly et al. 2003. Climate change decreases aquatic ecosystem productivity of Lake Tanganyika, Africa. *Nature* 424: 766-768.

Orr, J.C. et al. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. *Nature* 437: 681-686.

Otley, H.M. 2005. Nature-based tourism: experiences at the Volunteer Point penguin colony in the Falkland Islands. *Marine Ornithology* 33: 181–187.

Overpeck, J.T. et al. 2006. Paleoclimatic evidence for future ice-sheet instability and rapid sea-level rise. *Science* 311:1747-1750.

Pakhomov, E.A., and C.D. McQuaid. 1996. Distribution of surface zooplankton and seabirds across the Southern Ocean. *Polar Biology* 16: 271–286.

Paredes R. and C.B. Zavalaga. 1998. Overview of the effects of El Niño 1997-98 on the Humboldt Penguins and other seabirds at Punta San Juan, Peru. *Penguin Conservation* 11: 5-7.

Parades, R., C.B. Zavalaga and D.J. Boness. 2002. Patterns of egg laying and breeding success in Humboldt Penguins (*Spheniscus humboldti*) at Punta San Juan, Peru. *The Auk* 119: 244-250.

Paredes, R. and C.B. Zavalaga. 2001. Nesting sites and nest types as important factors for the conservation of Humboldt Penguins (*Sphensicus humboldti*). *Biol. Conserv.* 100: 199-205.

Paredes, R., C.B. Zavalaga, G. Battistini, P. Majluf and P. McGill. 2003. Status of the Humboldt Penguin in Peru, 1999-2000. *Waterbirds* 26: 129-138.

Petersen, S.L., P.G. Ryan and D. Gremillet. 2006. Is food availability limiting African Penguins *Spheniscus demersus* at Boulders? A comparison of foraging effort at mainland and island colonies. *Ibis* 148(1), 14-26.

Piatkowski, U. and K. Pütz. 1994. Squid diet of emperor penguins (*Aptenodytes forsteri*) in the eastern Weddell Sea, Antarctica during late summer. *Antarctic Science* 6: 241-247.

Pimm, S., P. Raven, A. Peterson, C.H. Sekercioglu and P.R. Ehrlich. 2006. Human impacts on the rates of recent, present and future bird extinctions. *Proceedings of the National Academy of Sciences* 103(29): 10941-10946.

Primack, R.B. 2001. Extinction, Causes of. Pp. 697-713 *In: Encyclopedia of Biodiversity* [Levin, S.A., (ed.)]. Academic Press, New York, USA.

Pulido, V. 1991. *El Libro Rojo de la Fauna Silvestre del Peru*. Marijosa Editorial, Lima, Peru.

Pütz, K. 1998. Where do Falkland penguins go in winter? *Warrah* 14: 6-7.

Pütz, K. et al. 2002. Winter dispersal of Rockhopper penguins *Eudyptes chrysocome* from the Falkland Islands and its implications for conservation. *Marine Ecology Progress Series*, 240, 273–284.

Pütz, K., A.P. Clausen, N. Huin and J.P. Croxall. 2003. Re-evaluation of Historical Rockhopper Penguin Population Data in the Falkland Islands. *Waterbirds* 26(2): 169-175

Quayle, W.C., L.S. Peck, H. Peat, J.C. Ellis-Evans and P.R. Harrigan. 2002. Extreme responses to climate change in Antarctic lakes. *Science* 295: 645.

Rance, C. 1995. Tragedy at Te Rere. *Forest & Bird* 25: 22-23.

Ravelo, A.C., D.H. Andreasen, M. Lyle, A. O. Lyle, and M.W. Wara. 2004. Regional climate shifts caused by gradual cooling in the Pliocene epoch. *Nature* 429:263-267.

Reid, K. 1995. Oiled penguins observed at Bird Island, South Georgia. *Marine Ornithology* 23: 53-57.

Reid, K. and J.P. Croxall. 2001. Environmental response of upper trophic level predators reveals a system change in an Antarctic marine ecosystem. *Proceedings of the Royal Society Biological Sciences* 268: 377-384.

Remsen, J. V., Jr., A. Jaramillo, M. Nores, J. F. Pacheco, M. B. Robbins, T. S. Schulenberg, F. G. Stiles, J. M. C. da Silva, D. F. Stotz, and K. J. Zimmer. Version 27, November 2006. A classification of the bird species of South America. American Ornithologists' Union. http://www.museum.lsu.edu/~Remsen/SACCBaseline.html

Richardson, A.J. and D.S. Schoeman. 2004. Climate Impact on Plankton Ecosystems in the Northeast Atlantic. *Science* 305, 1609-12. DOI: 10.1126/science.1100958.

Riebesell, U. et al. 2000. Reduced calcification of marine plankton in response to increased atmospheric CO_2. *Nature* 407:364-367.

Rignot, E. and P. Kangaratnam. 2006. Changes in the velocity structure of the Greenland Ice Sheet. *Science* 311:986-990.

Rignot E., G. Casassa, S. Gogineni, P. Kanagaratnam, W. Krabill, H. Pritchard, A. Rivera, R. Thomas, J. Turner, D. Vaughan. 2005. Recent ice loss from the Fleming and other glaciers, Wordie Bay, West Antarctic Peninsula. *Geophys. Res. Lett.* 32: L07502, doi: 10.1029/2004GL021947.

Rintoul, S. R., C.W. Hughes, D. Olbers. 2001. *In:* G. Siedler, J. Church, J. Gould, (Eds.), *Ocean Circulation and Climate.* Academic Press, San Diego, pp. 271-302.

Robertson, C.J.R. and B.D. Bell. 1984. Seabird status and conservation in the New Zealand region. In: Status and conservation of the world's seabirds. Croxall, J. P., Evans, P. G. H. & Schreiber, R.W. (eds), *ICBP Technical Publication* No. 2, pp 573-586.

Robertson, G. 1992. Population-Size and Breeding Success of Emperor Penguins *Aptenodytes forsteri* at Auster and Taylor Glacier Colonies, Mawson Coast, Antarctica. *Emu* 92(2): 65-71.

Robertson, G. and K. Newgrain. 1996. The food and energy intake rates of adult emperor penguins (*Aptenodytes forsteri*) rearing chicks. *Antarctic Science* 8: 37-44.

Robertson, C.J.R. and G.V. van Tets. 1982. The Status of Birds at the Bounty Islands. *Notornis* 29: 311-336.

Rounsevell, D.E. and N.P. Brothers. 1984. The status of seabirds on Macquarie Island. Pp. 587-592 in *Status and Conservation of the World's Seabirds*. ICBP Tech. Publ. 2. J.P. Croxall, P.G.H. Evans and R.W. Schreiber (eds). ICBP, Cambridge, U. K.

Rottman, J. and M.V. Lopez. 1992. *Estrategia Nacional para la Conservacion de Aves*. Serie Tecnica SAG No. 1. Santiago, Chile.

Russ, R.B., I.G. McLean and B.J.S. Studholme. 1992. The Fiordland crested penguin survey, Stage II: Dusky and Breaksea Sounds. *Notornis* 39: 113-118.

Ruttimann, J. 2006. Sick seas. *Nature* 442: 978-980.

Ryan, P.G. 1991. The impact of the commercial lobster fishery on seabirds at the Tristan da Cunha Islands, South Atlantic Ocean. *Biological Conservation* 57(3): 339-350.

Ryan, P. G. and J. Cooper. 1991. Rockhopper Penguins and other marine life threatened by driftnet fisheries at Tristan da Cunha. *Oryx* 25: 76-79.

Sagar, P.M., R. Murdoch, M.W. Sagar and D.R. Thompson. 2005. Rockhopper penguin (*Eudyptes chrysocome filholi*) foraging at Antipodes Islands. *Notornis* 52(2): 75-80.

Schaefer, M.R. 1970. Men, birds and anchovies in the Peru Current dynamic interaction. *Transactions of the American Fisheries Society* 9: 461-467.

Schell, D.M. 2000. Declining Carrying Capacity in the Bering Sea: Isotopic Evidence from Whale Baleen. *Limnology and Oceanography* 45(2): 459-462.

Schreiber, R.W. and E.A. Schreiber. 1984. Central Pacific seabirds and the El Nino Southern Oscillation: 1982-1983 perspective. *Science* 225: 713–715.

Schultz, A. and S.L. Petersen. 2003. Absence of haematozoa in breeding Macaroni *Eudyptes chrysolophus* and Rockhopper *E. chrysocome* Penguins at Marion Island. *African Journal of Marine Science* 25: 463-474.

Schuster, K. and J.T. Darby. 2000. Observations on the chick-rearing strategy of yellow-eyed penguins (Megadyptes antipodes) on Otago Peninsula, New Zealand. *Notornis* 47(2): 141-147.

Scientific Committee for the Conservation of Antarctic Living Marine Resources (SCAR). 1992. Status and trends of Antarctic and sub-Antarctic seabirds. In: Report of the Eleventh Meeting of the Scientific Committee of CCAMLR. Hobart, CCAMLR. *Available at:* http://www.ccamlr.org/pu/E/e_pubs/sr/drt.htm

SCAR. 1996. Status and trends of Antarctic and sub-Antarctic seabirds. In: Report of the Fifteenth Meeting of the Scientific Committee of CCAMLR. Hobart, CCAMLR. *Available at:* http://www.ccamlr.org/pu/E/e_pubs/sr/drt.htm

Seddon, P.J. and L.S. Davis. 1989. Nest-site selection by Yellow-eyed Penguins. *Condor* 91: 653-659.

Sekercioglu, C.H., G.C. Daily and P.R. Ehrlich. 2004. Ecosystem consequences of bird declines. *Proceedings of the National Academy of Sciences* 101 (52): 18042-18047. *Available at*: http://www.stanford.edu/%7Ecagan/Sekercioglu_etal_PNAS_2004.pdf

Shannon, L.J. and R.J.M. Crawford. 1999. Management of the African Penguin *Spheniscus demersus* - insights from modelling. *Marine Ornithology* 27: 119-128.

Shirihai, H. 2002. *The Complete Guide to Antarctic Wildlife*. Princeton University Press: Princeton, New Jersey.

Shukman, D. 2006. Sharp rise in CO2 levels recorded. BBC News, March 14, 2006. Available at http://news.bbc.co.uk/1/hi/sci/tech/4803460.stm.

Sibley, C.G. and B.L. Monroe. 1990. *Distribution and taxonomy of birds of the world*. New Haven, USA: Yale University Press.

Sibley, C.G. and B.L. Monroe. 1993. *A supplement to 'Distribution and taxonomy of birds of the world'*. New Haven, USA: Yale University Press.

Simeone, A., M. Bernal and J. Meza. 1998. Incidental mortality of Humboldt Penguins (*Spheniscus humboldti*) in gillnets, central Chile. *Marine Ornithology* 27: 157-161.

Simeone, A., M. Bernal, J. Meza. 1999. Incidental mortality of Humboldt Penguins *Spheniscus humboldti* in gill nets, Central Chile. *Marine Ornithology*. 27: 157-161.

Smetacek, V. and S. Nicol. 2005. Polar ocean ecosystems in a changing world. *Nature* 437: 362-368, 15 September 2005, doi:10.1038/nature04161.

Smith, V.R. 2002. Climate Change in the Sub-Antarctic: An Illustration from Marion Island. *Climate Change* 52(3): 345-357 / DOI 10.1023/A:1013718617277.

Smith, R.C., D. Ainley, K. Baker, E. Domack, S. Emslie, B. Fraser, J. Kenett, A. Leventer, E. Mosley-Thompson, S. Stammerjohn, and M. Vernet. 1999. Marine ecosystem sensitivity to climate change. *BioScience* 49:393–404.

Sparks, J. and T. Soper. 1967. *Penguins*. Newton Abbott: David & Charles.

Splettstoesser, J.F. 1997. Mortality among chicks in the Emperor Penguin (*Aptenodytes forsteri*) colony at Riiser-Larsen Ice Shelf, Antarctica. *Polar Rec*. 33: 63–64.

Splettstoesser, J.F. and F.S. Todd. 1998. Further observations of beak deformations in Emperor Penguin chicks. *Marine Ornithology* 26: 79 (1998)

Stahel, C. and R. Gales. 1987. *Little Penguin. Fairy penguins in Australia*. University of New South Wales Press.

Stainford, D.A., T. Aina, C. Christensen, M. Collins, N. Faull, D.J. Frame, J.A. Kettleborough, S. Knight, A. Martin, J.M. Murphy, C. Piani, D. Sexton, L.A. Smith, R.A. Spicer, A.J. Thorpe, and M.R. Allen. 2005. Uncertainty in predictions of climate response to rising levels of greenhouse gases. *Nature* 433:403-406.

Stott, P.A., D.A. Stone, and M.R. Allen. 2004. Human contribution to the European heatwave of 2003. *Nature* 432:610-613.

Stotz, D. F., Fitzpatrick, J. W., Parker, T. A. and Moskovits, D. K. 1996. *Neotropical birds: ecology and conservation*. Chicago: University of Chicago Press.

Studholme, B.J.S., R.B. Russ and I.G. McLean. 1994. The Fiordland crested penguin survey: Stage IV, Stewart and offshore islands and Solander Island. *Notornis* 41: 133-143.

Suckling, K.F. 2006. Federal endangered species recovery plans employing a 75-200 year foreseeable future threshold. January 21, 2006.

Tarling, G.A. and M.L. Johnson. 2006. Satiation gives krill that sinking feeling. *Current Biology* 16(3): 83-84.

Taylor, G.A. 2000. Action plan for seabird conservation in New Zealand, Part A: Threatened seabirds. *Threatened Species Occasional Publication 16*. New Zealand Department of Conservation, Wellington. *Available at:* http://www.doc.govt.nz/Conservation/001~Plants-and-Animals/006~Threatened-species/index.asp

Taylor, R.H. and G.A. Taylor. 1989. Re-assessment of the status of southern elephant seals *(Mirounga leonina)* in New Zealand. *New Zealand Journal of Marine and Freshwater Research* 23: 201-213.

Taylor, R.H., P.R. Wilson and B.W. Thomas. 1990. Status and trends of Adélie penguin populations in the Ross Sea region. *Polar Record* 26(159): 293-304.

Taylor, S.S., M.L. Leonard, D.J. Boness and P. Majluf. 2001. Foraging trip duration increases for Humboldt Penguins tagged with recording devices. *Journal of Avian Biology* 32: 369-372.

Taylor, S.S., M.L. Leonard, D.J. Boness and P. Majluf. 2002. Foraging by Humboldt Penguins (*Spheniscus humboldti*) during the chick rearing period: general patterns, sex differences and recommendations to reduce incidental catches in fishing nets. *Canadian Journal of Zoology* 80: 700-707.

Thomas, C.D. et al. 2004. Extinction risk from climate change. *Nature* 427: 145-148.

Thompson, K.R. 1993. Falkland Islands Seabird Monitoring Programme: summary of findings to 1992/93. *Falklands Conservation Report SMP/3*. Falkland Conservation, Stanley.

Thompson, D.R., R.W. Furness and S.A. Lewis. 1995. Diets and long-term changes in d15N and d13C values in northern fulmars *Fulmarus glacialis* from two northeast Atlantic colonies. *Marine Ecology Progress Series*, 125, 3–11.

Tickell, W.L.N., 2000. Albatrosses. Yale University Press; New Haven and London.

Todd, F.S., S. Adie and J.F. Splettstoesser. 2004. First ground visit to the Emperor Penguin *Aptenodytes forsteri* colony at Snow Hill Island, Weddell Sea, Antarctica. *Marine Ornithology* 32: 193–194.

Tovar, H. and D. Cabrera. 1985. Las Aves Gunaeras y el Fenomeno El Nino. In *El Nino* (eds. W. Arntz, A. Landa, and J. Tarazona), pp. 181-186. Bolivian Marine Institute, Peru-Callao.

Tovar, H. and L. Vasquez. 1982. Las poblaciones de aves guaneras durante El Niño de 1957. *Boletin de Lima*. 22:34–46.

Trathan, P.N., J.P. Croxall, E.J. Murphy and I. Everson. 1998. Use of at-sea distribution data to derive potential foraging ranges of macaroni penguins during the breeding season. *Marine Ecology* 169: 263-275.

Tremblay, Y. and Y. Cherel. 2000. Benthic and pelagic dives: a new foraging behaviour in rockhopper penguins. *Marine Ecology Progress Series* 204: 257–267.

Trillmich, F. and K.A. Ono. 1991. *Pinnipeds and El Niño. Responses to environmental stress.* Spinger-Verlag, Berlin.

Turbott, E. G. 1990. *Checklist of the birds of New Zealand*. Third edition. Wellington: Ornithological Society of New Zealand.

Tynan, C.T. 1998. Ecological importance of the Southern Boundary of the Antarctic Circumpolar Current. *Nature* 392: 708-710. (16 April 1998); doi:10.1038/33675.

Underhill, L.G., P.A. Bartlett, L. Baumann, R.J.M. Crawford, B.M. Dyer, A. Gildenhuys, A., D.C. Nel, T.B. Oatley, M. Thornton, L. Upfold, A.J. Williams, P.A. Whittington and A.C. Wolfaardt. 1999. Mortality and survival of African Penguins *Spheniscus demersus* involved in the *Apollo Sea* oil spill: an evaluation of rehabilitation efforts. *Ibis* 141(1): 29-37.

United Nations Framework Convention on Climate Change Secretariat ("UNFCCC").   2004. *United Nations Framework Convention on Climate Change the First Ten Years*. United Nations Framework Convention on Climate Change, Bonn, Germany. 96 pp. Available at http://unfccc.int/2860.php.

UNFCCC. 2005. Kyoto Protocol: Status of Ratification. Web site at http://unfccc.int/files/ essential_background/kyoto_protocol/application/pdf/kpstats.pdf

U.N. Secretary-General. 2005. Oceans and Law of the Sea: Reports of the Secretary General, delivered to the General Assembly, U.N. Doc. A/60/63 (Mar. 4, 2005).

Union of Concerned Scientists (UCS). 2005. Politics trumps science at U.S. Fish & Wildlife Service; survey reveals inappropriate orders to alter scientific findings, decisions. February 9, 2005 (includes press release, survey summary, selected essays, directive not to respond, and focus on Alaska). *Available at:* http://www.ucsusa.org/scientific_integrity/interference

UCS. 2004a. Scientific Integrity in Policymaking. An Investigation into the Bush Administration's Misuse of Science. February, 2004. *Available at:* http://www.ucsusa.org/scientific_integrity/interference

UCS. 2004b. Restoring scientific integrity in policymaking. February 18, 2004. *Available at:* http://www.ucsusa.org/scientific_integrity/interference

UCS. 2004c. Analysis of the April 2 document from the White House Office of Science and Technology Policy on scientific integrity in the Bush administration. April 19, 2004. *Available at:* http://www.ucsusa.org/scientific_integrity/interference

UCS. 2004d. Scientific integrity in policy making; further investigation of the Bush administration's misuse of science. July, 2004. *Available at:* http://www.ucsusa.org/scientific_integrity/interference

van Heezik, Y. 1990. Seasonal, geographical and age-related variations in the diet of the Yellow-eyed Penguin (*Megadyptes antipodes*). *New Zealand J. Zool.* 17: 201-212.

Vargas, F.N., S. Harrison, S. Rea and D.W. Macdonald. 2006. Biological effects of El Niño on the Galápagos penguin. *Biological Conservation*: 127: 107-114.

Verity P.G., V. Smetacek and T.J. Smayda. 2002). Status, trends and the future of the marine pelagic ecosystem. *Environmental Conservation* 29: 207-237

Vilina, Y. A., J.J Capella, J. González and J.E. Gibbons. 1995. Apuntes para la conservación de las aves de la reserva nacional Pingüino de Humboldt. *Boletín Chileno de Ornithología* 2: 2-6.

de Villiers, M. 2002. Effect of a storm on breeding African Penguins *Spheniscus demersus* at Foxy Beach, Boulders Penguin Colony, Simon's Town. *Bird Numbers* 11: 7-9.

Vitousek, P.M., P.R. Ehrlich, A.H. Ehrlich and P.A. Matson. 1986. Human Appropriation of the Products of Photosynthesis. *BioScience*, Vol. 36, No. 6 (Jun., 1986), pp. 368-373, doi:10.2307/1310258

Wallace, R. S., K. Grzybowski, E. Diebold, M.G. Michaels, J.A Tear and M.J. Willis. 1999. Movements of Humboldt Penguins from a breeding colony in Chile. *Waterbirds* 22: 441-444.

Watson, G.E. 1975. *Birds of the Antarctic and Sub-Antarctic*. American Geophysical Union, Washington DC.

WBGU. 2006. The future of oceans – warming up, rising high, turning sour. German Advisory Council on Global Change. Special Report, March, 2006. Available at www.wbgu.de

Weimerskirch, H., P. Inchausti, C. Guinet and C. Barbraud. 2003. Trends in bird and seal populations as indicators of a system shift in the Southern Ocean. *Antarctic Science* 15: 249-256.

Whittington, P., R.J.M. Crawford, O. Huyser, D. Oschadleus, R. Randall, P. Ryan, L. Shannon, A. Woolfardt, J. Cooper, R. Lacy, and S. Ellis (Eds.). 2000. *African Penguin Population and Habitat Viability Assessment. Final Report.* IUCN/SSC Conservation Breeding Specialist Group: Apple Valley, MN.

Wikelski, M., J. Foufopoulos, H. Vargas and H. Snell. 2004. Galápagos Birds and Diseases: Invasive Pathogens as Threats for Island Species. *Ecology and Society* 9(1): 5.

Williams, T. D. 1995. *The penguins* Spheniscidae. Oxford: Oxford University Press.

Williams, M. (ed.). 2002. *Climate Change Information Kit.* GE.02-01874/E-September 2002 – 5 000 UNEP/IUC/2002/7. United Nations Framework Convention on Climate Change, Bonn, Germany. *Available at:* http://unfccc.int/2860.php

Wilson, P.R., D.G. Ainley, N. Nur, S.S. Jacobs, K.J. Barton, G. Ballard and J.C. Comiso. 2001. Adelie penguin population change in the pacific sector of Antarctica, relation to sea-ice extent and the Antarctic circumpolar current. *Marine Ecology Progress Series* 213: 301-308.

Woehler, E. J. 1993. *The distribution and abundance of Antarctic and Subantarctic penguins.* Cambridge, U.K.: Scientific Commission on Antarctic Research.

Woehler, E.J. 1995. Consumption of Southern Ocean marine resources by penguins. In: Dann, P., Norman, I. & Reilly, P. (Eds). *The penguins: ecology and management.* Chipping Norton: Surrey Beatty & Sons. pp. 266–295.

Woehler, E. J. 1996. Concurrent decreases in five species of Southern Ocean seabirds in Prydz Bay. *Polar Biology* 16: 379-382.

Woehler, E. J. and J.P. Croxall. 1997. The status and trends of Antarctic and subantarctic seabirds. *Marine Ornithology* 25: 43-66.

Woehler, E.J., J. Cooper, J.P. Croxall, W.R. Fraser, G.L. Kooyman, G.D. Miller, D.C. Nel, D.L. Patterson, H.U. Peter, C.A. Ribic, K. Salwicka, W.Z. Trivelpiece and H. Weimerskirch. 2001. A Statistical Assessment of the Status and Trends of Antarctic and Subantarctic Seabirds. SCAR/CCAMLR/NSF. 43 pp. *Available at:* http://www.scar.org/researchgroups/lifescience/Montana_Report.pdf

Worm, B. et al. 2006. Impacts of Biodiversity Loss on Ocean Ecosystem Services. *Science* 314: 787-790, 10.1126/science.1132294.

Zavalaga, C.B., and R. Paredes. 1997. Humboldt Penguins at Punta San Juan, Peru. *Penguin Conservation* 10: 6-8.