NRDC

THE EARTH'S BEST DEFENSE

A petition to list the insular population of Hawaiian false killer whale (*Pseudorca crassidens*) as endangered under the Endangered Species Act

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Executive summary

False killer whales (*Pseudorca crassidens*) are pelagic cetaceans found in tropical and subtropical waters. Only one population in the species' world-wide distribution is known to reside in close association with an island system. The insular Hawaiian population of false killer whales has demonstrated long-term site fidelity with individuals being re-sighted in the near-shore waters surrounding the Hawaiian islands over a 20-year time period (Baird et al. 2008a). This population is also genetically and demographically independent from other populations of false killer whales in the eastern North Pacific region (Chivers et al. 2007).

Recent population surveys of the insular population of Hawaiian false killer whales estimate only about 120 individuals (Baird et al. 2005, Mobley et al. 2000). Further evidence suggests that this population has declined in size over the past 10-20 years (Mobley et al. 2000, unpub., Reeves et al. 2009, Baird and Barlow unpub.). While the exact causes for the decline are not specifically known, multiple factors threaten the population.

Although the insular population of Hawaiian false killer whales is found primarily in waters that are excluded from longline fisheries (less than 75 km from the shores of the main islands), fin disfigurements suggest that some members have experienced interactions with the longline fisheries (Baird and Gorgone 2005). The population is also subject to unregulated near-shore and "short" longline fisheries, and recent anecdotal information suggests that they may experience deliberate shootings from local fisherman (NMFS 2009). These and other fisheries are also likely contributing to a decline in the size or number of the primary prey species for false killer whales, which are large pelagic fishes including mahi mahi, yellowfin tuna and bigeye tuna (Sibert et al. 2006, Anonymous 2006, NMFS 2009a). Hawaiian false killer whales may be further threatened by ocean acidification and acoustic impacts.

Recent toxicological research has documented the presence of persistent organic pollutants in each of 9 tissue samples tested from the insular Hawaiian population of false killer whales (Ylitalo et al. 2009). One third of these samples showed high enough concentrations to suggest that these individuals may suffer from health effects due to the level of pollutants.

Finally, small populations are inherently at risk for extinction from environmentally stochastic events. The cumulative effects of these risks combined with the population's small size and declining numbers qualifies the insular population of Hawaiian false killer whales as an endangered species under the U. S. Endangered Species Act.

Notice of Petition

The Natural Resources Defense Council ("NRDC") hereby petitions the Secretary of Commerce, through the National Marine Fisheries Service ("NMFS"), to list the Hawaiian insular population of false killer whales (*Pseudorca crassidens*) as an endangered species and designate critical habitat to ensure its recovery 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. § 533(e), and 50 C.F.R. § 424.14(a).

NRDC is a national not-for-profit conservation organization with approximately 1.3 million members and activists. One of NRDC's organizational goals is to further the ESA's purpose by preserving our national biodiversity. NRDC's members have a direct interest in ensuring the survival and recovery of Hawaiian false killer whales and in conserving the unique native plant and animal communities on which they rely and which they benefit.

NMFS has jurisdiction over this Petition. This Petition sets in motion a specific process, requiring NMFS to make 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). NMFS must make this initial finding "(t)o the maximum extent practicable, within 90 days after receiving the petition." *Id*. A petitioner need not demonstrate that listing is warranted, but rather present information demonstrating that such a listing *may* be warranted. While NRDC believes that the best available science demonstrates that listing the Hawaiian insular population of false killer whales as endangered is in fact warranted, the available information clearly indicates that listing the species may be warranted. As such, NMFS must promptly make a positive finding on the Petition and commence a status review as required by 16 U.S.C. § 1533 (b)(3)(B).

Respectfully submitted this 30th day of September, 2009.

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I. Systematics and natural history of false killer whales (*P. crassidens*)

A. Species description

False killer whales (*Pseudorca crassidens* (Owen 1846)) are pelagic cetaceans in the family Delphinidae. They are distributed extensively worldwide throughout the tropics and occasionally found in warm temperate areas, generally in latitudes lower than 50º in both hemispheres (Stacey et al. 1994). This species inhabits tropical waters of the North Pacific, including southern Japan, Hawaii, Palmyra and Johnston Atolls, and American Samoa. False killer whales are relatively poorly studied because they are typically found in deep waters far from shore, usually in waters deeper than 1000 m; however, in Hawaii, the species is observed in both shallow (<200 m) and deeper (>2000 m) waters (Baird et al. 2008a).

B. Identifying characteristics

False killer whales have a small conical head without a beak and a long, straight mouthline. Their dorsal fin is tall and their flippers (pectoral fins) have a distinctive hump or bulge in the middle of the front edge giving them a characteristic "S"-shape. They are almost entirely black on the dorsal surface, sides of the body, dorsal fin, pectoral flippers, and tail flukes. There may be an area of pale gray present on the sides of the head. There is also a blaze, varying from gray to white, on the ventral surface beginning on the throat and extending between the flippers. The dorsal fin is slender, falcate and positioned at midback. The maximum recorded length for males is 5.96 meters (Tomilin 1957) and 5.06 meters for females (Perrin and Reilly 1984). The maximum body mass recorded is 1,360 kg (Leatherwood et al. 1988).

C. Taxonomic classification

False killer whales (*Pseudorca crassidens*) are in the order Cetacea, Suborder Odontoceti, Sperfamily Delphinoidea, and Family Delphinidae. There are no subspecies recognized (Stacey et al. 1994), although distinct cranial morphologies have been described between false killer whales from Australia, Scotland, and South Africa (Kitchener et al. 1990). Invalid synonyms of *Pseudorca crassidens* include *Pseudorca meridionalis* (Flower 1865).

D. Life history

Female false killer whales reach sexual maturity around 8-11 years of age, corresponding to a size of 340-380 cm. Males mature a bit later with estimates ranging from 8-21 years and 370-457 cm (Stacey et al. 1994). The length of gestation ranges from 15.1-15.7 months and a single young is born. The calving rate is low, with an average interval between births of 7 years (Kasuya 1986). False killer whales are estimated to live to be 57.5-62.5 years of age. Females live longer than males on average. False killer whales are social animals and cooperative hunters. Groups of 10-20 individuals are often sighted, with groups as large as 300 occasionally reported. Observed groups of 10-20 animals may often be part of larger groups consisting of hundreds of individuals spread over wide areas (Reeves et al. 2002). Off the coast of Japan, the average group size of false killer whales was reported to be 55. Sex ratios determined from mass stranding events show roughly equal numbers of males and females.

E. Habitat

False killer whales have been reported from all tropical, subtropical, and warm temperate seas, but are more often found in warmer waters. While the species is most commonly encountered in deep pelagic waters in the tropics, it is occasionally seen in semi-enclosed seas including the Red Sea and Mediterranean Sea (Cawardine 1995). In Hawaii, animals have been observed in both shallow (<200 m) and deep (>2000 m) water habitat and have been observed to move extensively between the main Hawaiian Islands (Baird et al. 2008a).

F. Prey

False killer whales primarily feed on fish and cephalopods. They have also been observed attacking other cetaceans, including small cetaceans, humpback whales, and sperm whales. In Hawaii, the species has been reported feeding on yellowfin tuna (*Thunnus albacares*), broadbill swordfish (*Xiphias gladius*), mahi mahi (*Coryphaena hippurus*), skipjack tuna (*Katsuwonus pelamis*), wahoo (*Acanthocybium solandri*), and mongchong (*Taractichthys steindachneri*), and observational studies suggest that the majority of their diet in Hawaii is composed of these large game fish (Baird et al. 2008a).

II. The insular population of Hawaiian false killer whales qualifies as a listable entity under the ESA

The ESA provides for the listing of all species that warrant the protections afforded by the Act. The term "species" is defined broadly under the act to include "any subspecies of fish or wildlife or plants and any distinct population segment of any species of vertebrate fish or wildlife with interbreeds when mature." 16 USC 1532(16).

NMFS and the U.S. Fish and Wildlife Service ("FWS") have published a policy to define a "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the ESA. 61 FR 4722 (February 7, 1996). Under this policy, a population segment must be found to be both "discrete" and "significant" before it can be considered for listing under the Act. The insular Hawaiian false killer whale meets both of these criteria and thus is a listable entity under the ESA.

A. Discreteness

Under the joint NMFS/FWS policy, a population segment of a vertebrate species is considered discrete if it satisfies either of the following conditions:

1. It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors.

2. It is delimited by international governmental boundaries within which difference in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

The insular population of Hawaiian false killer whales satisfies the first criteria: they are markedly separated from other false killer whales by a number of distinct factors.

1. The insular population of Hawaiian false killer whales is behaviorally unique from other false killer whales

Throughout their distribution, false killer whales are considered a wide-ranging pelagic species not typically associated with coastal or island habitats. The insular Hawaiian false killer whales are the only known long-term, island-associated false killer whales in the world. Photo-identification data demonstrate that this demographically isolated population resides in close proximity (median=8 km from shore) to the Hawaiian Islands with re-sightings of individuals spanning a 21-year period (Baird et al. 2008a).

One other study has reported repeat sightings of individual false killer whales near islands off the coast of Costa Rica over a two-year period (Acevedo-Gutierrez et al. 1997). However, these whales were considered by the authors to be pelagic and only foraging near the islands. Although false killer whales may approach other islands, no other false killer whale population is known to consist of island-associated residents.

2. The insular population of Hawaiian false killer whales is genetically distinct from other false killer whales

Recent genetic data indicates that insular Hawaiian false killer whales are genetically distinct and demographically independent from other false killer whales (Chivers et al. 2007). In a study of mitochondrial haplotypes sampled from false killer whales throughout the Pacific including Hawaii, the central Indian Ocean, the eastern and western Pacific Ocean, and the western Atlantic Ocean, researchers found that the Hawaiian population was dominated by a few unique haplotypes that are not found elsewhere (Chivers et al. 2007). Additional samples obtained since the 2007 study support the same findings (Chivers unpub.). The haplotypes found within the Hawaiian archipelago are sufficiently divergent from haplotypes found in other geographic areas to be statistically significant, which suggests the population has been isolated for some time with limited maternal gene flow (Chivers et al. 2007).

Mitochondrial DNA differentiation provides evidence solely on matrilineal gene flow. Currently, no information from bi-parentally inherited markers is available to determine whether male-mediated gene flow is occurring (as is commonly observed in cetacean populations). However, the available data indicate that the insular population of false killer whales includes genetically distinct matrilines. Because cultural traits such as foraging strategies and alloparenting are also believed to be transmitted via matrilines in many cetacean species, the presence of unique genetic matrilines in the insular population also suggests unique cultural traits (Whitehead 1998). While the social structure of false killer whales is poorly known, observed nucleotide diversity is more comparable to species with known matrilineal structure such as sperm whales, pilot whales, and killer whales than it is to other delphinids (Chivers et al 2007).

3. The insular population of Hawaiian false killer whales constitutes a stock under the Marine Mammal Protection Act

Insular Hawaiian false killer whales are classified as a "stock" under the Marine Mammal Protection Act (MMPA). The exact geographic boundary that defines the insular stock is unknown (Chivers et al. 2007); however, the 2008 Stock Assessment Report provisionally applies the 25-75 nmi distance from the main Hawaiian Islands as a stock boundary, corresponding to the longline exclusion boundary (Caretta et al. 2009). In classifying stocks, NMFS generally follows the phylogeographic approach of Dizon et al. (1992), which involves a four-part analysis of 1) distributional data, 2) population response data, 3) phenotypic data, and 4) genotypic data. While the analysis of whether a given marine mammal population is considered a stock differs from DPS analysis under the NMFS/USFWS DPS policy, the classification of Hawaii insular false killer whales as a stock supports the finding that the population is a listable entity under the ESA.

B. Significance

According to the listing policy, once a population is established as discrete, its biological and ecological significance are considered. This consideration may include, but is not limited to, the following:

1. Persistence of the discrete population segment in an ecological setting unusual or unique to this taxon;
2. Evidence that loss of the discrete population would result in a significant gap in the range of a taxon;
3. Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range; and
4. Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

The insular population of Hawaiian false killer whales meets two of the significance criteria.

1. The insular population of Hawaiian false killer whales occupies a unique ecological setting

The Hawaiian archipelago is the most isolated island group in the world. The isolation of this island group and its biology has led to high rates of endemism, or ecologically and evolutionarily unique organisms (Briggs 1961, 1966, Carlquist 1966). In a multitaxon study of centers of marine endemism worldwide, the Hawaiian Islands ranked fifth, demonstrating the high evolutionary isolation of this region (Roberts et al. 2002).

While centers of endemism are usually rare in cetaceans, numerous cetacean species around the Hawaiian Islands appear to be evolutionarily isolated from the surrounding pelagic waters. Several other cetaceans that are considered to be wide-ranging have also developed morphologically and genetically distinct populations near the Hawaiian archipelago lending further evidence that the area is ecologically unique for marine mammals. For example, Bryde's whales and short-finned pilot whales sampled around the Hawaiian Islands are genetically distinct from animals sampled in the surrounding pelagic waters (Chivers et al. 2003, 2007). Additionally spinner dolphins, rough-toothed dolphins and bottlenose dolphins also appear to have demographically independent island populations throughout the Hawaiian archipelago (Norris et al. 1994, Galver 2002, Martien et al. 2005, Andrews et al. 2006, Baird et al. 2008b). According to Baird et al. (2008a), "The factors that may encourage the evolution of island-associated populations may be similar for all of these species; the central tropical Pacific is oligotrophic, and the oceanographic influence of the islands increases productivity immediately around the islands (Doty and Oguri 1956, Gilmartin and Revelante 1974, Seki et al. 2002), and reduces the spatial and temporal variability in prey availability." These ecologically unique characteristics of the Hawaiian Islands have resulted in the evolution of unique populations of cetaceans including the insular Hawaiian false killer whales.

Furthermore, the insular population of Hawaiian false killer whales is the only population of false killer whales known to be residents of an island system (Baird et al. 2008a). The remainder of the species is found in pelagic waters further indicating that the Hawaiian population occurs in an ecological setting that is unusual and unique to the taxon.

2. The insular population of Hawaiian false killer whales differs markedly from other populations of the species in its genetic characteristics

As discussed above, an examination of mitochondrial haplotypes found that the Hawaiian Island-associated false killer whales are uniquely identifiable by their mitochondrial haplotypes from false killer whales sampled throughout the rest of the eastern North Pacific (Chivers et al. 2007).

III. Abundance and population trends in the insular population of Hawaiian false killer whales

The most recent abundance estimate for Hawaiian insular *P. crassidens* is 123 individuals (CV=0.72) using mark-recapture photo-identification data from 2000-2004 (Baird et al.

2005). An earlier study using line-transect aerial surveys from 1993-1998 estimated 121 individuals (CV=0.47) for the insular stock occurring within 46 km of the main islands (Mobley et al. 2000). When compared with other stocks, these abundance estimates indicate that insular false killer whales may have the smallest population size of any odontocete species within the Hawaiian EEZ (Barlow 2006).

Aerial surveys conducted in 1989 within 55 km of the islands of Hawaii, Lanai and Oahu recorded false killer whales as the third most commonly seen species of odontocete representing 17% of sightings (Reeves et al. 2009). Groups of more than 300 individuals were seen on three different days with minimum counts of 380, 460 and 470. This information, combined with the more recent population estimates of 121 (Mobley et al. 2000) and 123 (Baird et al. 2005), suggests that the population of false killer whales around the islands has undergone a substantial decline within the past 20 years (Reeves et al. 2009). Because these 1989 surveys were conducted with different methodology than more recent ones, it is not possible to statistically assess the significance of this downward trend. However, a series of five aerial surveys using consistent methodology from 1993 through 2003 (conducted by Mobley et al.) do show a downward trend in sighting rates, further indicating a decline in the size of the population (Figure 1; Mobley et al. 2000, unpub., Baird 2009).

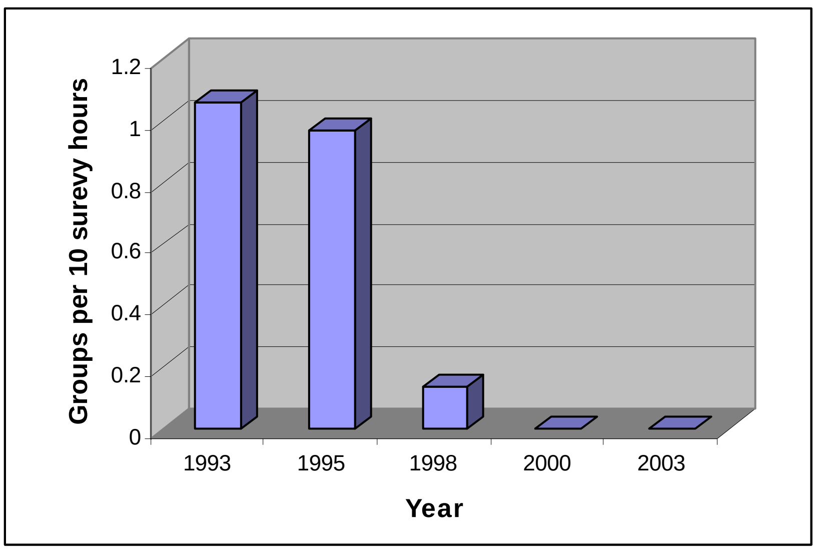

Figure 1. Groups of false killer whales identified by aerial line-transect survey over a 10 year period (1993-2003). From Mobley et al. 2000, unpublished.

Mobley et al. (2000, unpub.) flew aerial transect lines between 1993-2003 to determine the distribution and abundance of all marine mammals within approximately 25 nautical miles (46 km) of the major Hawaiian Islands (Figure 2). They encountered false killer whales in numerous locations (Figure 3) during their surveys in 1993, 1995 and 1998. In subsequent surveys in 2000 and 2003, however, no false killer whales were sighted (Mobley et al. unpub.).

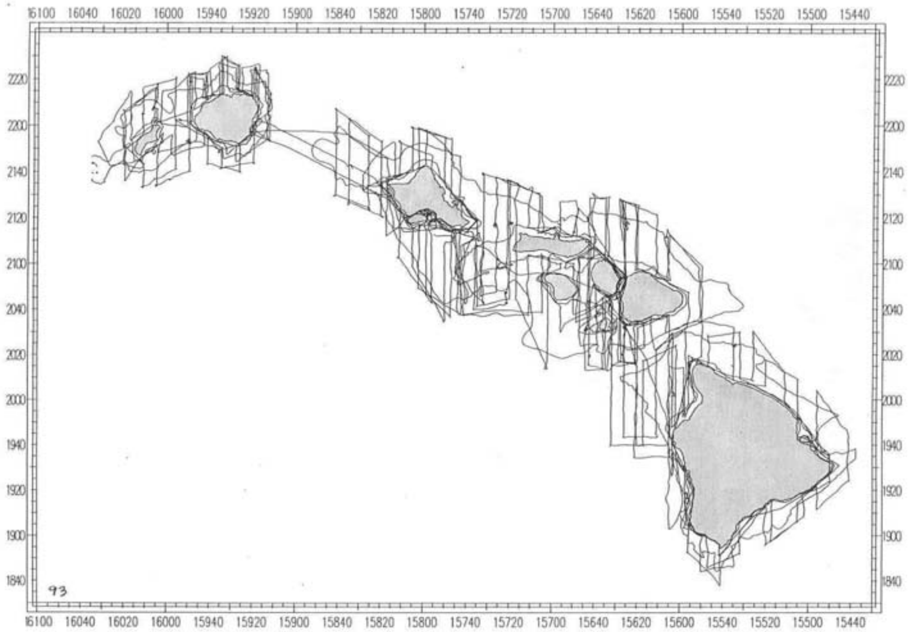

Figure 2. Example of aerial transect lines flown by Mobley et al. during their 1993 survey. Contour lines indicated 100 and 1000 fathom isobaths.

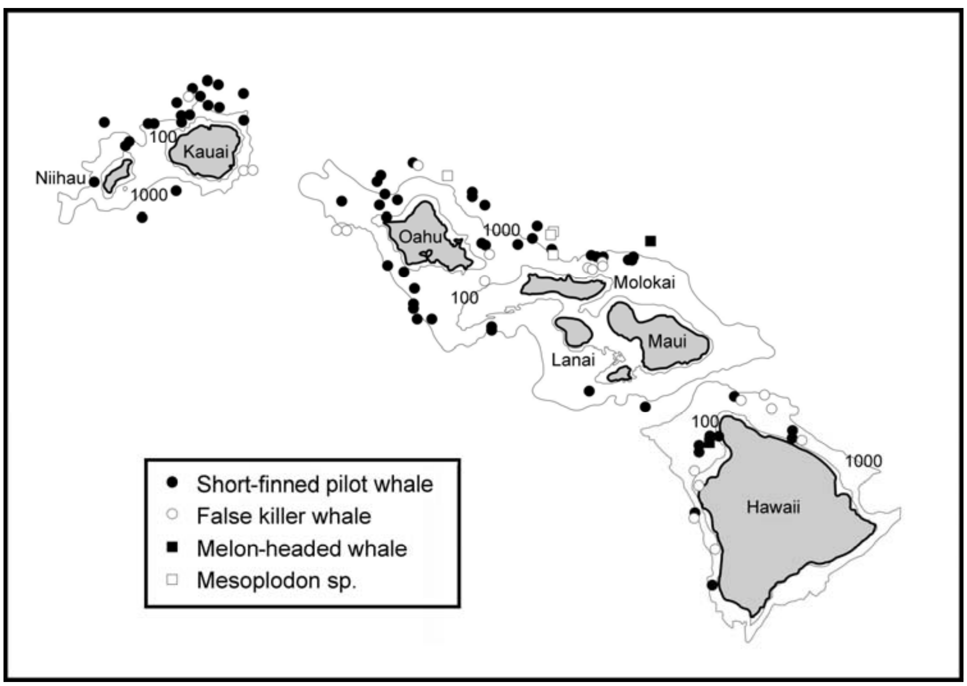

Figure 3. Locations of false killer whales when sighted during the 1993, 1995 and 1998 aerial surveys (Mobley et al. 2000).

Taken together, several lines of evidence indicate that the insular Hawaiian stock of false killer whales has experienced a decline within the past one to two decades: 1) the largest group of individuals observed in 1989 (numbering 470) is larger than the entire estimated abundance today; 2) false killer whales represented 17% of sightings in the 1989 aerial survey and only 1.5% in boat-based surveys from 2000-2006 (Baird et al. 2008a, Reeves et al. 2009); 3) group size has declined from a median of 195 individuals in 1989 to a median of 15 in boat-based surveys from 2000-2006 (Baird et al. 2008a, Reeves et al. 2009); 4) aerial surveys within approximately 46 km of the Hawaiian coast conducted throughout the 1990s made 18 sightings of false killer whales (239 hours of survey effort), compared with zero sightings in 2000 and 2003 (125 hours of survey effort) (Mobley et al. 2000, Mobley et al. unpublished); and 5) re-sighting rates of false killer whales identified in the 1980s are low compared with rates in other species such as pygmy killer whales, Blainville's beaked whales and Cuvier's beaked whales, potentially suggesting a reduced survival rate in the 1990s (Baird 2009). Finally, a preliminary analysis of mark-recapture data dating back to 1986 indicates that the mean annual survival rate for the insular stock appears lower than would be expected (0.92) for a long-lived cetacean species (Baird and Barlow unpub.).

IV. The insular population of Hawaiian false killer whales qualifies as endangered under ESA

The Endangered Species Act, 16 U.S.C. § 1531-1534, allows for the protection of any species of fish, wildlife, or plant. In the case of vertebrates, the Act also allows for the protection of distinct population segments (DPS). The insular population of Hawaiian false killer whales meets the criteria of a distinct population segment. It therefore qualifies as a "species" under the ESA. 16 U.S.C. §1531. Petitioners seek protection for the species throughout its range.

Under the ESA, a species must be listed if it is in danger of extinction or threatened by possible extinction in all or a significant portion of its range, 16 U.S.C. 1533 (a)(1). In making this determination, the agency must rely "solely on the best scientific and commercial data available" and analyze the species' status in light of five statutory listing factors:

1. the present or threatened destruction, modification, or curtailment of its habitat or range;
2. overutilization for commercial, recreational, scientific or educational purposes;
3. disease and predation
4. the inadequacy of existing regulatory mechanisms; and
5. other natural or manmade factors affecting its continued existence.

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

The insular population of Hawaiian false killer whales is endangered by three of the five listing factors: present modification of its habitat, the inadequacy of existing regulatory mechanisms, and other natural or manmade factors.

A. Modification of habitat

1. Mortality/serious injury via fishing gear

Incidental mortalities due to fisheries are among the greatest threats to cetaceans. For example, a recent study of bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida, indicates that 2% of the population died in 2006 as a result of ingestion of fishing gear (R. Wells, pers comm., Powell 2009). Fisheries interactions between pelagic longlines and Hawaiian *P. crassidens* have been identified in fisherman's logs and by NMFS observer records (Nitta and Henderson 1993, Carretta et al. 2007). Hawaiian false killer whales have been observed taking catches from longlines and trolling lines of commercial and recreational fishing vessels (Shallenberger 1981). While it is difficult to determine the relative proportions of insular and pelagic false killer whales that interact with the longline fisheries, fin disfigurations within the insular population of Hawaiian false killer whales suggests that the near-shore individuals experience fisheries interactions and injuries (Baird and Gorgone 2005).

The Hawaii-based longline fishery expanded in the late 1980s (Pooley 1993), and the present Hawaiian longline exclusion boundary was implemented in 1992. Between October and January, roughly 25% of the longline fishing effort occurs within the range of the insular stock (R. Baird, pers. comm.). Forney and Kobayashi (2007) report that from 1994-2005, 20 false killer whales were killed or seriously injured in the Hawaii-based deep-set longline fishery based on 4-34% observer effort (i.e., a rate of 0.81 false killer whales caught per 1000 sets). The 2008 Stock Assessment Report states that, between 1994 and 2007, there have been 24 false killer whales observed as hooked or entangled in the Hawaii-based deep-set longline fishery, with an additional 15 unidentified animals that may have been false killer whales based on observer descriptions (Carretta et al. 2009).

Between 2003 and 2007, the deep-set longline fishery had 20-28% observer coverage with 14 false killer whale mortalities and serious injuries observed, and animals hooked or entangled within the Hawaii EEZ accounted for the majority of these. The average mortality/serious injury rate within that period was 7.4 (CV=0.19) animals per year in the Hawaiian EEZ (Carretta et al. 2009), for an estimated take of 37 animals in that period. This compares with average annual mortality of 5.4 outside of the U.S. Exclusive Economic Zone and 0.3 within the Palmyra Exclusive Economic Zone. While these takes are considered by the 2008 Stock Assessment Report to be from the pelagic stock, the SAR recognizes that some of this take may be coming from the insular population and recommends further study. Baird and Gorgone (2005) found a disfigurement rate of 4% in the insular population of Hawaiian false killer whales and conclude the rate of disfigurement may be four times higher than in other odontocete populations.

Interactions also occur between the insular false killer whale population and near-shore commercial and recreational fisheries (Nitta and Henderson 1993, Rhodes et al. 2007) including a federally unregulated shortline fishery, but the extent of these interactions is not well known since there are no observer programs in place for these fisheries. The shortline fishery off Hawaii was recently classified as a Category II fishery in the federal List of Fisheries. This fishery targets big-eye tuna (*Thunnus obesus*) and lustrous pomfret (*Eumisgistes illustris*) and has grown from 5 to 11 vessels from 2003 to 2008. No reporting system has been implemented to record marine mammal interactions, but anecdotal evidence suggests that interactions have occurred off the north side of Maui (74 FR 27745). Additional recent anecdotal information suggests that the insular population of Hawaiian false killer whales may be impacted by deliberate shootings as a result of interactions with small-scale fishers (NMFS 2009). Therefore both direct and indirect evidence suggests that the insular population of Hawaiian false killer whales experiences mortality and serious injury due to interactions with fisheries.

2. Overfishing and prey reductions

Large-scale reductions in predatory fish populations have been well documented world-wide (e.g. Baum et al. 2003, 2005, Sibert et al. 2006, Polacheck 2006), though the extent to which this may impact cetacean predators is not known. In Hawaii there have been documented changes in prey populations that may negatively influence false killer whale foraging. Bigeye tuna, for example, is currently overfished in the Pacific (NMFS 2009a). Biomass of yellowfin tuna in the Pacific in general has declined (Sibert et al. 2006). Catch-per-unit-effort data from the Hawaiian troll fishery for yellowfin tuna from 1987-2006 show a significant declining trend, and average body weight of mahi mahi caught in the Hawaiian longline fishery has also declined since 1987 (Anonymous 2006). These observations suggest that prey reductions may be impacting the insular population of Hawaiian false killer whales.

3. Potential for increased levels of toxic chemicals

Accumulation of high tissue levels of persistent organic pollutants (POPs) has been associated with biological and physiological effects including reproductive impairment and immunosuppression in several species of marine mammals (DeLong et al. 1973, DeSwart et al.1994, Ross et al. 1995, Beckmen et al., 2003, O'Hara and O'Shea 2001). The high trophic level at which false killer whales feed is likely to increase their exposure to organochlorine pollutants (Baird et al. 1989, Muir and Norstrom 1991, Bergman et al. 1992, Bergman et al. 1994, Jarman et al. 1996, Endo et al. 2007). In addition, false killer whales are long-lived, increasing their susceptibility to bioaccumulation. Recent analyses have documented wide ranges of persistent organic pollutants in 9 of 9 samples taken from false killer whales from the insular Hawaiian population (Ylitalo et al. 2009). One third of these samples contained levels of PCBs above the safety recommendations identified for other species (Kannan et al. 2000), indicating that Hawaiian false killer whales may suffer health effects from pollutant exposure.

False killer whales are also at risk from swallowing plastic debris, which has lead to death in several similar species (Stamper et al. 2006).

4. Ocean acidification

Increasing atmospheric concentrations of CO_2 may further endanger Hawaiian insular false killer whales. Ocean acidification may decrease the availability of prey by reducing the forage base of large game fish such as yellowfin tuna and mahi mahi. The combination of rising CO_2 levels and rapidly declining midwater oxygen concentrations due to warming seawater will likely cause large-scale increases in dead zones in the Pacific (Brewer and Peltzer 2009). This expansion of dead zones may severely compress the amount of hospitable habitat available for squid and other species that spend part of their diurnal cycle at depth. Ocean acidification will also decrease rates of calcification in calcareous organisms including molluscs and crustaceans, and may reduce survival and reproduction in these taxa due to greater energetic costs of shell-building (Fabry et al. 2008). Collectively, squid and calcareous organisms such as crustaceans form a large part of the mesopelagic micronekton in Pacific communities (Brodeur and Yamamura 2005), as in other marine ecosystems (Fredericksen et al. 2007, Richardson and Schoeman 2004). Many species of game fish forage directly on mesopelagic microneckton (Bertrand et al. 2002, Dagorn et al 2000), suggesting productivity declines in this trophic link will negatively impact primary predators such as the false killer whale.

5. Potential for acoustic impacts on false killer whale behavior

Noise-producing activities around the Hawaiian Islands have the potential to disrupt vital behavior in the insular population of false killer whales. For example, mid-frequency acoustic sources are associated with a variety of impacts on cetaceans, with particularly acute impacts, including injury and mortality, seen in beaked whale species exposed to mid-frequency naval sonar, and strandings, habitat displacement, and disruptions in vocalization, dive patterns, and other essential behaviors seen in various other species (e.g., Nowacek et al. 2004, Fernandez et al. 2005, Kastelein et al. 2005, Weilgart 2007, Brownell et al. 2009). The U.S. Navy's Hawaii Range Complex, which employs mid-frequency active sonar in unit-level, strike-group, and multi-strike-group exercises, encompasses virtually the entire known range of the insular population (U.S. Navy 2008). Like other delphinids, false killer whales commonly vocalize in the mid-frequencies (Murray et al. 1998).

B. Inadequacy of existing regulatory mechanisms

1. State law

The State of Hawaii maintains several statutes and regulations that nominally extend to marine mammals, but their applicability is limited in this case and none has proven effective in conserving the insular population. In particular, Hawaii Revised Statutes § 195D and Hawaii Administrative Rules § 13-124 prohibit take of endangered and threatened species and of species indigenous to Hawaii. Since neither state nor federal law currently lists any stock of false killer whales as endangered or threatened, the population does not receive any special protections that state law affords listed species. Haw. Rev. Stat. § 195D-4; Haw. Admin. R. § 13-124 Exs. 2, 3. Nor has the state recognized the insular population as a distinct biological unit for management purposes under its indigenous species regulation. Haw. Admin. R. § 13-124 Ex. 1. Furthermore, NOAA General Counsel has stated, in a 2008 legal opinion, that these same statutes and rules are preempted by the MMPA, 16 U.S.C. § 1379, and are therefore unenforceable by Hawaii, to the extent that they relate to the taking of marine mammals (Luxton 2008).

In practice, Hawaii's laws have not succeeded in conserving the species within the limited purview of state waters. As described above and noted again below, the state of Hawaii does not monitor for marine mammal bycatch in any of its commercial or recreational fisheries, and a high occurrence of dorsal fin disfigurements (Baird and Gorgone 2005) and other observations suggest fisheries interactions with the Hawaii insular population. Nor has Hawaii successfully addressed other threats to the population posed by fisheries. While state law (Haw. Rev. Stat. § 187A-5.5) allows the Department of Land and Natural Resources to adopt rules, consistent with the Magnuson-Stevens Fishery Conservation and Management Act, to correct overharvesting in fisheries occurring within both federal and state waters, that discretion has not prevented the decline in population or body size of the insular stock's principal prey species, particularly yellowfin tuna and mahi-mahi, as noted above (Sibert et al. 2006, Anonymous 2006).

2. Federal law

a. MMPA

The Marine Mammal Protection Act, 16 U.S.C. §§ 1361-1423, was enacted in 1972 to ameliorate the consequences of human impacts on marine mammals. Accordingly, the law contains specific provisions to reduce marine mammal bycatch from commercial fishing and requires that proponents of various other activities obtain prior authorization from the Secretary of Commerce before incidentally taking marine mammals. 16 U.S.C. §§ 1371(a)(5), 1374, 1387. The measures afforded by the MMPA are inadequate, however, to protect the insular stock of Hawaiian false killer whales from the significant threats described above and below.

First, the MMPA has not adequately protected the population from bycatch and other fisheries interactions. Several fisheries known to take false killer whales, including the same longline fisheries that have pushed the pelagic stock into strategic status, partly occur within the insular stock's range on at least a seasonal basis (Carretta et al. in prep.). Although the Category II shallow-set longline fishery maintains an observer coverage of 100%, the Category I deep-set fishery achieves only 20% coverage (Carretta et al. 2009) and the Category II shortline fishery goes entirely unobserved despite reports of marine mammal interactions on the north side of Maui (74 FR 27745). Disturbingly, near-shore false killer whales photographed over years of surveys have evinced an unusually high rate of dorsal fin disfigurements indicative of line-related injury (Baird and Gorgone 2005). The most recent stock assessment report for the insular population sets a limit on potential biological removal at fewer than 1 whale (n=0.8) per year (Carretta et al. 2009). Nonetheless, because NMFS does not presently recognize the population as a "strategic stock," and because it has not otherwise decided pursuant to 16 U.S.C. § 1387(f)(1) to address bycatch of the population, the insular stock of false killer whales has not benefited from a take reduction plan for any of the salient Hawaii fisheries.

Second, even a strategic stock designation would not sufficiently address the ambit of threats facing the population, including bycatch. Although NMFS' stock assessment reports from 2004 through 2007 characterized the insular and pelagic populations as part of a single strategic stock (Carretta et al. 2004), NMFS demurred convening a take reduction team for Hawaii's Category I longline fishery on the grounds of insufficient funding, pursuant to 16 U.S.C. § 1387(f)(3). Nor would observer coverage of the shortline and deep-set longline fisheries necessarily improve with a "strategic" designation: the MMPA requires that NMFS first allocate funds for observers to species listed as endangered or threatened under the ESA, with strategic stocks a lower priority. 16 U.S.C. § 1387(d)(4)(B). Finally, and perhaps most importantly, the development of a bycatch reduction plan would not address other threats to the stock, including overfishing of its principal prey species, toxic contamination, and direct shootings of animals by local fishers.

For all these reasons, the MMPA has not proven adequate to protect the insular population.

b. Magnuson-Stevens Fishery Conservation and Management Act

First enacted in 1976, the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. §§ 1801-1884, is the leading federal statute governing marine fisheries in U.S. waters and the Exclusive Economic Zone. The law establishes various Regional Fishery Management Councils throughout the country that promulgate management plans for each federally managed fishery, with the review and approval of the Secretary of Commerce. 16 U.S.C. § 1852(a)(1), § 1854. While the law provides some authority to protect marine mammal species,[1] it does not mandate the use of regulatory mechanisms adequate to conserve the false killer whale.

First, the reach of the Magnuson-Stevens Act, even within the United States, is limited. The provisions of the Act do not apply to Hawaii waters (that is, within three nautical miles from shore), 16 U.S.C. § 1856(a), which are managed exclusively by the Hawaii Department of Land and Natural Resources. As described above, Hawaii does not manage its shortline or other commercial or recreational fisheries for marine mammal interactions and there is evidence of inshore false killer whale injuries and even mortalities associated with these fisheries.

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[1] The Magnuson-Stevens Act charges Regional Fishery Management Councils with promulgating measures that "prevent overfishing and rebuild overfished stocks, and to protect, restore, and promote the long-term health and stability of the fishery" while achieving "optiumum yield" from each fishery 16 U.S.C. § 1853(a)(1),2); The law also specifies that optimum yield is to be calculated by taking into account "social, economic, and ecological factors" including impacts on marine mammals. 50 C.F.R. § 600.310. However, these regulations, and the Act's optimum yield mandates, are so general that they have proved to have little impact on the consideration of ecological factors by Fishery management Councils when setting catch limits.

Second, while changes have been made to the longline fisheries that are managed under Magnuson-Stevens, [2] these changes have not proven adequate to prevent the hooking or entanglement of insular false killer whales. As NMFS's 2008 Stock Assessment Report for Hawaiian *P. crassidens* explains, the deep-set longline fishery (which targets tuna) is well known to regularly hook or entangle false killer whales (Carretta et al. 2008). While this fishery normally operates outside the areas in which the insular stock is expected to be found, longline boats fish within the insular population's range for four months a year (Carretta et al. in prep.). Moreover, scientists have documented a high rate of injury to the whales' dorsal fins consistent with fishing gear encounters. (Id.) Thus, as currently administered, the Magnuson-Stevens Act is not providing the insular false killer whales with sufficient regulatory protections to guard it against the possibility of serious injury or mortality. Given the extremely small size of this stock (possibly as few as 120 individuals), the loss of even a few mature adults could have serious reproductive consequences on the population as a whole.

Third, the Magnuson-Stevens Act has not been successful in preventing the depletion of fisheries (Baum et al. 2003, 2005, Sibert et al. 2006, Polacheck 2006). This is particularly true of highly migratory species, which travel in and out of U.S. jurisdiction. In the central Pacific documented declines have occurred in catch-per-unit effort or body size of several of the stock's main prey, bigeye tuna, yellowfin tuna and mahi mahi (NMFS 2009a, Sibert et al. 2006, Anonymous 2006). As described above, because the insular stock of false killer whales rely on these very species as their primary prey, the decline of these fisheries, and the failure of the Magnuson-Stevens Act to arrest that decline, poses another threat to the population.

The regulatory mechanisms put in place by the Magnuson-Stevens Act are thus inadequate to conserve Hawaii's insular population of false killer whales. The Act does not apply in State waters, has not adequately regulated the longline fisheries where it does apply to prevent false killer whale injury and mortality, and has generally proven unable to prevent the overharvesting and subsequent decline of the insular population's primary prey base.

3. Foreign and international law

The insular population of false killer whales occurs entirely within the territorial sea and Exclusive Economic Zone of the United States. No other nation has jurisdiction over the species or over any part of its range, nor has any other nation adopted laws to conserve or prevent its decline.

Furthermore, no international conventions or agreements exist that substantively address existing threats to the population. Because the insular stock does not predictably and

[2] The Magnuson-Stevens Act contains a general provision requiring fishery management plant to minimize bycatch and unavoidable bycatch mortality to the extent practicable, e.g., 16 U.S.C. § 1853(a)(11), as well as a requirement specific to tuna fisheries in the eastern tropical Pacific Ocean requiring the minimization of bycatch. 16 U.S.C. § 962.

cyclically cross U.S. jurisdiction (¶ 1(a)), it does not fall within the competence of the Convention on Migratory Species, 19 I.L.M. 15 (1980) and, accordingly, is not listed in the convention's appendices of covered wildlife (Convention on Migratory Species 2009). Nor does it fall within the ambit of any of the International Whaling Commission's management provisions, such as the moratorium on commercial whaling or the Southern Ocean Sanctuary, pursuant to the International Convention for the Regulation of Whaling, 161 U.N.T.S. 74 (1946). Finally, while false killer whales are listed generically, along with the majority of other cetaceans, under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, 12 I.L.M. 1088 (1973), international trade in false killer whales and whale parts does not constitute an existing threat to the Hawaii insular stock.

C. Other factors

1. Risks inherent to small populations

Purvis et al. (2000) describe the four most important risk factors for extinction as 1) high trophic level, 2) low population density, 3) slow life history, and 4) small geographic range size. The Hawaiian stock of false killer whales meets each of these risk factors. This stock feeds at a high trophic level (consuming primarily large pelagic fishes (Baird et al. 2008a)), and has a low population density estimated at roughly 120 animals (Baird et al. 2005, Mobley et al. 2000). This species is slow to mature and reproduce with an estimated calving interval of 7 years (Stacey et al. 1994). Its range is limited to the main Hawaiian Islands up to 96 km from shore (Baird et al. in review), giving it the smallest known range size of any stock of false killer whale.

Small populations are particularly vulnerable to extinction due to demographic and environmental stochasticity, the risks of local catastrophes, slower rates of adaptation, deleterious effects of inbreeding, and "mutational meltdown." Demographic stochasticity is chance variation in demographic parameters such as reproductive rate, a feature inherent to small populations, while environmental stochasticity refers to variability in environmental or ecological conditions such as oceanographic productivity or disease outbreaks. Small populations are also at risk of deleterious genetic effects on population health due to the loss of genetic variability over time (inbreeding) and the potential for "mutational meltdown" that arises from the expression of harmful alleles, also known as genetic load. Franklin (1980) posited that small populations have a reduced capacity for genetic adaptation due to these effects.

Island endemics are particularly susceptible to the effects of overexploitation or introduced species as they not only have small population sizes and ranges but have often evolved in isolation from a diversity of competitors and predators.

Of particular concern for low density animals with low reproductive rates such as cetaceans is the effect of small population sizes on the ability of individuals to find mates (the Allee effect). The Allee effect, also known as depensation, can cause a decline in per capita reproduction at low population densities. This effect is thought to be a potential factor in limiting recovery in several depleted cetacean species including Antarctic blue whales (*Balaenoptera musculus*) (Whitehead et al. 2000).

2. Synergistic and cumulative effects

The anthropogenic threats to false killer whales outlined above do not act in isolation, and their potential cumulative and synergistic impacts on the population must be considered. While some of these threats, such as contamination with persistent organochlorine pollutants, may themselves have significant sublethal effects, they may also contribute cumulatively towards reduced survival and reproductive rates in false killer whales. A decline in reproductive rate from toxic contamination, when combined with, for example, the allee effect, could have a significant impact on long-term population abundance. Likewise, mortality from bycatch when combined with potential mortality due to a reduction in prey base may result in a lowered survival rate.

Synergistic effects arise when the effects of multiple stressors are greater than the sum of the stressors considered in isolation. Such effects have been documented in the case of particular combinations of contaminants, but may also be observed across stressor types. For example, a reduction in prey can cause the animals to be on a lower nutritional plane and result in metabolism of stored fat. If contaminant levels are high, metabolizing fat can quickly mobilize high levels of toxins into the bloodstream causing acute health problems (e.g., Colborn and Smolen 1996).

V. Conclusion

The insular population of Hawaiian false killer whales is a small, discrete and ecologically unique population that has experienced decline in recent decades. The population faces a number of threats including interactions with local fisheries, a possible reduction in its prey species and exposure to toxic chemicals. Ocean acidification and acoustic impacts may also pose risks to Hawaiian false killer whales. In combination with the risks inherent to small populations and the potential cumulative effects of the above threats, the insular population of Hawaiian false killer whales qualifies as an endangered species under the U.S. Endangered Species Act.

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