I. Application for a Permit for Scientific Research under the Marine Mammal Protection Act and Endangered Species Act

II. Date of Application 7 November 2005

III. Applicant and Personnel

A. **Applicant/Permit Holder, Principal Investigator, Co-Investigators and other Personnel Directly Involved in Taking**

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B. Qualifications and Experience:
Curriculum vitae of the PI and CIs are in Appendix I

Research Assistants are chosen during the preparation of each field activity. As research assistants are identified, their qualifications and curricula vitae will be submitted to the NOAA Fisheries Office of Protected Resources.

IV. Proposal
A. Summary:

We are seeking a permit to conduct cetacean studies for a five-year period from the date of issuance. The primary purpose of these cetacean studies is to determine the abundance, distribution, movement patterns, habitat use, contaminant levels, prey, behavior, energetics and stock structure of cetaceans in U.S. territorial and international waters, focusing on the Pacific NW region. These studies are conducted through vessel surveys, photo-identification (from large vessels and small boats), biological sample collection, acoustic monitoring, tagging and tracking of individual animals. Cetacean abundance data will be used to monitor trends in abundance through time. Genetic and other analyses of biological samples collected will be used to determine stock structure for the appropriate management of these species. Tagging and tracking activities will help address outstanding needs for data on distribution, movements and dive times to improve stock assessments. Cetacean research activities will also include the salvage and import/export of cetacean parts, specimens and biological samples. In addition to import/export/re-export authorization for biological samples we will collect during the research activities described herein, we are requesting authorization to import/export/re-export parts, specimens salvaged by us and biological samples or salvaged parts and specimens collected by other researchers under their own authorization (such sample material will be deposited in our archive and analyzed by our chemical contaminants, molecular genetics and life history staff). The total number of biological samples to be salvaged and/or imported/exported is listed by species in Tables 1 and 2.

B. Introduction

1. Status of the species

(a) Species Description:

Harbor Porpoise *(Phocoena phocoena)*
- Morro Bay
- Monterey Bay
- San Francisco-Russian River
- Northern California/Southern Oregon
- Oregon/Washington coastal
- Washington inland-waters

Dall's Porpoise *(Phocoenoides dalli)*
- California/Oregon/Washington stock
- Alaska stock

Pacific White-sided Dolphin *(Lagenorhynchus obliquidens)*
- California/Oregon/Washington Northern and Southern stocks

Risso's Dolphin *(Grampus griseus)*
- California/Oregon/Washington stock

Striped Dolphin *(Stenella coeruleoalba)*
California/Oregon/Washington stock
Short-beaked Common Dolphin *(Delphinus delphis)*
California/Oregon/Washington stock
Northern Right Whale Dolphin *(Lissodelphis borealis)*
California/Oregon/Washington stock
Killer Whale *(Orcinus orca)*
Eastern North Pacific Northern Resident stock
Eastern North Pacific Southern Resident stock
Eastern North Pacific Transient stock
Eastern North Pacific Offshore stock
Short-finned Pilot Whale *(Globicephala macrorhynchus)*
California/Oregon/Washington stock
Baird's Beaked Whale *(Berardius bairdii)*
California/Oregon/Washington stock
Alaska stock
Mesoplodon spp.
California/Oregon/Washington stock
Cuvier's Beaked Whale *(Ziphius cavirostris)*
California/Oregon/Washington stock
Sperm Whale *(Physeter macrocephalus)*
California/Oregon/Washington stock
Pygmy Sperm Whale *(Kogia breviceps)*
California/Oregon/Washington stock
Gray Whale *(Eschrichtius robustus)*
Eastern Pacific stock
Eastern North Pacific stock
Minke Whale *(Balaenoptera acutorostrata)*
California/Oregon/Washington stock
Alaska stock
Blue Whale *(Balaenoptera musculus)*
Eastern North Pacific stock (California/Oregon/Washington)
Fin Whale *(Balaenoptera physalus)*
California/Oregon/Washington stock
Alaska stock
Humpback Whale *(Megaptera novaeangliae)*
Eastern North Pacific stock
Central North Pacific stock
Western North Pacific stock

(b) Life History and Population Status:

The applicant requests the authority to take marine mammals during research activities described in the application. Below is a status summary of each cetacean species for which takes are being requested. The most up-to-date information about the status of each species and/or stock and factors affecting the status of these stocks can be found in the stock assessment reports listed below, including appropriate references. These reports include the best data available on Stock Definition and Geographic Range, Population Size including a minimum Population Estimate and Current Population Trend, Current and Maximum Net Productivity rates, Potential Biological Removal, Annual Human-caused Mortality and Serious Injury and Status of Stock. The pertinent and most current stock assessment reports for the region are Carretta et al., 2004, Carretta et al. 2005, Krahn et al 2002, 2004 and Wiles 2004.

CETACEANS:

Harbor Porpoise (*Phocoena phocoena*): Harbor porpoises are widely distributed in cold-temperate waters of the Northern Hemisphere. In the Pacific Ocean, harbor porpoise are found in coastal and inland waters from Point Conception, California to Alaska and across to Kamchatka and Japan (Gaskin 1984). Harbor porpoise appear to have more restricted movements along the western coast of the continental U.S. than along the eastern coast. Regional differences in pollutant residues in harbor porpoise indicate they do not mix freely between California, Oregon, and Washington (Calambokidis and Barlow 1991). This pattern is in sharp contrast to the eastern coast of the U.S. and Canada where harbor porpoise are believed to migrate seasonally from as far south as the Carolinas to the Gulf of Maine and the Bay of Fundy (Polacheck *et al.* 1990). Genetic studies indicate that harbor porpoise along the west coast of North America are not panmictic or migratory, and movement is sufficiently restricted that genetic differences have evolved (Rosel 1992; Rosel *et al.* 1995; Barlow *et al.* 1995). In the west coast, the following six stocks of harbor porpoise are currently recognized for management purposes under the MMPA: Morro Bay, Monterey Bay, San Francisco-Russian River, Northern California/Southern Oregon, Oregon/Washington coastal, and Washington inland-waters (Carretta 2005). Furthermore, three stocks have been proposed and recommended by the Alaska SRG: the southeast Alaska stock, the Gulf of Alaska stock, and the Bering Sea stock (Angliss *et al.* 2001). However, this additional stock division has not yet been recognized for management purposes.

The central California stock (Morro Bay, Monterey Bay and San Francisco -Russian River) is estimated to be 8609 animals (CV = 0.38) based on pooled aerial surveys conducted between 1999 and 2002 (NMFS, K. Forney, unpubl. based on methods from Forney 1999a). Incidental mortality of harbor porpoise in fishing gear was largely limited to halibut set gillnet fisheries in central California. There has been a ban on set gillnets inshore of 60 fathom Point Reyes out to Point Arguello, CA since September 2002. Because the known human-caused mortality or serious injury (0.8 harbor porpoise per year) for the San Francisco-Russian River stocks is less that the PBR, this stock is not considered a “strategic” stock under the MMPA. Because average annual fishing mortality is less than 10% of the PBR, the fishing mortality can be considered insignificant and approaching zero mortality and serious injury rate. With the closure of the set net fisheries, it is likely that this goal will be met for the other two Central California stocks that are being monitored. The northern California stock was also estimated based on pooled aerial surveys, 1997-99 an updated estimate of abundance is 17,763 harbor porpoise (CV = 0.39) (Caretta et al. 2004). No significant trends in relative abundance were evident. The incidental capture of harbor porpoise in California was largely limited to set gillnet fisheries in central California. Coastal setnets are not allowed in northern California, and there have been not mortality reported in the KCA Klamath River tribal salmon gillnet fishery in the last five years.

Because the known human-caused mortality or serious injury is less than the PBR, this stock is not considered a ”strategic” stock under the MMPA. Because the average annual fishery morality is less than 10% of PBR, the fishery mortality can be considered insignificant and approaching zero mortality and serious injury rate (Caretta et al. 2004). For harbor porpoise in coastal Oregon and Washington waters the best-corrected estimate of abundance is 39,586 animals (CV = 0.384) based on an aerial survey in the early 1997 (Laake *et al.* 1998). This estimate is significantly higher than a 1991 estimate (26,175) due to a larger sampling area and different estimate of g(0) (Laake *et al.* 1998). In the U.S. EEZ of Oregon and Washington, fishery mortalities from set gillnets are presently known only to occur in northern Washington (Forney *et al.* 2000). The mean estimated fishery mortality is 3.2 animals per year based on data through 2001and is considered insignificant (Forney *et al.* 2000). The Oregon/Washington coastal stock of harbor porpoise is not considered strategic under the MMPA because estimated human caused mortalities (12) do not exceed PBR (328). Its status relative to OSP and its population trends are unknown (Caretta *et al.*, 2004).

The Washington inland-waters stock of harbor porpoise is estimated to be animals 3,509 (CV = 0.396) based on aerial surveys during the early 1996 (Calambokidis *et al.*, 1997, Laake *et al.*, 1997a, 1997b). Northern Washington set gillnet fisheries were monitored by NMFS observers from 1993-98 and the only fishery for which mortalities were observed was the Puget Sound treaty and non-treaty sockeye salmon gillnet (areas 7 and 7A) (Forney *et al.* 2000). An incidental take estimate of 15.4 animals was calculated for this fishery which is close to the PBR (Caretta *et al.*, 2004)). Because the estimated human-caused mortality does not exceed the calculated PBR(20) for this stock, it is not considered strategic under the MMPA. Data are insufficient to determine its status relative to OSP (Caretta *et al.* 2004).

Until further genetic analyses are conducted, only one stock of harbor porpoise is recognized in Alaskan waters. A corrected abundance estimate from aerial surveys of 27,714 (CV = 0.215) plus a corrected abundance estimate from vessel surveys of 2,030 (CV = 0.404) give a total corrected abundance estimate of 29,744 animals for this stock (Small and DeMaster 1995). However, this should be considered a minimum abundance estimate because survey effort did not include the Aleutian Islands or the Bering Sea. No reliable abundance estimates for British Columbia are available. There is currently no reliable information on trends in abundance for this stock. NMFS observers monitored incidental take in the following six fisheries within the range of the Alaska stock of harbor porpoise during 1990-1993: Bering Sea (and Aleutian Islands) groundfish trawl, longline and pot fisheries, and Gulf of Alaska groundfish, trawl, and pot fisheries. No mortalities were observed in these fisheries by the observer program, however, one harbor porpoise mortality and one injury were recorded in boat operators’ log books in 1990 (Small and DeMaster 1995). NMFS fishery observers in Prince William Sound observed one incidental take in 1990 and three incidental takes in 1991 in the salmon drift gillnet fishery (Small and DeMaster 1995). The estimated average annual mortality rate incidental to commercial fisheries is 33 animals. Based on available information, the estimated level of human-caused mortality does not exceed the calculated PBR for this stock, thus the Alaska stock of harbor porpoise is not considered strategic under the MMPA.

Dall’s Porpoise (*Phocoenoides dalli*): Dall’s porpoise are endemic to the temperate waters of the

North Pacific Ocean and adjacent seas where it occurs from central Baja California, Mexico in the east, northern Japan in the west, and the southern Bering Sea in the north (Jefferson 1988). They have been sighted as far north as 65°N (Buckland *et al.* 1993a) and as far south as 28°N (Leatherwood and Fielding 1974). Throughout its entire range, as many as eight stocks have been proposed, but in many areas questions regarding stock structure have yet to be resolved (IWC 1991b, 1992a).

The stock structure of this species in the eastern North Pacific is not known, but based on patterns of stock differentiation in the western North Pacific, where they have been more intensely studied, it is expected that separate stocks will emerge when data become available (Perrin and Brownell 1994). The following stocks are currently recognized for management purposes in U.S. waters: the California/Oregon/Washington stock and the Alaska stock.

The best overall abundance estimate for the California/Oregon/Washington stock is 99,517Dall's porpoise (CV = 0.33;Caretta *et al.* 2004), from combining average estimates for 1996 inland Washington waters and the 1996-2001 outer coast estimate from . No information regarding trends in abundance is available for this stock. Dall's porpoise are incidentally killed in drift gillnets used to catch swordfish, thresher shark and mako shark in offshore California, Oregon and Washington waters (Hanan *et al.* 1993). The average estimated annual mortality for Dall's porpoise in this fishery during five years of monitoring (1994-98) is 12 animals. This figure is less than 10% of the PBR for this stock; therefore, total fishery mortality for the California/Oregon/Washington stock of Dall's porpoise is considered insignificant. Similar drift gillnet fisheries occur along the entire Pacific coast of Baja California, Mexico and may take some Dall's porpoise from the same population during cold-water periods (Barlow *et al.* 1995). Additional mortality is also known to occur in the California/Oregon/Washington groundfish trawl fisheries, the California salmon troll fishery and the Washington Puget Sound salmon set and drift gillnet fishery. However, no overall estimate of mortality can be made for these three fisheries because of uncertainties in the data (Barlow *et al.* 1995). The average annual estimated human-caused mortality for this stock (7) based on 1997-20001 data is less than the PBR (729); thus, this stock is not considered strategic under the MMPA.

Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*): In U.S. waters, the following two stocks of Pacific white-sided dolphins are recognized for management purposes under the MMPA: California/Oregon/Washington stock and the Alaska stock. Along the U.S. West Coast, two forms of white-sided dolphins are known to occur (Walker *et al.* 1986; Chivers *et al.* 1993). However, there are no known differences in color pattern between these two forms, and it is not currently possible to distinguish animals without genetic or morphometric analysis (Carretta *et al.* 2001, 2003, 2005). Until means of differentiating the two forms for abundance and mortality estimation are developed, these two stocks must be managed as a single unit, namely the California/Oregon/Washington stock (Carretta *et al.* 2001). The best available abundance estimate for Pacific white-sided dolphins in U.S. West Coast waters for both the northern and southern forms is 59,274 animals (CV = 0.50), f based on the 2001 shipboard survey off CA, OR and WA (Barlow 2003).

In U.S. waters, Pacific white-sided dolphins are incidentally caught in California/Oregon thresher shark/swordfish drift gillnet fishery and in the California/Oregon/Washington domestic groundfish trawl fisheries (Carretta *et al.* 2001, 2003, 2005). The average estimated annual mortality for Pacific white-sided dolphins in this fishery for 1997-12001 is 5.4 animals (Carretta *et al.* 2005). Similar driftnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and probably take the southern form of this species. The overall marine mammal mortality rate in this fishery is similar to the California driftnet fisheries during 1990-1993 (0.15 marine mammals per set), but species-specific information is not available for the Mexican fishery. Average annual human-caused mortality for this stock during 1997-2001 (5.4) is considerably less than the calculated PBR (382) and therefore it is not considered a strategic stock under the MMPA. The status of Pacific white-sided dolphins in California, Oregon and Washington relative to OSP is not known and there is no indication of a trend in abundance for this stock (Carretta *et al.* 2005). The total fishery mortality is less than 10% of PBR and can therefore be considered insignificant.

Risso's Dolphin (*Grampus griseus*): Risso's dolphins are distributed worldwide in temperate and tropical waters (Carretta *et al.* 2001, 2003, 2005). In the eastern North Pacific, Risso's dolphins are commonly seen on the shelf in the Southern California Bight and in slope and offshore waters of California, Oregon, and Washington. The southern end of this population's range in the eastern North Pacific is not well documented, but Risso's dolphins have been sighted off northern Baja California, Mexico but a conspicuous 500 nmi gap was present between these animals and Risso's dolphins sighted south of Baja California and in the Gulf of California (Mangels and Gerrodette 1994). Thus, the Risso's dolphins off the U.S. west coast appear to be separate from those found in the ETP and the Gulf of California. Risso's dolphins are divided into two discrete areas for MMPA stock assessment reports: 1) waters off California, Oregon and Washington, and 2) Hawaiian waters.

An abundance estimate of 16,066 Risso's dolphins (CV = 0.28) was produced for waters of California, Oregon and Washington waters, from a weighted 1996-2001 average based on two most recent e ship surveys (Barlow 2003). No definitive statement on population trends or productivity rates is available for this stock (Carretta *et al.* 2001, 2003, 2005).

Risso's dolphins are incidentally killed in thresher shark/swordfish drift gillnets of California and Oregon, with an average estimated annual fishery-related mortality of 3.65 animals from 1997-2001 (Carretta *et al.* 2005). Similar drift gillnet fisheries exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same population (Carretta *et al.* 2001, 2003, 2005). The overall mortality rate for this fishery is similar to that observed in the California driftnet fishery, but species-specific information is not available for the Mexican fishery (Julian and Beeson 1998). Risso's dolphin mortality of an unknown extent has also been documented in the squid purse seine fishery off Southern California (Heyning *et al.* 1994). This mortality probably represents animals killed intentionally to protect catch or gear, rather than incidental mortality, and such intentional takes are now illegal under the 1994 amendments to the MMPA. The status of Risso's dolphins off the U.S. west coast relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. The average annual human-cause mortality for this stock (3.65) is estimated to be less than the PBR (115), so it is not classified as strategic under the MMPA.

Striped Dolphin (*Stenella coeruleoalba*): Striped dolphins are found in tropical and warm-temperate pelagic waters worldwide (Carretta *et al.* 2001, 2003, 2005). In U.S. waters, the following stocks of striped dolphins are recognized for management purposes under the MMPA: the California/Oregon/Washington stock, the Hawaii stock, and the western North Atlantic stock.

For the California/Oregon/Washington stock, Barlow (2003) estimates a population size of 13,934 animals (CV = 0.53), from a 1996-2001 weighted average based on two recent ship surveys. A Take Reduction Plan was implemented in 1997, which led to a decline in overall cetacean entanglements in drift gillnet fisheries. The average minimum estimated annual mortality from 1997-2001 was therefore zero. Similar driftnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and probably take the southern form of this species. The overall marine mammal mortality rate in this fishery is similar to the California driftnet fisheries during 1990-1995 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fishery. Total fishery mortality for this stock is considered insignificant. The status of this stock relative to OSP is unknown. Because of the low levels of human-caused mortality, striped dolphins in the U.S. waters of the west coast are not considered a strategic stock under the MMPA.

Short-beaked Common Dolphin (*Delphinus delphis*): In the eastern Pacific, the short-beaked common dolphin (*Delphinus delphis*) is widely distributed from southern California to central Chile, and west to about 135°W. For management purposes under the MMPA, three stocks of common dolphins are currently recognized in the eastern tropical Pacific (ETP): northern common, central common and southern common (Perrin *et al.* 1985; Dizon *et al.* 1992a). Wade and Gerrodette (1993) produced abundance estimates for these stocks from data collected during annual large-scale surveys between 1986 and 1990. The estimates (with coefficients of variation in parentheses) are as follows: northern, 476,300 (0.367); central, 406,100 (0.383); and southern 2,210,900 (0.217). Observers rarely distinguished between the short-beaked and long-beaked species during these surveys, so the estimate for the northern stock likely includes long-beaked common dolphins as well (Wade and Gerrodette 1993).

For management purposes under the MMPA, a single Pacific stock of short-beaked common dolphins is recognized and includes only animals found in the U.S. EEZ of California, Oregon, and Washington. Along California this species is the most common cetacean and occurs between the coast and at least 300 nmi offshore (Carretta *et al.* 2001, 2003,2005). They have been sighted as far north as 42°N, but are primarily seen south of Point Conception, California (Barlow *et al.* 1995). Their southward distribution into Mexican waters is continuous to approximately 13°N (Perrin *et al.* 1985; Wade and Gerrodette 1993; Mangels and Gerrodette 1994) and may be an extension of the northern common dolphin stock recognized in the ETP (Perrin *et al.* 1985). However, preliminary data on variation in dorsal fin color pattern suggests that there may be multiple stocks in California (Farley 1995). The best available abundance estimate for this stock is 449,846 animals (CV = 0.25) from a 1996-2001 weighted average based on two ship surveys (Barlow 2003). The status of the population relative to OSP is currently unknown. The total human-caused mortality (93) is less than PBR (3,656); therefore, short-beaked common dolphins are not considered a strategic stock under the MMPA (Carretta *et al.* 2005).

Northern Right Whale Dolphin (*Lissodelphis borealis*): The northern right whale dolphin is widely distributed in the cold-temperate North Pacific (Carretta *et al.* 2001, 2003, 2005). Little information is available on the stock structure or population size of this species. In U.S. EEZ, there is only a California/Oregon/Washington stock recognized for management purposes under the MMPA. The best estimated abundance for this stock is 20,362 animals (CV = 0.26), from a 1996-2001 weighted average from two ship surveys in California, Oregon and Washington waters (Barlow 2003). In U.S. waters, northern right whale dolphins are taken incidentally in the California/Oregon thresher shark/swordfish drift gillnet fishery, with a estimated minimum total annual take of 23 animals from 1997-2001 (Carretta *et al.* 2005). Only 1997-98 mortality estimates are included in the average because takes dropped significantly after the 1997 Take Reduction Plan was implemented. Drift gillnets exist along the entire Pacific coast of Baja California, Mexico and may take additional animals from this population, likely at a similar rate to those taken in the California fishery (an estimated 0.14 animals per set; Julian and Beeson, 1998).

The average annual human-caused mortality (23) is estimated to be less than the calculated PBR (158); thus, this stock is not considered strategic under the MMPA (Carretta *et al.* 2005). The total fishery mortality is greater than 10% of PBR and cannot be considered insignificant. They are not listed as threatened or endangered under the ESA or depleted under the MMPA. This stock's status relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance.

Killer Whale (*Orcinus orca*): Killer whales have been observed in all oceans and seas throughout the world (Leatherwood and Dahlheim 1978). In U.S. waters, the following six stocks of killer whales are recognized for management purposes under the MMPA: the eastern North Pacific northern resident stock, the eastern North Pacific southern resident stock, the eastern North Pacific transient stock, the eastern North Pacific offshore stock, the Hawaiian stock, and the western North Atlantic (Carretta *et al.* 2005).

The eastern North Pacific northern resident stock of killer whales occurs from British Columbia through Alaska (Carretta *et al.* 2001, 2003, 2005). Killer whales along British Columbia and Washington State have been labeled as resident, transient and offshore (Bigg *et al.* 1990, Ford *et al.* 1994). Although less is known about killer whales in Alaska, it appears that all three types exist in these waters (Dahlheim *et al.* 1997).

In Alaska waters, two populations of resident killer whales have been identified. These are the Southern Alaska Residents and the Western Alaska Residents (Krahn et al. 2004). Southern Alaska Residents include those whales from both the Southeast Alaska and Prince Williams Sound/Kenai Fjords areas. Intermixing between Prince William Sound and Southeast Alaska Residents has been documented (Krahn et al. 2004). The Western Alaska Residents occur from Kodiak Island westward to the Aleutian Islands and the Bering Sea shelf (Dahlheim 1997, Krahn et al. 2004). Movements of whales between geographical areas have been documented (Angliss and Lodge 2003). For example, whales identified in Prince William Sound have been observed near Kodiak Island (Heise et al. 1991) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim *et al.* 1997). The minimum estimate given for the eastern North Pacific killer whales is 1,038 killer whales (Carretta *et al.* 2005). Killer whale mortalities incidental to commercial fisheries in these waters have not been identified as either resident or transient. Six fisheries that potentially interact with killer whales were monitored between 1990 and 1999 and the only fisheries for which incidental kill was observed was the Bering Sea groundfish trawl and longline fishery. An estimated 1.4 mortalities occurred per year (when averaged from 1990 to 1999) for both the resident and transient stocks. This number cannot be considered insignificant because it is greater than 10% of PBR (0.72); however, since human related mortalities were below PBR (7.2) this stock is not considered strategic under the MMPA (Angliss *et al.* 2001).

The eastern North Pacific southern resident stock of killer whales occurs from mainly within the inland waters of Washington state and southern British Columbia, but also in coastal waters from British Columbia through California (Carretta *et al.* 2001, 2003, 2005). The SRKW are the only population of the eastern North Pacific killer whales to spend a considerable amount of time in the California Current ecosystem and to inhabit the coastal regions off California, Oregon, and Washington. From late spring (May or June) to early fall (October or November), SRKW are frequently sighted within the Georgia Basin, an area encompassing the waters of Georgia Strait, the San Juan Islands, and the Strait of Juan de Fuca in Washington State and British Columbia (Ford et al. 2000). In the summer, some of the Southern Residents travel to the outer coast of Washington and southern Vancouver Island for short periods while one pod (J pod) is generally found in waters inside the San Juan Islands (NMFS 2005). In early fall, all three pods move into Puget Sound, Washington (Osborne 1999). Although the winter range of the SRKW is less known, these whales occur intermittently in the Georgia Basin/Puget Sound area throughout the winter (Osborne 1999). SRKW have also been reported in Oregon waters (Depoe Bay, Yaquina Bay, and the mouth of the Columbia River) in March and April (NMFS 2005), and in Monterey Bay, California in January and March (Black *et al.* 2001, Krahn *et al.* 2004).

The population estimate for this stock was 99 whales in 1995, then declined to 79 whales in 2001 before increasing slightly to 84 whales in 2004 and 91 in 2005 (Center for Whale Research unpubl. data, Krahn *et al.* 2004). The total fishery mortality and serious injury for this stock is zero and can therefore be considered insignificant. They were listed as depleted under the MMPA in 2003, proposed for listing as threatened under the ESA on December 16, 2004, and were listed as endangered under the ESA in November 2005.

On May 2, 2001, the National Marine Fisheries Service (NMFS) received a petition from the Center for Biological Diversity and 11 co-petitioners to list Southern Resident killer whales (SRKW) as threatened or endangered under the Endangered Species Act (ESA). In August 2001, NMFS formally accepted the petition and began a status review to determine if these killer whales qualified for protection. To assist in the status review, NMFS formed a Biological Review Team (BRT) of scientists from the Alaska, Northwest, and Southwest Fisheries Science Centers, and worked with scientists, Tribal, State, and Canadian co-managers. In July 2002, NMFS determined that, while the population of SRKW was declining, the listing of this population was "not warranted" because the SRKW did not meet the significance criteria for consideration as a distinct population segment (DPS) when considered in the context of the global taxon.

Because of the uncertainties regarding killer whale taxonomy, NMFS announced that it would reconsider the taxonomy of killer whales within 4 years. At the same time, NMFS started the process to list SRKW as a "depleted" population under the Marine Mammal Protection Act (MMPA) and made the designation in May 2003.

On December 17, 2003, as a result of a court challenge brought by the original petitioners on December 18, 2002, the U.S. District Court for the Western District of Washington instructed NMFS to reconsider the process by which it determined listing eligibility and to make a new finding within a year. NMFS reconvened a second BRT in 2004 to consider new scientific and commercial data and update the status review for SRKW. In addition, NMFS co-sponsored a Cetacean Taxonomy workshop in 2004 and met with the public and Washington State and Tribal co-managers to discuss the updated status review.

Based on the best scientific data on behavior, demography, range, and genetics, the BRT unanimously concluded that the SRKW community is discrete from other eastern North Pacific killer whales. The BRT also evaluated the ecological setting, range, genetics, and behavioral and cultural diversity of the SRKW with respect to other North Pacific killer whales, and determined that the SRKW are significant, and therefore qualify as a DPS. In the conclusion of the second status review, the BRT expressed its concerns about the viability of the Southern Resident population and stated that "[t]he population is at risk for extinction, due either to small-scale impacts over time or to a major catastrophe" (Krahn *et al.* 2004).

The Eastern North Pacific Transient stock is a trans-boundary stock, including killer whales from British Columbia. The minimum population estimate for the Eastern North Pacific Transient stock of killer whales is 346 animals, which includes animals found in Canadian waters (see PBR Guidelines regarding the status of migratory transboundary stocks, Wade and Angliss 1997). At present, reliable data on trends in population abundance for the Eastern North Pacific Transient stock of killer whales are unavailable (Angliss and Lodge 2003). There are six different commercial fisheries that could interact with killer whales and the two in which incidental takes are documented is the Bering Sea/Aleutian Is. groundfish trawl and longline fisheries. The estimated total annual takes for these fisheries from 1994-98 is 0.6 whales (Carretta *et al.* 2001, 2003, 2005). This number exceeds 10% of PBR and cannot be considered insignificant. The estimated annual human-caused mortality (0.8) is not known to exceed PBR (2.8); therefore the stock is not considered strategic under the MMPA (Carretta *et al.* 2001, 2003, 2005).

Occurring from Southeast Alaska through California is the eastern North Pacific offshore stock of killer whales (Carretta *et al.* 2005). A conservative estimate for this stock is 466 animals (Carretta *et al.* 2005) along the U.S. west coast. The CA/OR thresher shark/swordfish fishery was observed from 1994-98 and resulted in an estimated mortality of zero killer whales. Set and drift gillnet fisheries exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same population (Carretta *et al.* 2005). The status of killer whales in California in relation to OSP is unknown, and there are insufficient data to evaluate trends in abundance. No habitat issues are known to be of concern for this species. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. There has been no documented human-caused mortality of this stock, and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for offshore killer whales is zero and can be considered to be insignificant and approaching zero mortality and serious injury rate (Carretta *et al.* 2005).

Short-finned Pilot Whale (*Globicephala macrorhynchus*): The short-finned pilot whale occurs in tropical and warm temperate waters worldwide. In the North Pacific Ocean its distribution extends into cool temperate waters. In general, stocks for this species are not well defined, except off Japan where two morphologically distinct allopatric stocks occur (Kasuya *et al.* 1988). The species overall abundance is undoubtedly high but some populations are depleted (IWC 1987).

In U.S. waters the following four stocks of short-finned pilot whales are recognized for management purposes under in the MMPA: the California/Oregon/Washington stock, the Hawaii stock, the western North Atlantic stock, and the northern Gulf of Mexico stock.

Although the full geographic range of the California/Oregon/Washington stock is not known, it may be continuous with animals found off Baja California, and is morphologically distinct from short-finned pilot whales found further south in the ETP (Polisini 1981). The 1996-2001 weighted average abundance estimate for the stock based on two ship surveys is 304 animals (CV= 1.02; Barlow2003). Short-finned pilot whales are taken incidentally in CA/OR thresher shark/swordfish drift gillnet fishery. The average estimated annual mortality for short-finned pilot whales in this fishery for the five complete years of monitoring (1997-2001) is 1.2 animals. Similar drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same population. The overall mortality rate in this fishery is similar to that observed in California driftnet fisheries in 1990-1995 (0.14 marine mammals per set; Julian and Beeson 1998), but species specific information is not available for the Mexican fisheries. The status of short-finned pilot whales off California, Oregon, and Washington relative to OSP is unknown. The estimated human-caused mortality (1.2) is greater than PBR (1.19), therefore, the stock is considered strategic. This stock is not listed as threatened or endangered under the ESA nor as depleted under the MMPA.

Baird's Beaked Whale (*Berardius bairdii*): The Baird's beaked whale is found in deep waters and along the continental slopes of the North Pacific Ocean, mainly north of 34°N in the west and 28°N in the east (Balcomb 1989). It also inhabits the seas adjacent to the North Pacific, namely the Bering Sea, the Okhotsk Sea, Sea of Japan, and the southern Gulf of California, Mexico (Balcomb 1989). They have been harvested and studied in Japan, but little is known about this species elsewhere (Balcomb 1989). In the U.S. waters of the eastern North Pacific, the following two stocks of Baird's beaked whales are recognized for management purposes under the MMPA: the California/Oregon/Washington stock and the Alaska stock.

Although this species has been sighted along the west coast on several aerial and shipboard line-transect surveys, sightings have generally been too rare to produce reliable population estimates for the California/Oregon/Washington stock. The best population estimate currently available for this stock is 228 animals (CV = 0.51), from a 1996-2001weighted average based on two ship surveys (Barlow 1997). This stock of Baird's beaked whales is susceptible to mortality in drift gillnets, which are used to catch swordfish, thresher shark, and mako shark in California offshore waters. Mean annual takes from this fishery for 1994-98 was zero. The estimate was based only on 1997-98 data because the Take Reduction Plan, implemented in 1997, significantly reduced mortality. Similar driftnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and probably take this species. The overall marine mammal mortality rate in this fishery is similar to the California driftnet fisheries during 1990-1993 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fishery. The status of Baird's beaked whales in California, Oregon, and Washington waters relative to OSP in unknown, and there are insufficient to determine population trends. They are not classified as strategic since the known human-caused mortality is zero. They are not listed as endangered or threatened under the ESA nor as depleted under the MMPA.

***Mesoplodon* spp.:** There is relatively little information for any of the species within the *Mesoplodon* genus. Within U.S. Pacific waters, mesoplodont beaked whales are distributed throughout deep waters and along the continental slopes of the North Pacific Ocean (Carretta *et al.* 2001, 2003, 2005). Although mesoplodont beaked whales have been sighted along the U.S. west coast on several aerial and shipboard line-transect surveys, sighting have generally been too rare to produce reliable abundance estimates, and species identification has been problematic. For the MMPA stock assessment reports, four *Mesoplodon* stocks are defined: all *Mesoplodon* species off California, Oregon and Washington waters, M. *densirostris* in Hawaiian waters, *M. stejnegeri* in Alaskan waters, and a western north Atlantic stock.

At least five species in this genus have been recorded off the U.S. west coast, but owing to the rarity of records and the difficulty in identifying these animals in the field, virtually no species-specific information is available (Mead 1989b). The five species known to occur in this range are: Blainville's beaked whale (*M. densirostris*), Hector's beaked whale (*M. hectori*), Stejneger's beaked whale (*M. stejnegeri*), Ginko-toothed beaked whale (*M. ginkodens*), and Hubb's beaked whale (*M. carlhubbsi*). The best possible abundance estimate for the California/Oregon/ Washington stock of unidentified mesoplodont beaked whales is 1,247 animals (CV = 0.92) from a 1996-2001 weighted average based on two ship surveys (Barlow 2003). Mesoplodont beaked whales are susceptible to mortality in drift gillnets, which are used to catch swordfish, thresher shark, and mako shark in California offshore waters. The average annual estimated mortality for in this fishery of whales identified to the genus *Mesoplodon* for five years of monitoring, 1994-98, is zero animals (Carretta *et al.* 2001, 2003, 2005). Similar driftnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same populations. The overall marine mammal mortality rate in this fishery is similar to the California driftnet fisheries during 1994-98 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fishery. The status of mesoplodont beaked whales in California, Oregon, and Washington waters relative to OSP in unknown, and there are insufficient to determine population trends (Carretta *et al.* 2005). The estimated annual average human-caused mortality does not exceed the PBR; thus, this group of species is not considered strategic under the MMPA. None of the five species are listed as endangered or threatened under the ESA nor as depleted under the MMPA.

Cuvier's Beaked Whale (*Ziphius cavirostris*): Cuvier's beaked whales are more commonly encountered than most other beaked whales. Three stocks of Cuvier's beaked whales have been defined based on (1) large distances between areas in which they are found, (2) different oceanographic habitats found in those areas, and (3) the different fisheries that operate within those three areas. The three stocks are: California/Oregon/Washington, Hawaii, and Alaska.

The 1996-2001 weighted average abundance estimate for California, Oregon and Washington waters is 1,884 (CV = 0.68) Cuvier's beaked whales (Barlow2003). The population to which the animals in California belongs, may be affected by high-seas driftnets and coastal driftnets and therefore, the status of these animals should be considered uncertain (Forney 1994). From the observed CA/OR thresher shark/swordfish drift gillnet fishery, the minimum total annual take from 1997-2001 is estimated to be zero (Carretta *et al.* 2005). The status of this stock relative to OSP is unknown. They are not listed as endangered or threatened under the ESA nor as depleted under the MMPA. Additionally, the stock is not considered strategic since there are no known human-caused mortalities. Noise in the environment, particularly active sonar is a concern for this species.

Sperm Whale (*Physeter macrocephalus*): The sperm whale has an extensive distribution that ranges throughout all deep oceans of the world from the equator to the edges of the polar pack ice (Rice 1989). There is much uncertainty surrounding the identity and status of sperm whale populations.

In the U.S. waters of the North Pacific, the following three discrete, non-contiguous areas are recognized for management purposes under the MMPA: the California/Oregon/Washington stock, the Hawaii stock, and the Alaska stock. The most precise abundance estimate for sperm whales of the California/Oregon/Washington stock is 1,407 animals (CV = 0.39), based on 1993 and 1996 ship line transect surveys in California, Oregon and Washington coastal waters (Barlow and Taylor 2001). Sperm whales are likely to be caught only in offshore drift gillnets, which are used to catch swordfish, thresher shark, and mako shark in California offshore waters (Hanan *et al.* 1993). Over the last three years , the average annual rate of mortality in fisheries has been 1.7 sperm whales per year (Carretta *et al.* 2001, 2003, 2005). Similar driftnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and probably take the southern form of this species. The overall marine mammal mortality rate in this fishery is similar to the California driftnet fisheries during 1990-1995 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fishery. Sperm whales are classified as endangered under the ESA; consequently, the California to Washington stock is automatically considered depleted and strategic under the MMPA.

Pygmy Sperm Whale (*Kogia breviceps*): The pygmy sperm whale, like the dwarf sperm whale, is widely distributed throughout the world's oceans, but they are not known to occur in polar and subpolar latitudes (Caldwell and Caldwell 1989). They are difficult to see and identify in the wild, and there are no reliable population estimates for this species. Owing to the difficulty in distinguishing between the pygmy and dwarf sperm whale in the field and the rarity of encounters, additional study is required before each of the two species can be evaluated comprehensively.

In U.S. Pacific waters, available data are insufficient to identify any seasonality in the distribution of pygmy sperm whales, or to delineate possible stock boundaries. For management purposes under the MMPA, two stocks of pygmy sperm whales are recognized in U.S. waters of the Pacific Ocean, the California/Oregon/Washington stock and the Hawaii stock. Sightings of pygmy sperm whales along the U.S. west coast have been generally too rare to produce reliable population estimates (Barlow *et al.* 1995).

Based on two sightings identified only to the genus *Kogia* the 1996-2001weighted average is 247 pygmy sperm whales (CV=0.1.06), (Barlow2003). Pygmy sperm whales have potential to interact with the CA/OR thresher shark/swordfish drift gillnet fishery. The average annual estimated mortality of pygmy sperm whales for this fishery for five years of monitoring (1994-98) is zero animals per year. Similar driftnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same population. The overall marine mammal mortality rate in this fishery is similar to the California driftnet fisheries during 1990-1995 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fishery. The status of pygmy sperm whale in California, Oregon and Washington waters relative to OSP is unknown. Estimated human-caused mortality of these animals in California, Oregon and Washington waters (zero) is not known to exceed the calculated PBR (28); therefore, this stock of pygmy sperm whales is not considered strategic under the MMPA (Carretta *et al.* 2005).

Gray Whale *(Eschrichtius robustus)*: The only extant stocks of gray whales occur in the Pacific Ocean. The western Pacific stock, which is found off the east coast of Asia, is estimated at approximately 250 animals (Vladirmirov 1994), but no quantitative data are available to assess this estimate (Berzin *et al.* 1995). The western North Pacific stock feeds in the northern Okhotsk Sea and winters off southern Korea and Japan (Wolman 1985).

The eastern Pacific stock spends the summer feeding in the northern Bering, Chukchi and Beaufort Seas (Rice and Wolman 1971). The whales in this stock migrate near shore along the coast of North America from Alaska to the Central California coast (Rugh *et al.* 1993) starting in October and November. From Point Conception south to Baja California most of the whales take a more direct offshore route across the southern California Bight to northern Baja California (Rice *et al.* 1984). The eastern North Pacific Stock winters mainly along the west coast of Baja California, where females give birth to their calves in certain bays and lagoons there from early January to mid-February (Rice *et al.* 1981). The northern migration generally begins in mid-February and continues through May (Rice *et al.* 1981). The most recent reliable estimate for the eastern North Pacific stock is 26,635 animals (CV = 0.1006) based on shore counts from a 1997/1998 survey (Hobbs and Rugh 1999). This estimate is not significantly larger than estimates from the 1995/96 survey or the 1993/94 (22,263 and 23,109, respectively), but it is significantly higher than the 1992/93 survey (17,674).

No mortalities were reported for any of the six Alaska fisheries from 1990-98. There was a minimum estimated annual mortality of 5.9 resulting from commercial fisheries (Angliss *et al.* 2001). That estimate was based on reports from NMFS observers and self reports in 1990-98 for the following fisheries: the northern Washington set gillnet fishery (0.2), the CA/OR thresher shark/ swordfish drift gillnet fishery (1.0), the Bristol Bay salmon set and drift gillnet fishery (0.5), and from unknown West coast fisheries (4.2) (Angliss *et al.* 2001). This stock of gray whales is subjected to direct takes from subsistence hunters. In 1997, the IWC approved a 5-year quota (1998-2002) of 620 gray whales for Russian and U.S. aboriginals, to average 124/ year and not to exceed 140 whales. In 1998, 122 whales were harvested. Another source of human-caused mortalities for gray whales is ship-strikes, averaging a minimum of 1 whale per year from 1990-98 (Angliss *et al.* 2001).

The total human-caused mortalities was estimated to be 83, therefore, the eastern North Pacific stock is not classified as strategic under the MMPA because it does not exceed PBR (575) (Angliss *et al.* 2001). In 1999, NMFS convened a meeting at NMML on the status of gray whales since their de-listing from the ESA in 1994. It was decided at the meeting the this stock of gray whales have continued to increase and are in no threat of becoming extinct (Angliss *et al.* 2001). Therefore, their status remains unlisted. The western North Pacific stock is still considered endangered under the ESA.

Minke Whale (*Balaenoptera acutorostrata*): The minke whale has a cosmopolitan distribution in polar, temperate and tropical waters worldwide. Several stocks are recognized around the world. The IWC recognizes three stocks of minke whales in the North Pacific: one in the Sea of Japan/East China Sea, one in the rest of the western Pacific west of 180°N, and one in the remainder of the Pacific (Donovan 1991). Although reliable abundance estimates do not exist for several of the stocks, the worldwide population size of minke whales is likely in the hundreds of thousands.

In U.S. waters of the North Pacific, two stocks of minke whales, the California/Oregon/ Washington stock and the Alaska stock, are recognized for management purposes under the MMPA. No estimates have been made for the number of minke whales in the entire North Pacific. The best estimate for the California/Oregon/Washington stock is 1,015 minke whales (CV = 0.73) based on ship surveys off California, Oregon and Washington in 1996 and 2001(Barlow 2003). Minke whales from this stock may occasionally be incidentally taken in both coastal set gillnets and offshore drift gillnets. Coastal set gillnets are used to catch halibut, flounder, angel, shark, yellowtail, white seabass, and white croaker in California coastal waters. Drift gillnets are used to catch swordfish, thresher shark, and mako shark in California offshore waters (Hanan *et al.* 1993). Mean annual fishery takes were zero, based on 1994-98 data; however, only 1997-98 mortality estimates were included due to the 1997 Take Reduction Plan reducing takes significantly (Carretta *et al.* 2001, 2003, 2005). The overall marine mammal mortality rate in this fishery is similar to the California driftnet fisheries during 1990-1995 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fishery. The status of this stock is unknown and there is no information on trends in the abundance. The annual human-caused mortality appears to be less than the calculated PBR for this stock (5.8), so they are not considered a strategic stock under the MMPA. Additionally, they are not listed as depleted under the MMPA.

Blue Whale (*Balaenoptera musculus*): Blue whales are found in tropical to polar waters worldwide. The IWC formally recognizes several management stocks, but stock differentiation for blue whales throughout the world still remains equivocal.

In the North Pacific, the IWC only recognizes one stock (Donovan 1991); however, strong evidence exists for a separate population that spends winter/spring in Mexican coastal waters and summer/autumn in California waters (Barlow *et al.* 1995). For management purposes under the MMPA, two stocks are considered to occur in U.S. waters of the North Pacific, the eastern North Pacific stock (California/Oregon/Washington) and the Hawaii stock. The best abundance estimate for this stock is 1,744 blue whales (CV=0.28), resulting from averaging line transect (Barlow 2003) and a mark-recapture (Calambokidis *et al.* 2003) results, weighted by their variances. The population trend has some indication of an increase since 1979/80 (Barlow 1994), but this is not conclusive when compared to other studies.

Blue whales from this stock potentially interact with the offshore gillnet fishery, but no mortalities or serious injury were observed from 1994 to 1998 (Carretta *et al.* 2001, 2003, 2005). Similar driftnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same population. The overall marine mammal mortality rate in this fishery is similar to the California driftnet fisheries during 1990-1995 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fishery. Previously, blue whales in the entire North Pacific were estimated to be at 33% (1,600 out of 4,900) of historic carrying capacity (Mizroch *et al.* 1984). The initial abundance has never been estimated separately for the "California" stock, but it was almost certainly depleted by commercial whaling. Because blue whales are formally classified as endangered under the ESA, the California/Oregon/Washington stock is considered strategic under the MMPA.

The population appears to be crowing however increasing levels of anthropogenic noise is suggested to be a habitat concern for blue whales (Reeves et al. 1998).

Fin Whale (*Balaenoptera physalus*): The fin whale occurs in all major oceans worldwide and seasonally migrates between temperate and polar waters (Gambell 1985). Several stocks have been suggested for both the Southern and Northern Hemisphere. However, whether the current stock boundaries define biologically isolated units is uncertain and confirmation or revision of such boundaries awaits further study. Available abundance estimates for fin whale stocks worldwide vary in their reliability, depending on the data available and the analytical techniques used. Fin whales in the Southern Hemisphere number approximately 103,000 (Gambell 1985).

In the North Pacific, the IWC recognizes two stocks of fin whales, the East China Sea stock and the rest of the North Pacific (Donovan 1991). For management purposes under the MMPA, four stocks of fin whales are recognized in the U.S. waters: the California/Oregon/Washington stock, the Alaska stock (Northeast Pacific), the Hawaii stock, and the western North Atlantic stock.

Recently, 3,279fin whales (CV=0.31) were estimated for California, Oregon and Washington waters based on ship surveys in summer/autumn of 1996 and 2001 (Barlow 2003). There is some indication that fin whales have increased in abundance in California coastal waters between 1979/80 and 1991 (Barlow 1991) and between 1991 and 1996 (Barlow 1997), but these trends are not significant. The only fishery that potentially interacts with fin whales is the offshore drift gillnet fishery. One fin whale death was observed in 1999 and this resulted in an estimated average annual take from 1995-99 of 1.5 whales. Fin whales in the entire North Pacific were estimated to be less than 38% (16,625 out of 43,500) of historic carrying capacity (Mizroch *et al.* 1984). Because fin whales are listed as an endangered species under the ESA, this stock is automatically considered strategic under the MMPA. The observed fishery mortality (1) is less than 10% of PBR and therefore may be approaching zero mortality and serious injury rate (Caretta *et al.* 2004). There is some indication the population may be growing however anthropogenic noise is a concern (Croll *et al.* 2002).

Humpback Whale (*Megaptera novaeangliae*): The humpback whale has a cosmopolitan distribution and several stocks are recognized throughout the world. This species occurs in all ocean basins, though it is less common in Arctic waters. Katona and Beard (1990) estimated that approximately 8,000 individual humpback whales had been photo-identified throughout the world as of 1990, and this number has increased substantially since then. The world population of humpbacks is probably still in the low tens of thousands. At present there is little direct killing of humpback whales, and incidental mortality is apparently not a major problem in most areas.

Although the IWC only recognizes a single stock in the North Pacific (Donovan 1991), there is now good evidence for multiple populations of humpback whales here (Johnson and Wolman 1984; Baker *et al.* 1990). Four relatively separate migratory populations have been identified in the North Pacific (Barlow 1995) based on sightings of distinctively-marked individuals: the eastern North Pacific stock (coastal California/Oregon/Washington - Mexico stock), the Mexico offshore island stock (feeding destination unknown), the central North Pacific stock (Hawaii/Alaska), and the western North pacific stock (Japan/feeding destination probably the Aleutian Islands). All but the Mexico offshore island stock are formally recognized for management purposes under the MMPA.

The eastern north Pacific stock (California/Oregon/Washington - Mexico) is estimated at 1,314 humpback whales (CV = 0.30) (Barlow 2003)) based on shipboard surveys in 1996 and 2001. Calambokidiset al. (2003) estimated the abundance at 1,034; CV=0.11) from 1991-2002 using Petersen mark-recapture estimate based on photo-identification. Ship surveys and mark-recapture population estimates provide some indication that humpback whales of this stock are increasing (Carretta *et al.* 2005). Humpback whales from this stock are likely to be taken only in offshore drift gillnets, which are used to catch swordfish, thresher shark, and mako shark. The deaths of two humpback whales in southern California have been attributed to entanglement in fishing gear (Heyning and Lewis 1990). Also, two unidentified whales, possibly humpbacks, were taken in the approximately 1% of drift gillnets observed in 1980-1985 (Hanan 1986; Heyning and Lewis 1990). Total annual fishery takes, averaged from 1998-2002 was 1.2 (Carretta *et al.* 2005). Similar driftnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same population. The overall marine mammal mortality rate in this fishery is similar to the California driftnet fisheries during 1990-1995 (0.14 marine mammals per set; Julian and Beeson 1998), but species-specific information is not available for the Mexican fishery. Humpback whales are classified as endangered under the ESA; thus, California/Oregon/Washington - Mexico stock is automatically considered depleted and strategic under the MMPA. Increasing levels of anthropogenic noise have been suggested as a habitat concern for humpback whales.

The central North Pacific stock of humpback whales winters in Hawaiian waters and migrates in the spring to northern British Columbia/Southeast Alaska and Prince William Sound west to Kodiac (Calambokidis *et al.* 1997). The most recent abundance estimate for the central North Pacific stock of humpback whales is 4,005 (CV=0.095) whales, based on averaging estimates of abundance in their wintering areas from 1991-1993 (Calambokidis *et al.* 1997). The estimated minimum mortality rate incidental to commercial fisheries is 3.5 humpback whales per year (determined from 1990-99 data), based on observer data (0.4), and self-reported fisheries information (0.4) , stranding records traceable to a specific fishery (0.2) and other stranding records indicating mortality or serious injury (2.5). Additionally, mortalities due to ship strikes averaged 0.8 from 1995-99. Fishery caused mortalities (3.5) exceeds 10% of PBR (0.7) and therefore cannot be considered insignificant. Since the estimated total human caused mortality (4.3) is a minimum estimate, it is unclear if this exceeds PBR (7.4). The humpback whale is listed as endangered under the ESA and therefore is also listed as depleted and strategic under the MMPA.

The western North Pacific stock spends winter/spring off Japan and probably migrates to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands)in the summer/fall (Berzin and Rovnin 1966; Nishiwaki 1966; Darling 1991). The most recent abundance estimate for the central North Pacific stock of humpback whales is 394 (CV=0.084) whales, based on averaging estimates of abundance in their wintering areas from 1991-1993 (Calambokidis *et al.* 1997). NMFS observers reported 1 mortality of humpback whales incidental to commercial fisheries in Alaska in 1999 and 1 humpback whale stranded in 1997 due to an unknown fishery. These give an minimum estimated annual mortality of 0.6 from 1990-99 (Angliss *et al.* 2001). This number (0.6) exceeds 10% of PBR (0.07) and therefor cannot be considered insignificant. Since the estimated human-caused mortality (0.6) is a minimum, it is unclear if this exceeds the PBR (0.7) (Angliss *et al.* 2001). This stock is considered strategic under the MMPA because humpback whales are listed as endangered under the ESA. Trend data and the status of this stock relative to OSP are currently unknown.

Literature Cited

Angliss, R. P., D. P. DeMaster, and A. L. Lopez. 2001. Alaska marine mammal stock assessments, 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-124, 203 pp.

Angliss, R.P. and K.L. Lodge. 2004. Alaska Marine Mammal Stock Assessments, 2003. U.S. Dep. Commer., NOAA Tech.Memo. NMFS-AFSC-144, 108pp.

Balcomb, K.C., III. 1989. Baird's beaked whale *Berardius bairdii* Stejneger, 1883 and Arnoux's beaked whale *Berardius arnuxii* Duvernoy, 1851. Pp. 261-288 in S.H. Ridgway and R. Harrison (eds.), *Handbook of marine mammals*, Vol. 4. Academic Press, London.

Baker, C. S., S. R. Palumbi, R. H. Lambertsen, M. T. Weinrich, J. Calambokidis and S. J. O'Brien. 1990. Influence of seasonal migration on geographic distribution of mitochondrial DNA haplotypes in humpback whales. Nature 344:238-240.

Barlow, J., R.L. Brownell, Jr., D.P. DeMaster, K.A. Forney, M.S. Lowry, S. Osmeck, T.J. Ragen, R.R. Reeves and R.J. Small. 1995. U.S. Pacific Marine Mammal Stock Assessments. NOAA Tech. Mem. NMFS 219, 162 pp.

Barlow, J. 1991. Abundance of large whales in California coastal waters: A comparison of ship surveys in 1979/80 and 1991. *Rep. Int. Whal. Commn.* 44:399-406.

Barlow, J. and B. L. Taylor. 2001. Estimates of large whale abundance off California, Oregon, Washington, and Baja California based on 1993 and 1996 ship surveys. Administrative Report LJ-01-03 available from Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 12p.

Barlow, J. 1994. Abundance of large whales in California coastal waters: a comparison of ship surveys in 1979/80 and in 1991. Rept. Int. Whal. Commn. 44:399-406.

Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Admin. Rep. LJ-97-11. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 25p.

Barlow, J. 2003. Preliminary estimates of the abundance of cetaceans along the U.S. West coast:1991-2001. Southwest Fisheries Science Center Administrative Report LJ 03 03/31 pps.

Berzin, A.A., S.A. Blokhin, H. Minakuchi, R.L. Brownell, Jr., A.M. Burdin, and V.N. Burkanov. 1995. Bowhead and gray whale populations in the Okhotsk Sea. Pp. 44-45 in *Abstracts of the North Pacific Marine Science Organization(PICES): Workshop on the Okhotsk Sea and adjacent areas*, Vladivostok, Russia, 19-24 June 1995.

Bigg, M.A., P.F. Olesiuk, G.M. Ellis, J.K.B. Ford and K.C. Balcomb III. 1990. Social organization and genealogy of resident killer whales in (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. *Rep. Int. Whal. Commn.* Special Issue 12:386-406.

Black, N. A., A. Schulman-Janiger, R. L. Ternullo, and M. Guerrero-Ruiz. 1997. Killer whales of California and western Mexico: A Catalog of photo-identified individuals. U.S. Dep. Commer., NOAA Tech. Memo. NMFSSWFSC-247. 174p.

Buckland, S.T., K.L. Cattanach and R.C. Hobbs. 1993. Abundance estimates of Pacific white-sided dolphin, northern right whale dolphin, Dall's porpoise and northern fur seal in the North Pacific, 1987/90. INPFC Symposium

Calambokidis, J., S. D. Osmek, and J. L. Laake. 1997. Aerial surveys for marine mammals in Washington and British Columbia inside waters. Final Report by Cascadia Research, Olympia, WA, to National Marine Mammal Laboratory, AFSC, NMFS, Seattle, WA. 96 pp.

Calambokidis, J. and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California. Pp. 101-110 in J.E. Reynolds III and D.K.. Odell (eds.) Marine mammal strandings in the United States. NOAA Technical Report NMFS 98.

Calambokidis, J, T. Chandler, L. Schlender, G.H. Steiger, and A Douglas. 2003. Research on humpback and blue whale off California, Oregon and Washington in 2002. Final contract report to Southwest Fisheries Science Center, National Marine Fisheries Service. 8604 La Jolla Shores Drive, La Jolla, CA 92037. 49pp.

Caldwell, D.K. and M.C. Caldwell. 1989. Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838): Dwarf sperm whale *Kogia simus* Owen 1866. Pp. 235-260 in S.H. Ridgway and R. Harrison (eds.), *Handbook of marine mammals*, Vol. 4. Academic Press, London.

Carretta, J. V., Barlow, J., Forney, K. A., Muto, M. M. and J. Baker. 2001. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-317, 280 pp.

Caretta, J.V., Forney, K.A., Muto, M.M. , Barlow, J., Baker, J. and M. Lowry. 2003. U.S. Pacific Marine Mammal Stock Asessments: 2003. U.S. Deparment of Commerce, NOAA Technical Memorandum NMFS-SWFSC-358. 291p.

Carretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, and M.S. Lowry. 2005. U.S. Pacific Marine mammal Stock Assessments: 2004. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-TM-NMFS-SWFSC-375, 316p.

Croll, D. A., Clark, C. W., Acevedo, A., Tershy, B., Flores, S., Gedamke, J., and Urban, J. 2002. Only male fin whales sing loud songs. Nature 417: 809-811.

Dahlheim, M. E., D. Ellifrit, and J. Swenson. 1997. Killer whales of Southeast Alaska: a catalogue of photoidentified individuals. Day Moon Press, Seattle, WA. 82 pp. + appendices.

Dizon, A.E., W.F. Perrin and P.A. Akin. 1992. Stocks of dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern tropical Pacific: A phylogeographic classification. Southwest Fisheries Science Center Admin. Rep. No. LJ-91-33, 56pp.

Donovan, G . P. 1991. A review of IWC stock boundaries. *Rep. int Whal. Commn* Special Issue 13: 39-68.

Farley, T.D. 1995. Geographic variation in dorsal fin color of short-beaked common dolphins, *Delphinus delphis,* in the eastern Pacific Ocean. Southwest Fisheries Science Center Admin. Rep. LJ-95-06.

Ford, J. K. B., G. Ellis, and K. C. Balcomb. 1994. Killer whales: the natural history and genealogy of *Orcinus orca* in British Columbia and Washington State. UBC Press, Vancouver BC and University of Washington Press, Seattle. 102 pp.

Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 2000. Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington. 2nd edition. University of British Columbia Press, Vancouver, BC, and University of Washington Press, Seattle. 104 pp.

Forney, K.A., J. Barlow, M.M. Muto, M. Lowry, J. Baker, G. Cameron, J. Mobley, C.

Stinchcomb, and J.V. Carretta.2000. U.S. Pacific Marine Mammal Stock Assessments: 2000. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-300. 276p.

Forney, K. A. 1999a. The abundance of California harbor porpoise estimated from 1993-97 aerial line-transect surveys. Admin. Rep. LJ-99-02. Available from Southwest Fisheries Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 16pp.

Forney, K.A. 1994. Recent information on the status of odontocetes in California waters. NOAA Tech. MEM. NOAA-TM-NMFS-SWFSC-202.

Gambell, R. 1985. Sei whale *Balaenoptera borealis* Lesson, 1828. Pp. 155-170 in S.H. Ridgway and R. Harrison (eds.), *Handbook of marine mammals*, Vol. 5. Academic Press, London.

Gaskin, D. E. 1984. The harbor porpoise *Phocoena phocoena* (L.): Regional populations, status, and information on direct and indirect catches. *Rep. int Whal. Comm* 34:569 -586.

Hanan, D.A. 1986. California Department of Fish and Game coastal marine mammal study, annual report for the period July 1, 1983-June 30, 1984. Southwest Fisheries Science Center Admin. Rep. LJ-86-16. 55pp.

Hanan, D.A., D.B. Holts and A.L. Coan, Jr. 1993. The California drift gillnet fishery for sharks and swordfish, 1981-82 through 1990-91. Fish Bulletin175. Available from the marine Technical Information Center, California Department of Fish and Game, 330 Golden Shore, Suite 50, Long Beach, CA 90802.

Heise, K., G. Ellis, and C. Matkin. 1991. A catalogue of Prince William Sound Killer Whales. North Gulf Oceanic Society, Homer, AK. Published for the National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Heyning, J.E. and T.D. Lewis. 1990. Fisheries interactions involving baleen whales off southern California. *Rep. Int. Whal. Commn*. 40:427-431.

Heyning, J.E. and W.F. Perrin. 1994. Evidence for two species of common dolphin (Genus *Delphinus*) from the eastern North Pacific. *Contr. Nat. Hist. Mus. L.A. County*, No. 442.

Hobbs, R. C., and D. J. Rugh. 1999. The abundance of gray whales in the 1997/98 southbound migration in the eastern North Pacific. Unpubl. doc. submitted to Sci. Comm. Int. Whal. Comm. (SC/51/AS10). 18 pp.

Horwood, J. 1987. *The Sei Whale: Population biology, ecology and management*. Croom Helm, London, U.K., 375pp.

IWC. 1991. Report of the Scientific Committee. *Rep Int. Whal. Commn.* 41:51-219.

IWC. 1992a. Report of the Scientific Committee. *Rep Int. Whal. Commn.* 42:178-234.

Jefferson, T.A. 1988. *Phocoenoides dalli*. *Mammalian Species* 470

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, Megaptera novaeangliae. Mar. Fish. Rev. 46(4):30-37.

Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle and bird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull. 96:271-284.

Kasuya, T., T. Miyashita and F. Kasamatsu. 1988. Segregation of two forms of short-finned pilot whales off the Pacific coast of Japan. *Sci. Rep. Whales Res. Inst. (Tokyo)* 39:77-90.

Katona, S.K. and J.A. Beard. 1990. Population size, migrations, and feeding aggregations of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic ocean. *Rep.*

Int. Whal. Commn. Special Issue.
Kirishima, K. 1986. Analysis of POP data. Pp. 55-87 In T. Tamura , S. Ohsumi and S. Arai (eds.) *Report of research in search of countermeasures for fishery damages caused by small cetaceans*. Fisheries Agency, Tokyo. 258pp. [In Japanese with English summary].
Kishiro, T. and T. Kasuya 1993. Review of Japanese dolphin drive fisheries and their status. *Rep. Int. Whal. Commn.* 43:439-452.
Krahn, M.MFord, M.J. Perrin, W.F., Wade, P.R., Angliss, R.P., Hanson, M.B., Taylor, B.L., Ylitalo, G.M, Dahlheim, M.E., Stein, J.W. and Waples, R.S. 2004. 2004 Status Review of Southern Resident Killer Whales (Orcinus orca) under the Endangered Sjpecies Act. NOAA Technical Memorandum NMFS-NWFSC-62. 73 pp
Laake, J., J. Calambokidis, and S. Osmek. 1998. Survey report for the 1997 aerial surveys for harbor porpoise and other marine mammals of Oregon, Washington and British Columbia outside waters. Pp. 77-97, *In:* Hill, P. S., and D. P. DeMaster (eds.), MMPA and ESA Implementation Program, 1997. AFSC Processed Report 98-10. 246 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
Laake, J. L., R. L. DeLong, J. Calambokidis, and S. Osmek. 1997a. Abundance and distribution of marine mammals in Washington and British Columbia inside waters, 1996. Pp. 67-73, *In:* MMPA and ESA Implementation Program, 1996. AFSC Processed Report 97-10. 255 pp. Available at National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
Laake, J. L., J. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997b. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manage. 61(1):63-75.
Leatherwood, S. and M.E. Dahlheim. 1978. Worldwide distribution of pilot whales and killer whales. Naval Ocean Systems Center, Tech. Rep. 443:1-39.
Leatherwood, J.S. and M.R. Fielding. 1974. A survey of distribution and movements of Dall's porpoise, Phocoenoides dalli, off southern California and Baja California. Working paper No. 42, FAO, United Nations, ACMRR Mtg., La Jolla, CA.
Leatherwood, S., C. O. Matkin, J. D. Hall, and G. M. Ellis. 1990. Killer whales, Orcinus orca, photo-identified in Prince William Sound, Alaska 1976 to 1987. Can. Field Naturalist 104:362-371.
Mangels, K.F. and T. Gerrodette. 1994. Report of cetacean sightings during a marine mammal survey in the eastern tropical Pacific Ocean and Gulf of California aboard the NOAA ships *McArthur* and *David Starr Jordan* July 28-November 6, 1993. NOAA Tech. Mem. NOAA-TM-NMFS-SWFSC-211.
Mead, J.G. 1989. Beaked whales of the Genus *Mesoplodon*. Pp. 349-430 in S.H. Ridgway and R. Harrison (eds.), *Handbook of marine mammals*, Vol. 4. Academic Press, London.
Miyashita, T. 1993. Abundance and of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. *Rep. Int. Whal. Commn.* 43:417-437
Mizroch, S.A., D.W. Rice and J.M. Breiwick. 1984. The sei whale, *Balaenoptera borealis*. *Mar. Fish. Rev*. 46:25-29.
Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.
Nitta, E. And J.R. Henderson. 1993. A review of interactions between Hawaii's fisheries and

protected species. *Mar. Fish. Rev*. 55(2):83-92.
Perrin, W. F. and R. L. Brownell, Jr. 1994. A brief review of stock identity in small marine cetaceans in relation to assessment of driftnet mortality in the North Pacific. Rep. Int. Whal. Commn. Special Issue 15:393-401.
Perrin, W.F., M.D. Scott, G.J. Walker and V.L. Cass. 1985. Review of geographical stocks of tropical dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern Pacific. NOAA Tech. Rep. NMFS 28.
Polachek, T., F.W. Wenzel and G. Early. 1990. What do stranding data say about harbor porpoise (*Phocoena phocoena*). Working Paper SC/42/SM39 submitted to the Scientific Committee of the International Whaling Commission.
Polisini, J.M. 1981. A comparison of *Globicephala macrorhynchus* (Gray, 1846) with the pilot whale of the North Pacific Ocean: An analysis of the skull of the broad-rostrum pilot whales of the genus *Globicephala*. Dissertation abstracts International Vol. 41, No. 8, February 1981, p. 2928-B.
Reeves, R. R., P. J. Clapham, R. L. Brownell, Jr., and G. K. Silber. 1998. Recovery plan for the blue whale (Balaenoptera musculus). Office of Protected Resources, NMFS, NOAA, Silver Spring, Maryland. 30 pp.
Rice, D.W., A.A. Wolman and H.W. Braham. 1984. The gray whale, *Eschrichtius robustus*. *Mar. Fish. Rev*. 46(4):7-14.
Rice, D.W. and A.A. Wolman. 1971. The life history and ecology of the gray whale (*Eschrichtius robustus*). The American Society of Mammalogists. Spec. Pub. 3. 142pp.
Rice, D.W., A.A. Wolman, D.M. Withrow and L.A. Fleischer. 1981. Gray whales on the winter grounds in Baja California. *Rep Int. Whal. Commn.* 31:477-493.
Rice, D.W. 1989. Sperm whale *Physeter macrocephalus* Linnaeus, 1758. Pp. 177-233 in S.H. Ridgway and R. Harrison (eds.), *Handbook of marine mammals*, Vol. 4. Academic Press, London.
Rosel, P.E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, Univ. of California, San Diego. 191 pp.
Rosel, P.E., A.E. Dizon, and M.G. Haywood. 1995. Variability of the mitochondrial control region in populations of the harbor porpoise, *Phocoena phocoena*, on interoceanic and regional scales. *Can. J. Fish. Aquat. Sci.* 52:1210-1219.
Rugh, D., J. Breiwick, M. Dahlheim and G.C. Boucher. 1993. A comparison of independent, concurrent sighting records from a shore-based count of gray whales. *Wildl. Soc. Bull.* 21:427-437.
Small, R.J. and D.P. DeMaster. 1995. Alaska marine mammal stock assessments 1995. NOAA Tech. Mem. NMFS-AFSC-57. 93pp.
Wade P. R., and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.
Vladimirov, V.I. 1994. Recent distribution and abundance level of whales in Russian far-eastern seas. *Russian J. of Mar. Biol.* 20(1):9.
Wade, P.R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. *Rep. Int. Whal. Commn.* 43:477-493.

Walker, W. A., S. Leatherwood, K. R. Goodrich, W. F. Perrin and R. K. Stroud. 1986. Geographical variation and biology of the Pacific white-sided dolphin, *Lagenorhynchus obliquidens*, in the north-eastern Pacific. pp 441-465 *In:* Bryden, M. M. and R. Harrison (eds.), Research on Dolphins. Clarendon Press, Oxford.

Wolman, A.A. 1985. Gray whale Eschrichtius robustus (Lilljeborg, 1861). Pp. 67-90 in S.H. Ridgway and R. Harrison (eds.), *Handbook of Marine Mammals*, Vol. 3. Academic Press, London.

2. Background/Literature Review

The proposed research will focus on questions pertaining to 1) cetaceans other than southern resident killer whales, and 2) southern resident killer whales. These studies will address the abundance, distribution, stock structure, and ecology of all cetaceans in the Pacific Northwest. For southern resident killer whales (*Orcinus orca)*, the focus will be on abundance, distribution, feeding ecology, life history, energetics, habitat use, and risk factors.

<u>Cetaceans other than southern resident killer whales</u>
Marine mammal stock assessments are a core mission for the National Marine Fisheries Service under the MMPA. Adequate stock assessments require both accurate delineations of stock structure boundaries as well as robust estimates of population size and trends. It has been noted that many types of data can provide information on stock structure, including distribution, population response, morphology, genetics, life history, contaminants, and telemetry but each has inherent limitations. In some cases these data can provide information on where delineations in population structure occur although in others it can only indicate that additional structure exists with the population. In addition, NOAAs 2005-2010 Strategic plan calls for "understanding and predicting changes in the Earth's environment to conserve and manage coastal and marine resources" which broadens the need for information on these species to encompass their role in the ecosystems and the effect of environmental factors on their ability remain viable components of these ecosystems. This type of information will be critical to future informed management decisions (NMFS 2004). To achieve these goals we will work collaboratively with the SWFSC, NMML, OCNMS and other agencies with management responsibilities to acquire data that will cover some or all of the aspects previously noted for the Pacific Northwest. Surveys for stock assessments are conducted infrequently, but typically during seasons of better weather and longer daylight. Assessments of the role of marine mammals have been conducted only recently, generally as part of the stock assessment surveys (Philbrick et al. 2003) and have been investigated on a coast-wide basis. As such, while the general associations of some species with oceanographic conditions have been described (Tynan et al. 2005) the associations of marine mammal populations with prominent oceanographic features are generally unclear. Consequently, additional data are needed to address these questions (NMFS 2004).

<u>Southern Resident Killer Whales (*Orcinus orca)*</u>. The studies on Southern Resident Killer Whales (SRKW) will focus on assessing the seasonal movements, residency patterns, feeding ecology, risk factors and assessment, and health status of killer whales in the Pacific Northwest because the available data are inadequate to meet our conservation and management needs for these stocks. The data gaps and key research questions were developed in a series of three workshops that are summarized in the southern resident killer whale research plan (NWFSC, in prep.; see web site below. Our research methods to address these data gaps and research questions include 1) aerial and vessel surveys, including a) acoustic tracking using a towed hydrophone b) photo-identification, c) video-grammetry from a tethered airship d) focal follows to collect behavioral and energetic data and collection of fecal and prey remains from predation events; 2) collection of biological samples for contaminant, genetic, stable isotope, and fatty

acid studies; 3) suction cup tagging; 4) prey associations using echo sounders; and 5)health assessment. Photo-identification of individual whales or groups of whales will be incorporated into the sampling regime for many of these studies.

To develop a research plan for studies of Southern Resident killer whales, we relied on the best, most complete and up-to-date scientific information about the status of and risks to the SRKW population (Krahn et al 2002, 2004; Wiles 2004; DFO draft recovery strategy; see also NWFSC workshop reports). Many scientific experts—both in the field of killer whale biology and in other relevant scientific disciplines—provided extensive input for this plan during a series of workshops. The specific questions listed at the end of each topic are the high priority research questions identified by the scientists at the workshops for conservation and management. These research areas are also identified in the NMFS Draft Conservation Plan (2005).

To ensure that research projects focus on the most important data gaps and conservation needs and that projects are conducted in a logical and effective sequence, the NWFSC co-sponsored three workshops with WDFW and DFO during 2003 and 2004. Scientists at the workshops identified the highest priority questions under each of the research topics that would address the data needs identified by the managers. The highest priority questions from these workshops were the basis of a long-range research plan. Details on each workshop and the results are available at: http://www.nwfsc.noaa.gov/research/divisions/sd/kwworkshops/index.cfm. The research areas identified below are based on the high priority research needs identified by the scientists and managers at the workshops.

Population Status: The Center for Whale Research has conducted an annual photo-identification census of Southern Resident killer whales since 1973/74 that has provided comprehensive documentation of population size, births, deaths and survival over three decades. These annual photo-identification data enabled detection of the significant population decline during the mid 1990s to 2001. As of the summer 2004 census, the Southern Resident killer whale population contained 84 whales, distributed among 3 pods. L pod is the largest pod, containing 42 animals (including Luna or L98); J and K pods consist of 22 and 20 whales, respectively (Center for Whale Research, unpubl. Data) . Each pod has had at least one new calf in 2005 (K. Balcomb, pers. comm.)

The marked population decline in the mid-1990s was characterized by low calf production and large differences in survival rates between age and sex classes (Krahn *et al.* 2002, 2004). New analyses support concern for the population's viability, whether due to incremental, small-scale impacts over time (e.g., reduced fecundity, sub lethal contaminant affects), or a major catastrophe (e.g., oil spill). In addition, this population's small size and demographic isolation make it potentially vulnerable to intrinsic small population effects such as the deleterious consequences of low genetic variability and inbreeding depression, the lack of potential mates, and the collapse of matrilineal structure and culture. Finally, the small number of breeding males as well as possible reduced fecundity and subadult survivorship in L pod, may hinder population growth in the future. Although the Southern Resident population has recovered from low levels in the past, the factors responsible for the recent decline are unclear, may still exist and may continue to persist.

Critical research is necessary to inform challenging management decisions related to the conservation of SRKWs. While beneficial and uniquely informative research has been conducted on SRKWs over the past three decades, many aspects of the basic SRKW ecology, and factors that threaten this population, remain poorly understood. To ensure conservation and sustainability of this population, a better understanding of SRKW ecology and life history is needed to determine what internal and external factors threaten these whales.

Affects of contaminants: Exposure to high levels of toxic contaminants such as persistent organic pollutants (POPs) is one of the potential factors that may be contributing to the decline of SRKWs. These contaminants include several toxic classes of pesticides (e.g., DDTs and chlordanes) and industrial chemicals (e.g., PCBs) that are frequently found in the marine environment worldwide. In addition, new chemical contaminants of concern such as polybrominated diphenyl ethers or PBDEs, endocrine disrupters (e.g., synthetic estrogens, steroids) and current use pesticides (Richardson 2003, Schnoor 2003, Rayne *et al.* 2004) have been introduced into the environment since tissue samples were collected from southern resident whales during the mid-1990s. In particular, flame retardant chemicals (polybrominated diphenyl ethers—PBDEs) have increased dramatically in the environment in the last 10 years. These POP compounds bioaccumulate through the food chain to relatively high concentrations in top-level predators. Accumulation of certain POPs has been linked in some marine mammal species to various deleterious biological and physiological affects, including reproductive impairment, immune suppression and pathological lesions. With better information on contaminants and their levels in the environment and prey, management will be better able to work with appropriate agencies to reduce harmful chemicals in the NW environment.

Although the Southern Resident sample size is small, results from samples collected about 10 years ago indicate that these whales contain higher concentrations of POPs than those measured in killer whales from other fish-eating populations in the North Pacific (Jarman et al. 1996, Ross *et al.* 2000, Ylitalo *et al.* 2001, Rayne et al. 2004 NWFSC, unpublished data). Wide ranges of contaminant levels have been measured in killer whales and the levels appear to be influenced by diet, as well as by various biological factors (e.g., reproductive status, sex, age, order of birth**).** Several factors contribute to the high contaminant levels. Killer whales are top predators, so contaminants bioaccumulate through several trophic levels. They are long-lived, so contaminants accumulate over 50–60 years in the whales. Also they have large lipid (or fat) storage capacity in the blubber, where contaminants can accumulate to high levels.

In female whales, contaminant burdens increase up to sexual maturity and then decrease during the reproductive years as a result of contaminant transfer to the calves during gestation and lactation. First-born calves have higher levels of contaminants transferred from their mothers than do later offspring (Ylitalo *et al.* 2001). In males, contaminants continue to accumulate throughout their lives and there will be significantly higher concentrations of toxic contaminants in males compared to reproducing females. First-born males may be the most at risk for high contaminant levels and affects due to these combined affects. By comparing the contaminant levels with the results of the paternity study some information can be obtained on the relationship between the number of calves sired and contaminant levels.

Understanding how exposure relates to life history parameters and how contaminant burdens in Southern Residents compare to other killer whale populations is essential to assessing the health risk from exposure to various toxic chemicals. Thus, data are needed on the toxic chemical concentrations in killer whales that live throughout the eastern North Pacific, as well as on the life history parameters (e.g., sex, age, and recruitment order) of these animals. Additionally, because weight loss results in POPs being redistributed or released into circulation in the body, adverse health effects from these contaminants may increase as prey become less available. Deleterious biological effects related to contaminant exposure include immunosuppression, endocrine disruption, and lower reproductive success. The pods of the Southern Residents have some ecological differences. For example, L pod spends more time outside Puget Sound and therefore could be exposed to different POPs or levels of certain POPs. Comparing contaminant data from the three pods will provide information on relationships between the population's growth and contaminant levels.

To determine if exposure to high concentrations of chemical contaminants may be contributing to the decline of Southern Residents, it is necessary to collect toxic chemical contaminant data on healthy, free-ranging killer whales that occur throughout the North Pacific and compare the levels in animals from declining populations with the contaminant levels in whales from stable or increasing populations. Additional contaminant research is warranted to assess exposure to various contaminant classes and their effects on Southern Resident whales and to compare to effects in individuals from other eastern North Pacific killer whale populations. With better information on the levels of various POPs, in different age and sex classes and pods, relationships between survival and other life history affects can be better understood, and more appropriate conservation actions implemented.

New samples of SRKWs are needed to assess current levels of toxic POPs and to address new contaminants of concern in these whales (e.g., polybrominated diphenyl ether or flame retardants). In addition, fatty acid and stable isotope signatures can be determined in blubber samples to help establish prey preferences, particularly for the winter months when the whales are difficult to observe.

Analyses are needed to provide information on inter-pod differences and differences between age and sex classes, reproductive state and inter-pod differences in contaminant loads. Males are particularly important for study and will provide the best data on accumulation of contaminants over time since they continue to accumulate throughout their life. First born animals, particularly males, are important because they provide information regarding the transfer of contaminants to offspring. Comparison of contaminant loads in older females with other segments of the population may provide some information regarding longevity in relation to contaminant loads.

Specific research questions:

What are the differences in levels and patterns of contaminants among the Southern Resident pods, as well as differences between Southern Residents and other eastern North Pacific killer whale populations?

- Determine the sources and levels of contaminants in killer whales and whether new contaminants of concern are being accumulated by killer whales.

- Is there a relationship between exposure to contaminants in Southern Resident whales and their survivorship or reproductive success?

Genetic relationships: Assessing the viability of the Southern Resident killer whale population and developing plans for their conservation requires understanding of the breeding structure of the population. A population's demographics, including information on who is mating with whom, play a key role in determining the population's rate of growth (or decline). For example, a paucity of breeding age males, combined with the possibility that females may mate only with males outside of their pod, is a potential risk factor for the Southern Resident population (Krahn et al. 2004). However, little is known about breeding behavior and mating patterns within the Southern Residents. In particular, although there is information about maternal relationships in the population, there is no information available about paternal relationships and hence patterns of mating. These relationships can be inferred through genetic analysis of mothers, their offspring, and the pool of potential sires.

Understanding the Southern Resident's mating structure is therefore important for assessing conservation options. For example, the three pods of the Southern Residents have somewhat differing population trends, as do the Southern Residents as a group from that of closely related Northern Residents. If these differences are correlated with exposure to different environmental or anthropogenic factors, this could lead to insights into how to alleviate causes for poor survival or reproduction. In contrast, if low or negative rates of population growth in a pod are due to a lack of breeding opportunities or to inbreeding depression, this would potentially lead to different conservation scenarios than if the declines are due to external factors such as environmental contaminants or lack of sufficient prey.

Both a lack of mates and inbreeding depression are potentially serious concerns for the Southern Residents. The current level of inbreeding in the population is unknown, largely due to the absence of information on paternity. Barrett-Lennard (2000) showed that gene flow among population s of residents is not common, although a low level of male mediated gene flow has not been ruled out between southern and northern residents. Levels of inbreeding can be estimated most precisely using a full pedigree, where the relatedness of each individual is known. Accurate measures of inbreeding coefficients will help distinguish how much of the current mortality can be attributed to different sources, e.g., inbreeding depression versus pollutant load.

To date, an insufficient number of Southern Residents have been sampled and genetically analyzed to conduct a paternity analysis of the population. Hypotheses about patterns of mating within the Southern Residents have therefore been generated from data obtained from the more completely sampled Northern Resident population (Barrett-Lennard 2000). Genetic analysis of new tissue samples from the Southern Resident population will allow paternal relationships within the population to be studied. In addition, by combining these results with previous information on other killer whale populations (Barrett-Lennard 2000; Hoelzel et al. 2002), it may be possible to determine directly if Southern Resident females mate with males from other populations. A small amount of interbreeding between the Southern Residents and other populations would greatly reduce the rate of inbreeding within the population, and may explain how such a small population could maintain its genetic viability in the long-term. In order to address these questions, it is particularly important to obtain samples from breeding age males and mother-offspring pairs.

Methods of paternity analysis – All animals sampled will have their genotypes determined at multiple (up to 20) microsatellite loci that have been previously characterized for killer whales (Barrett-Lennard 2000; Hoelzel 2004; Hoelzel *et al.* 2002). Paternity analysis will proceed in two steps. First, all animals will be compared with the genotypes of all available potential sires to determine if there is a potential match. If an animal's dam has also been sampled, the genetic data will first be used to confirm that the hypothesized dam is indeed the genetic mother, and then the sire's genotype will be inferred by subtraction. Second, if there is no match to a known potential sire, the sire's inferred genotype will be compared against the allele frequencies that have been observed in the various Resident, Transient and Offshore killer whale populations to determine the most likely population (or possibly pod) of origin for the inferred sire. The samples will include all reproductive age males in each pod (age 13 or older) plus mother - offspring pairs that include offspring that are young enough that their potential sires are likely to be still alive

<u>Specific research questions:</u>

- What are patterns of mating within the Southern Residents, and between the Southern Residents and other eastern North Pacific killer whale populations?

- Are intrinsic demographic problems, such as a lack of appropriate mates or inbreeding depression, limiting the Southern Resident population's recovery?

<u>Identification of important prey resources:</u> Information is limited on which species and populations of salmon or other prey the whales target throughout the year and their geographic range. There is also little information about the geographical and temporal distribution of adult salmon. Additionally, virtually no data exist on which prey species SRKWs consume during the winter/spring and outside Puget Sound. Information about the winter diet is based on examination of a single stomach from a stranded animal (Ford et al. 1998; Baird and Hanson, unpubl. data). We also have little information on how feeding varies over time and area and in response to events such as El Nino. Furthermore, we have little information regarding prey selection and foraging behavior by the individual pods. With such limited information about food habits, it is difficult to relate changes in prey resources to potential risks for the whales.

Changes in prey abundance or quality is another factor that potentially may have contributed to the decline of Southern Residents. Information on food habits of Southern Residents is very limited. Salmon species, particularly Chinook, have been identified as important prey based on traditional techniques, such as examination of the stomach contents from a few stranded individuals and sampling of scales collected after feeding events in Puget Sound (Ford et al., 1998; Baird and Hanson, unpubl. data). The application of these traditional methods of diet analysis has known biases and limitations. For example, because observational data are typically limited to predation occurring at or near the water surface in inland waters during late spring and summer months, the data reveal little about the foraging habits of these whales below the surface or at other areas or other times of the year. Analyses of stomach content may be biased in favor of prey species with durable hard parts due to differential rates of digestion. Indirect chemical analytical techniques have been developed that may more accurately reflect long-term diet.

Multiple methods are currently being used to improve our knowledge of the important prey for Southern Resident killer whales. John Ford (Department of Oceans and Fisheries, Canada) and colleagues have been collecting scale samples after observed summer feeding events in Puget Sound, however only 68 (14%) of observed feeding events in Ford's study involved Southern Residents (Ford and Ellis 2005). Fatty acid signature analysis of blubber (Iverson, 2004) and stable isotope enrichments of ^{13}C and ^{15}N in the epidermis (Kelly, 2000) are indirect chemical methods that have been used to assess the dietary preferences and trophic position of marine mammals. In addition, patterns of organochlorine contaminants (OCs) have been shown to differ among cetacean stocks, presumably as a result of differences in the OC composition of their respective prey (Krahn, 1999; Muir, 1996). Studies of the ratios of particular contaminants measured in the small number of previous biopsies of Southern Residents collected in the mid-1990s, compared to those in potential prey species, were in agreement with earlier studies that salmon is a major prey species (Krahn *et al.* 2002). All these techniques have been combined (Herman *et al.* 2005; Krahn *et al.* 2005) to qualitatively examine the dietary specializations of eastern North Pacific killer whale populations. Data for these analyses are obtained from a small amount of tissue collected from free-ranging animals.

The combined analytical approach discussed above has provided new information on potential prey, however the number of tissue samples that have been analyzed for food habits of Southern Residents is small and does not represent a cross-section of the age and sex classes in each pod. Analyses of additional tissue samples for concentrations and ratios of additional contaminants will provide valuable new information on the pod, matriline and age-specific feeding ecology of the Southern Resident whales. Furthermore, analyses of skin samples for stable isotopes of carbon and nitrogen will establish the trophic feeding level of each animal. Finally, fatty acid analyses will provide qualitative inferences about diet (Herman *et al.* 2005).

Specific research needs:

- Determine what prey resources are important for each pod year round but particularly during the winter/spring period when prey resources may be less abundant.
- Determine where each pod feeds, geographically and in the water column.
- Determine the spatial and temporal variation in killer whale diet

Important habitats for southern resident killer whales, particularly in outer coastal waters: Habitat requirements of SRKWs are poorly known both in the Puget Sound and California Current ecosystems. During the summer, all three pods use the Puget Sound-Strait of Georgia area. However, new evidence indicates that the three pods differ in their use of habitat in Puget Sound (D. Hauser, unpubl. data). The winter-spring habitat of the southern residents, particularly outside the Puget Sound waters, may be especially important for survival and reproductive success because there may be lower prey availability or other risk factors during the winter**.**

Little is known about why K and L Pods leave Puget Sound for extended periods of time, particularly during the winter and spring. Despite expanded efforts to locate the winter areas, confirmed sightings of Southern Residents outside the Greater Puget Sound area number only 27 over a 38-year period (Center for Whale research, unpubl. data, NWFSC, unpubl. data). Most of these sighting reports were relatively close to the coast; there is little or no information concerning how far offshore the SRKWs may travel. Recent sightings in Monterey Bay, California, and the Queen Charlotte Islands, British Columbia, suggest that their current range may extend further south and north than previously documented. Sightings of the pods returning to Georgia Strait through Johnstone Strait also suggest that the Queen Charlotte region may be a seasonal part of their range. Despite the low number of coastal sightings, multiple sightings have occurred in a few locations. Specifically, L Pod has been reported off Tofino, British Columbia, on five occasions and off Westport, Washington, near the Columbia River, on four occasions.

How the whales locate and capture prey within the habitats is not well understood. Most SRKW diving activity occurs in the upper 30 m of the water column (Baird et al., 2005), where most salmon are distributed (Stasko *et al.* 1976, Quinn and terHart 1987, Quinn *et al.* 1989, Ruggerone *et al.* 1990, Olson and Quinn 1993, Nichol and Shackleton 1996, Candy and Quinn 1999, Baird 2000). Chinook salmon, an important prey item for resident killer whales in the Pacific Northwest, tend to be found in deeper water (25–80 m average depth) (Candy and Quinn 1999, Quinn and terHart 1987, Quinn et al. 1989, Ruggerone *et al.* 1990). By recording SRKW behavior at depth, we will better understand three-dimensional habitat use and foraging behavior. For example, recent analyses of time-depth recorder data show that SRKWs make dives deeper than 30m and that males and females have different diving patterns (Baird *et al.* 2005).

An important issue in conserving populations is protecting habitat required by the pods. Once important areas and habitats are clearly identified, the factors there that promote or threaten population growth can be evaluated and mitigation measures developed.

Determining the distribution of the whales outside Puget Sound is difficult. They are often difficult to see and can travel long distances each day. To locate whales in coastal waters requires costly extensive effort using techniques such as passive moored acoustic arrays, dedicated shipboard surveys and a shore based sighting network. Information is also needed on the oceanographic conditions in habitats used by the whales and on how these relate to whale distribution. Types and levels of noise in the California Current System are likely to be different than in Puget Sound. New information on noise is being collected using moored passive acoustic monitoring devices in Puget Sound and in the California Current ecosystem. Finally, there may be as yet unidentified risk factors in the winter habitat that may inhibit population growth for the southern residents.

Effects of vessel presence on southern resident killer whales: The presence of numerous vessels may cause changes in SRKW behavior or physical and social stress to the whales. When the whales change their behavior, we do not know whether the change is in response to the vessels presence or noise. There is evidence that other dolphin and whale species demonstrate horizontal or vertical avoidance behavior in response to vessel traffic (Nowacek *et al.* 2001, Jelinski et al. 2002, Williams *et al.* 2002a, 2002b, Lusseau 2003, Ng and Leung 2003). They may also display agonistic behaviors, such as slapping flukes or pectoral fins on the surface of the water (Williams *et al.* 2002a). However, these behaviors are also exhibited in social and communication contexts, and in some instances, no disturbance seems to have occurred in the presence of boats (R. Williams unpubl. data). In a recent study, Foote et al. (2004) found an increase in the duration of SRKW vocalizations associated with the increase in the numbers of whale-watching vessels, but the potential effects of unrecorded confounding factors make it difficult to establish cause and effect. Although cetaceans (whales and dolphins) are known to respond to boat traffic with stereotyped, short-term avoidance tactics, determining a link between short-term responses and a long-term effect such as decreased reproductive success is difficult. Once it is known that either noise or the vessel presence negatively affects the population, management can determine what regulations will be most effective in protecting the whales.

Commercial whale-watching vessels accompany the southern resident killer whales from early morning to dusk throughout the late spring, summer, and fall. The average number of boats near the whales has increased from about 5 in 1990 to up to 26 by 1996 (Baird 2001, Erbe 2002, Marine Mammal Monitoring Project 2002, Osborne 1999, Osborne *et al.* 2002). Because so many whale-watching boats operate in Greater Puget Sound area, the Whale Watch Operators Association Northwest adopted guidelines for commercial operators to ensure consistency in practices and reduce impacts on the whales. Similarly, the National Marine Fisheries Service (NMFS) and Canada Department of Fisheries and Oceans issued guidelines for recreational and commercial vessels to use when approaching the whales.

Chronic stress from noise exposure and repeated disturbance from vessel traffic can induce harmful physiological trauma (Gordon and Moscrop 1996), increased energetic expenditures, and temporary threshold shifts in hearing, as well as force whales away from critical feeding, or migrating areas (NRC 2004). In order to fully understand whether behavioral responses to vessel traffic have long-term effects, we need to determine the energetic costs of behavioral changes associated with vessel presence. Quantifying behaviors in terms of energetic cost will inform whether short-term avoidance tactics may have long-lasting effects on individuals. For example, if avoidance mechanisms in killer whales are energetically expensive, individuals may need to compensate for the increased energetic costs by consuming more prey while the presence of vessels during most of the daylight hours may decrease the amount of time whales can forage each day.

It is important to note that differences in distribution and use of different habitats by the three SRKW pods may mean that members of J, K, and L Pods experience differing levels of acoustical, behavioral, and energetic impact from vessels. Specifically, J Pod has the most exposure to whale-watching and private vessels because it spends the most time in Puget Sound (Wiles 2004). The L Pod has the least (Bain 2002, Koski pers. commun.) because it spends more time outside Puget Sound. Because of these differences, comparing behavior and responses of the three pods is important. Comparison with the Northern Resident killer whales, whose range overlaps somewhat with the SRKWs, is also useful because they are subjected to lower boat densities during the summer months.

Specific research needs:

- determine which characteristics of boats are likely to affect SRKWs (type, distance, size, direction, activity, movement/operation, time duration, density and number of boats).
- determine if vessels affect the SRKW's ability to find and capture prey.
- determine if vessel activity affects energy acquisition or expenditure.
  determine if vessel activity affects habitat use by each pod.

3. Hypothesis/Objectives and Justification: The objective of research conducted by the Marine Mammal Program of the NWFSC is to contribute critical information for the conservation and management of U.S. and international populations of marine mammals and their key habitats. These efforts are justified because the NMFS is mandated under provisions of both the MMPA and ESA to conserve and recover marine resources covered by this legislation. These activities include monitoring the abundance of cetacean stocks, determining stock structure and population dynamics, habitat relationships, and assessing the impact of human activities on these populations of the Pacific Northwest.

All species: We collect data to address these objectives with vessel-based surveys of marine mammals using line-transect methodology, aerial surveys and small boat operations. Focal follows of individual or groups of animals from small boats and tagging will also be conducted. Much of the scientific effort is directed at improving our ability to detect trends in marine mammal populations in order to best predict and prevent detrimental effects of natural or man-caused environmental changes (e.g., contaminants, noise, habitat degradation) on these populations. We also develop and test mathematical models to determine how risk factors such as contaminants, noise and changes in prey of marine mammal populations might influence changes in population levels or our estimates of these levels.

Ecological and oceanographic research is also conducted to provide a framework within which to interpret trends in the distribution and abundance of the protected living marine resources that are involved in management actions by NMFS. By expanding research efforts to include the physical and biological habitat, and other marine organisms, we establish a context which can be used to better interpret results of directed abundance surveys which serves to support NOAA's strategic plan goals for eco-system monitoring and management. To this end research is conducted aboard most vessel surveys to study physical, chemical, and biological oceanography, and ecology of plankton, micronekton, seabirds, and additional selected taxa.

The species included in this research are all species which have designated stocks within the Washington/Oregon area of the EEZ as well as international waters to the west of this region as outlined in the Pacific Stock Assessment Reports (see Caretta *et al.* 2005, Table 1.). This includes ESA listed cetaceans in this region: blue whale, fin whale, sperm whale, and humpback whale. In collaboration with the SWFSC and NMML, we will collect data to complement or complete ongoing investigations of distribution, stock structure, feeding ecology health status, and habitat relationships. By their very nature vessel surveys provide opportunistic encounters of various cetacean species within this region. The type of methods employed for a given species will be a function of several factors. One factor will be the applicability for a given species (e.g., photo-ID is not conducted on some species because individual differences are too subtle to detect with photography). In addition, the context of the temporal and spatial circumstances of the encounters will also dictate the methods used. For example, biopsies of humpback whales during mid summer off the coast of Washington may be of limited value for stock structure given the currently available samples – but additional samples could be of value for feeding studies and assessment of pollutants. However, biopsy samples from late fall or early spring, in addition to their value for feeding studies and contaminants, may be quite valuable for assessment of stock structure to address questions such as whether these animals represent migrants from other regions moving through the area.

Southern Resident Killer Whales: Some key questions identified for conservation and management for the Southern Resident killer whale population are:

1. What is the population abundance and trends? How many births and deaths annually?
2. What are the differences in levels and patterns of contaminants among the Southern Resident pods, as well as differences between Southern Residents and other eastern North Pacific killer whale populations? Is there a relationship between exposure to contaminants in Southern Resident and their survivorship or reproductive success?
3. What are the patterns of mating within the Southern Residents, and between the Southern Residents and other eastern North Pacific killer whale populations? Are intrinsic demographic problems, such as a lack of appropriate mates or inbreeding depression, limiting the Southern Resident population's recovery?
4. What are the important prey species of Southern Residents?
5. What are the effects of large numbers of vessels and noise?
6. What are the important habitats for southern residents and other marine mammals in coastal waters, particularly during the winter/spring period?
7. What was the historical size of the Southern Resident killer whale population? Is there genetic evidence that the Southern Resident's have experienced a severe genetic bottleneck?

C. Methods

1. Duration of the Project and Locations of Taking

Duration: The proposed research is part of an on-going long-term research program at the Northwest Fisheries Science Center. The requested duration is for five years. Methods listed may be employed at any time during this period. Many studies are part of long term, on-going research on the populations and are coordinated with other Science Centers, co-managers, and organizations.

Location: The following research activities will be conducted in U.S. EEZ waters off CA, OR, WA, and territorial waters, coastal waters, inlets and estuaries off CA, OR and WA and international waters of the eastern North Pacific Ocean. This region would include the Olympic Coast, Cordell Bank, Gulf of Farallones and Monterey Bay National Marine Sanctuaries. Some studies would be conducted within Marine Sanctuary waters under a valid Sanctuary permit. Takes in the NW and other North Pacific areas would be done in coordination with other Fisheries Science Centers. Ports of imports of samples would depend on the origin of the samples and would include but not be limited to Seattle.

2. Type of Taking, Methodology Involved and Numbers of Animals that would be Taken

Cetacean Studies:

1. Cetaceans other than southern resident killer whales

The types of takes will depend on the method employed but includes both Level A and B.

Activities under this project will potentially include 1) aerial and boat surveys, including a) acoustic tracking using a towed passive hydrophone, b) photo-identification c) focal follows to collect behavioral and energetic data or fecal material and predation events remains, 2) collection of biological samples for contaminant, genetic, stable isotope, and fatty acid studies, 3) tagging with scientific instruments; and 4) health assessment (Table 1). Vessel surveys and photo identification are used for estimating abundance and distribution of marine mammals. Biological sample collection is an essential tool for determining among other things, a population's structure, status and health. The skin and blubber have been used to measure contaminant loads and stress levels, and to investigate diet. Tagging is an important technique for studying the behavior, ecology and physiology of cetaceans. Tagging activities will focus on determining distribution, movements and dive behavior. Level B harassment may occur incidental to vessel surveys, photo-identification, acoustic tracking, focal follows for behavior, health assessment (using ultrasound and/or breath sampling) and foraging studies. The potential for level A harassment exists in conjunction with biological sample collection (via biopsy) and tagging activities. Cetacean research activities may occur during any month of the year in the eastern North Pacific Ocean, mainly in the U.S. EEZ waters including Olympic Coast, Gulf of the Farallones, and Monterey Bay National Marine Sanctuary waters. Survey length and frequency will depend on the particular project and funding. Our field work will be performed from a variety of different size vessels. Typically vessels will be small (16- 40 feet) for focal follows, biological specimen collection, and scale and fecal collections but these vessels may be also deployed from ocean-going research vessels.

Table 1. Cetaceans other than southern resident killer whales- maximum number of annual takes

We are aware of the other researchers that hold General Authorizations and Research Permits for cetaceans in the Pacific Northwest, and will coordinate our efforts with them to avoid duplication in research and undue disturbance of the animals.

Species	Regions in which research activities may occur	Photo-grammetry	Biopsy	Photo ID	Focal follows for behavior and prey or fecal material	Breath sample	Ultrasound	Data lagging tags: time-depth, acoustic, video recorded	Tagging: satellite or radio tag	Incidental harassment for all research activities	Worldwide import, export, reexport and/or salvage of biological samples, specimens or parts
Minke whale, *Balaenoptera acutorostrata*	Pacific Ocean (U.S. EEZ and Int. areas)	10	10	20	10	0	0	5*	5	50	10
Blue whale *Balaenoptera musculus*	Pacific Ocean (U.S. EEZ and Int, areas)	10	10	20	10	0	0	5*	10	20	5
Fin whale *Balaenoptera physalus*	Pacific Ocean (U.S. EEZ and Int. areas)	10	10	10	5	0	0	5*	5	10	5
Baird's beaked whale, *Berardius bairdii*	Pacific(U.S. EEZ and Int. areas)	5	5	20	0	0	0	5	5	20	5

Species (Common name)	Regions in which research activities may occur	Photo-grammetry	Biopsy	Photo ID	Focal follows for behavior and prey or fecal material 0	Breath sample	Ultrasound	Data Logging tags: time-depth, acoustic, video recorder	Tagging: satellite or radio tag	Incidental harassment for all research activities	Worldwide import, export, reexport and/or salvage of biological samples, specimens or parts
Short-beaked common dolphin, *Delphinus delphis*	Pacific Ocean (U.S. EEZ and Int.areass)	10	10	10	0	0	0	N/A	N/A	20	5
Gray whale, *Eschrichtius robustus*	Pacific Ocean (U.S. EEZ)	10	5	25	5	5	5	5*	10	50	20
Short-finned pilot whale *Globicephala macrorhynchus*	Pacific Ocean (U.S. EEZ and Int. areas)	10 0	10	10	5	5	5	10*	10	20	5
Risso's dolphin *Grampus griseus*	Pacific Ocean (U.S. EEZ and Int. areas)	10	10	10	5	0	0	N/A	N/A	20	5
Pygmy sperm whale, *Kogia breviceps*	Pacific Ocean (U.S. EEZ and Int. area s)	10	10	10	5	0	0	N/A	N/A	20	5
Pacific white-sided dolphin,*Lagenorhynchus obliquidens*	Pacific Ocean(U.S. EEZ and Int.areas)	50	50	50	5	5	5	5	N/A	300	10

Species (Common name)	Regions in which research activities may occur	Photo-grammetry	Biopsy	Photo ID	Focal follows for behavior and prey or fecal material	Breath sample	Ultrasound	Data Logging tags: time-depth, acoustic, video recorder	Tagging: satellite or radio tag	Incidental harassment for all research activities	Worldwide import, export, reexport and/or salvage of biological samples, specimens or parts
Northern right whale dolphin, *Lissodelphis borealis*	Pacific Ocean (U.S. EEZ and Int. areas)	50	50	50	5	5	5	5	N/A	300	10
Humpback whale, *Megaptera novaeangliae*	Pacific Ocean (U.S. EEZ and Int. areas))	25	25	100	15	10	10	10*	10	200	5
Mesoplodon beaked whales, *Mesoplodon spp.*	Pacific Ocean (U.S. EEZ and Int. areas)	10	10	20	10	0	0	N/A	N/A	50	10
Killer Whale *Orcinus Orca,*	Pacific Ocean (U.S. EEZ and Int. areas)										
Offshore		25	25	50	10	5	5	10*	2	50	10
Transients		50	50	100	25	10	10	25*	5	100	10
Other Resident		25	10	25	20	20	20	10*	5	50	10

Species (Common name)	Regions in which research activities may occur	Photo-grammetry	Biopsy	Photo ID	Focal follows for behavior and prey or fecal material	Breath sample	Ultrasound	Data Logging tags: time-depth, acoustic, video recorder	Tagging: satellite or radio tag	Incidental harassment for all research activities	Worldwide import, export, reexport and/or salvage of biological samples, specimens or parts
Harbor porpoise, *Phocoena phocoena*	Pacific Ocean, (U.S. EEZ and Int. areas)	100	50	20	50	0	0	12	N/A	100	10
Dall's porpoise *Phocoenoides dalli*	Pacific Ocean (U.S. EEZ and Int. areas)	100	50	100	50	10	10	12	N/A	100	10
Sperm whale, *Physeter macrocephalus*	Pacific Ocean (U.S. EEZ and Int. areas)	20	20	50	10	0	0	5*	5	100	10
Striped dolphin *Stenella coeruleoalba*	Pacific Ocean (U.S. EEZ and Int areas)	20	20	100	0 0	0	0	N/A	N/A	500	10
Cuvier's beaked whale, Ziphius cavirostris	Pacific Ocean (U.S. EEZ and Int. areas)	10	10	20	0	0	0	N/A	N/A	100	10

* indicates that takes could involve either suction cup or implanted tag, depending on the data requirements.

- **Aerial and boat surveys** In addition to the species identified in the take table we may inadvertently take other MMPA or ESA protected species in our operations area. These species include but are not limited to: harbor seals, California sea lions, Steller sea lions, elephant seas , northern fur seals, sea otters, salmon, sea turtles, and sea birds,

Aerial Surveys will be undertaken as needed subject to aircraft and funding availability. This effort will use conventional line-transect sampling and surveys are flown at 700 ft. altitude. Aerial survey platforms will include but are not limited to fixed wing, rotary wing, and manned and unmanned airships. These efforts will occur along the U.S. west coast and inland waters to determine the distribution and abundance of cetacean populations. These aerial surveys occur from the coastal waters to 150 nmi offshore. We will not fly over pinniped rookeries but will be off the beach. The aircraft circles high (700-1000 ft) over animals to confirm species identification and to estimate group size. Animals sometimes respond to changes in engine pitch or shadows projected by the aircraft by diving rapidly.

Vessel Surveys will occur for all species included but not limited to those listed in Table 1 from NOAA and chartered vessels and could result in Level B harassment by approach. Vessel survey platforms will include but are not limited to typical small and large surface vessels as well as autonomous surface and underwater vessels.

Surveys may be conducted during any time of the year in all waters but will be subject to vessel availability. Data are collected during research vessel surveys for seasonal distribution information and estimation of population abundance by cetacean species/stock. Although procedures may vary slightly depending on the specific objective of the survey, in general, the following protocol is used on NWFSC research vessel surveys. The vessel traverses predetermined tracklines within the study area at a constant speed (usually 10 knots). Marine mammal observers stationed on the flying bridge deck of the vessel search the area from directly ahead to abeam of the ship using pedestal-mounted 25X binoculars. At times, depending on the species sighted and the data collecting priorities at the time, the vessel may turn off the trackline and approach marine mammals to confirm species identification and to make group size estimates.

Acoustic detection and tracking using a towed passive hydrophone array will occur as part of the vessel surveys for potentially any species listed in Table 1. Close approaches may occur to obtain visual verification or sufficiently long duration, high quality recordings. Towed passive hydrophone arrays are commonly used for detecting cetaceans during surveys. Using an acoustic array designed to localize vocalizing whales will allow tracking for extended periods during night or inclement weather. At a minimum, we will use a 300 m long 2-element array which will be towed at cruising speed on the survey vessel (typically about 10 kts). We are in the process of developing a second, 400m, 5-element hydrophone array that will be towed in tandem with the two element array. In addition sonobuoys maybe deployed to provide additional acoustic data. These longitudinal data sets will greatly increase the sample sizes necessary to understand distribution, behavior budgets, movements and habitat use.

Following visual or acoustic detection, whale groups would be monitored and tracked using a hydrophone array towed from a boat. The array is typically towed 200-400m behind the vessel. Vessel size would vary depending on the location. In inland waters, small vessels, approximately 6-14m would be used, whereas in the open ocean, larger research vessels, up to 200+ feet may be used. Environmental conditions (wind, tide currents) and whale behavior will dictate how the vessel is maneuvered in order to position the array as to best detect and localize whale vocalizations. The most likely scenario will require towing the array off to the side or behind the whales. Duration of an encounter with whales will vary based on whale behavior, day length and weather conditions. The goal would be to monitor whales for multi-day periods but acoustic tracking would only be required at night or during inclement weather. As a result, these periods are expected to be less than a day. Approaches to within 100m would be inadvertent. Pinniped rookeries and haul-out areas would not be approached.

Photo-identification activities will be conducted year-round in all regions noted above and are primarily conducted from small boats. When photographs are taken from boats, the animals will be approached closely enough to optimize photographic quality (i.e., well-focused images, utilizing at least one half of the slide viewing area, from video, or film or digital 35mm cameras). These activities could result in Level B harassment. Distance for optimal approach varies with the species being photographed. Generally, large whales (including killer whales, all mysticete whales, sperm whales, and all beaked whales) will be approached within approximately 15-20 m. Smaller cetaceans (porpoise and dolphins) will be approached within approximately 5-10 m. Photo-identification is mainly used for individual identification for abundance and stock identification. Photo-identification of adult and juvenile males and females will occur. If the opportunity arises, females accompanied by calves may be approached for photo-identification, but efforts will cease immediately if there is any evidence that the activity may be interfering with pair bonding, nursing, reproduction, feeding or other vital functions. Individual animals may be approached within 100m up to 10 times per year. Photos will be provided to researchers with on-going studies of specific species.

Focal Follows: Individual whales will be followed from a small boat (<40ft) for the purpose of collecting behavioral data, prey remains from predation events or fecal material.

Behavioral data will include observations of feeding, socialization, interspecies interactions and anthropogenic activities.

Prey remains collection: There is a paucity of data on prey selection. Collection of prey remains from predation events near the water surface events provides a direct measure of prey selection. Collection of prey remains will potentially include marine mammals, both cetaceans and pinnipeds that occur in the waters of the US EEZ from Washington to central California. Common species include, but are not limited to, harbor seals, California sea lions, elephant seals, Steller sea lions, harbor and Dall's porpoises, Pacific white sided dolphins, and minke whales. A small, fine mesh net on a long handle (similar to a swimming pool skim net) is used to collect prey remains from a small boat. Prior to net deployment, whale behavior will be monitored from a distance of several hundred meters. When a whale, or group of whales, begins non-directional swimming or other behavior suggestive of predation, the boat will be repositioned to the place of the whales initial surfacing. The samples collected will be processed to determine the species of prey, and if possible, its stock. Data recorded will include date, time, location, number of animals, whale ID, behavioral activities, and environmental conditions. Individuals that have been identified will not be approached within 100m more than twice per day. The data will be entered into a relational data base.

Fecal samples: Chemical analyses of fecal samples have the potential to provide important information on a variety of parameters including health assessment as has been demonstrated with right whales in the North Atlantic (Rolland et al. in press). In addition to chemical analyses for sexual maturity, pregnancy, and stress, tissue from intestinal sloughing may be useful for additional genetic information. Collection of fecal samples is conducted with a small, fine mesh net on a long handle (similar to a swimming pool skim net) from a small boat while following approximately 100 m behind the whales in their fluke prints. In addition, highly trained scent-detection dogs may be used to locate fecal material. For this method, a small boat will be positioned approximately 100 yards from a group of whales, off to the side or behind the whales. Following detection of a fecal event the boat would move quickly into the wake of the whale for collection of the material as described above. Archived samples will be analyzed for various hormones that can be used to assess health status. Collection of this material will be opportunistic and occur during the conduct of photo-ID or biological sampling.

Breath Sampling: Collection of expired breath has the potential to provide valuable information about the health status of individual whales using a non-invasive method. Blood sampling, a primary diagnostic tool for health assessment, generally requires capture and restraint that is difficult for most species and virtually impossible for cetaceans. Remotely sampling blood has had only limited success. Similarly, urine and feces, which can yield valuable health information, are typically not available in a marine setting. Cetaceans must surface to breathe and because exhaled breath is the result of an exchange between pulmonary blood and aveolar air, the exhaled breath represents a potentially non-invasive approach to assessing diseases or metabolic disorders. Exhalant aevolar breath contains many volatile and semi-volatile compounds that are a reflection of biochemical constituents in the circulatory system, which in turn originate from the liver, other organs of internal metabolism or even tissue catabolism.

Metabolic perturbations often have their origins in lipid or liver metabolism. The expired air thus can offer a variety of information about internal metabolism and offers clues about predominant metabolic pathways or shunts. Importantly, because the air and food systems in cetaceans are completely separate, an uncontaminated sample can be obtained of compounds originating along the breathing passages, lungs and possibly the blood. Analyses of algal cultures will provide information on microbes present.

Analytical techniques are available to identify and quantify a wide spectrum of breath-released compounds at parts per million volume (ppmv) or lower. The analyses of breath by gas chromatography/mass spectrometry (gc/ms) have expanded the diversity of metabolic states that can be identified. In some cases, breath analysis is the primary approach to assess disease conditions. Despite some limitations, this approach can serve as a valuable diagnostic tool, particularly in the absence of a blood sample.

Samples will be collected using a specially designed vacuum cylinder, a system previously used on several species (Rasmussen and Riddle 2004). An algal culture plate inside the funnel will be used for bacterial cultures of the breath. Samples will be collected from free ranging whales by positioning a funnel at the end of a 6m pole (which is connected to the vacuum cylinder with plastic tubing) over the blowhole (inadvertent contact may occur) of the surfacing animal and manually opening the cylinder valve during exhalation. The equipment does not touch the animal although in certain rare circumstances there could be brief (< 10 sec) contact. An individual whale may be approached up to 3 times to obtain breath sample. This approach has been successfully used on killer whales (Hanson and Rasmussen, in prep), wild bottlenose dolphins, fur seals, captive manatees, pygmy and dwarf sperm whales, rough tooth dolphins and false killer whales. The vessel approach operations will be similar to those for biopsy and suction cup tag deployments although the minimum distance will be closer (up to 5m).

<u>Ultrasound sampling</u>: Ultrasounds sampling will be used to determine blubber thickness in Alaskan Resident killer whales. For the first year of the study, up to 10 adult animals will be approached to assess the utility of using this measurement to assess the health and nutritional status of individual killer whales. After the techniques are proven for this population of killer whales, up to 25 Alaskan resident killer whales may be approached annually for ultrasound measurements. Sampling will be conducted during discrete one month periods. Individual animals may be approached within 100 m up to three times per year to attempt ultrasound measurements, but no more than two measurements will be taken from each individual animal per year. No calves less than 3 years old will be approached for measurements. The animals to be sampled will either approach the vessel on their own or be approached by a small boat. In order to minimize disturbance, the vessel will approach slowly from behind and to the side of the surfacing whale. Attempted measurements will only be made on whales located in the periphery of a group of whales. If signs of harassment such as vessel avoidance or other related behaviors are demonstrated, ultrasound activities will be discontinued on that group of whales. If opportunity occurs, gray and humpback whales would also be sampled. The acoustic system, used safely on the endangered Atlantic Right Whale (Moore et al. 2001), consists of a 0.5MHz ultrasound transducer on a cantilevered 12m pole. The instrument will make contact with the back of a surfacing killer whale to obtain the blubber thickness measurement. Contact duration of one second is all that is required for a good signal for this measurement. Stereo video cameras will be mounted on a 2m mast at the pivot point of the ultrasound apparatus to record the location of the ultrasound readings on the animals, allow time-coded video footage of the ultrasound take, and to assist the researchers in estimating the length of the animals. (Moore et al. 2001).

Videogrammetry from a tethered airship: Videogrammetry from a tethered airship, because of its unique perspective, has the potential to provide high quality imagery for monitoring whale predation events and other behaviors, quantifying whale/boat interactions, and assessing body condition. This effort would be similar work that has been conducted with right whales, humpback whales, manatees, and killer whales (Lange et al. 2003). High-definition television cameras are mounted in an unmanned tethered airship and used to record images directly below within its 500ft maximum field of view. The airship is unpowered and tethered to a small boat (20-40 ft) and flown at an altitude of 250 ft to 400ft. Environmental conditions (wind, tide currents) and whale behavior will dictate how the vessel is maneuvered in order to position the airship over a group of whales but the most likely scenario will require towing the airship ahead of the whales. We would operate within the whale watch guidelines, although weather conditions may affect operating distance to ensure the camera is positioned correctly. These activities are likely to occur for several hours during each day but the number of days per year is expected to be less than 20. Approaches to within 100 m would be inadvertent and are expected to be infrequent (i.e., less than once per day).

Capture: N/A

Handling/Restraint: N/A

Biological sample collection will occur opportunistically during vessel surveys or from small boats using biopsy sampling (skin/blubber collected by projectile dart) or collection of prey remains, sloughed skin or feces. The blubber portion of the biopsy sample will be analyzed for fatty acids and persistent organic pollutants (POPs) whereas the epidermis will be analyzed for stable isotope ratios as described by Herman et al. (2005) and genetics. Collection of samples using projectile biopsy could result in Level A harassment although adverse impacts are extremely rare (Bearzi et al. 2000, see Noren et al. in prep). Potential adverse impacts of this activity will be mitigated by using an experienced collection team and limiting the encounter duration with a particular animal group to 45 minutes. No more than three biopsy sample attempts per individual will be made during any single encounter, and no other samples will be collected during this period. Number of approaches for biopsy depends on whether the first approach is successful. Individual animals may be approached within 100m up to 10 times per year for research data collection. If signs of harassment such as vessel avoidance or other related behaviors occur, the research activities will be suspended. The animals to be sampled will either approach the vessel on their own, be approached by the main research vessel during normal survey operations, or be approached by a small boat. The projectile biopsy sample procedure that will be used will vary with the species. The tissue sample will be collected from animals within approximately 5 to 30m of the bow of the vessel or small boat (Palsbøll *et al.* 1991). For small cetaceans (dolphins, porpoises, pygmy sperm whales, pilot whales), skin and blubber will be sampled using sterilized biopsy darts that are 7 mm in external diameter by approximately 26 mm long (Weller *et al.* 1997, Chivers *et al.* 2000, Möller and Beheregaray 2001, Krützen *et al.* 2002, Hobbs *et al.* 2003, Hansen *et al.* 2004). Biopsies will be collected from the area close behind the dorsal fin. Actual depth of penetration will be determined by the blubber thickness of the animals to be sampled. The depth of the biopsy tip is controlled by a cushioned stop (25mm in diameter) of neoprene vacuum hose encircling the biopsy head. For large cetaceans (killer whales, all mysticete whales, sperm whales, and all beaked whales), small samples (<1 gram) will be obtained from free-ranging individuals using a biopsy dart with a stainless steel tip measuring approximately 4 cm in length with an external diameter of 9mm and fitted with a 2.5 cm stop to ensure recoil and prevent deeper penetration. Between sample periods, the biopsy tips are thoroughly cleaned and sterilized with alcohol. Biological samples may be collected from adults, juveniles, females with calves. Calves will not be sampled.

For biopsies in which both blubber and epidermis will be analyzed, the epidermis will be separated from the blubber immediately. The biopsy plug will be removed from the dart using clean forceps and a new scalpel blade to detach the blubber from the dart. The skin will be carefully cut from the blubber, cutting close to the skin-blubber interface. The blubber sample will be transferred to a clean 17-mL Teflon screw-top vial and frozen as quickly as possible (within 3 hrs, if feasible). Until freezing, the samples will be kept in a bag in a cooler with ice. When the biopsy sample is sub-sampled, the skin will be stored on ice. Upon reaching shore, the samples will be transferred to a –80° C freezer and stored until analyzed.

For stranded cetaceans, full-thickness blubber samples (including epidermis) will be collected during necropsies and analyzed for fatty acids, POPs and stable isotope ratios as reported by Herman et al. (2005). A 5” x 5” square blubber sample will be sampled using a clean knife and placed in a pre-rinsed Teflon sheet. The sample should be placed in labeled whirlpak and stored on ice until transfer to a -80° C freezer. We are active participants in the Stranding Network, often called upon to necropsy stranded animals for the Network and ensure that all requested samples are collected for the Network.

Scientific instruments

Tagging activities will be conducted opportunistically in conjunction with vessel surveys and from small boats. Types of tags that will be employed: data logger tags, i.e., time depth, acoustic and video recording tags, and satellite and radio tags.

Data logging tags

Date logging tags will typically employ a suction cup attachment but may have an implantable attachment. The choice of tag or attachment systems tags will depend on the primary research question being addressed. Suction cup attached tags have been safely and successfully deployed on wide variety of cetacean species (Hooker and Baird 2001). Similarly, implanted tags that are proposed have been safely and successfully deployed on numerous species including gray whales (Swartz *et al.* 1987), blue whales (Mate *et al.* 1999) right whales (Mate *et al.* 2000), sperm whales (Mate *et al.* 2003). Suction cup attachments typically remain attached for a few hours to a few days. Implanted tags may remain attached for a few days to several months.

Approaches will be similar to those used during biopsy activities. During any single encounter, no more than five tag deployment attempts per individual will be made. Because the tag must be positioned fairly precisely on the body and there may be only a few animals present, there are more limited opportunities to place a tag therefore a higher number of approaches may be needed to successfully place the tag. Sex and age classes to be tagged include adult and juvenile males and females but no tagging attempts will be made on calves; however, we are requesting to tag animals accompanying calves. All tags will be deployed with a 150 lb compound crossbow, Pneumatic projector or pole to the anterior dorsal surface of the whales approximately mid-back but slightly off to one side, or the dorsal fin. Please note that dimensions and weights of tags given here may be larger and heavier than those actually used. Tag packages attached via suction cup mount will have a fix or tethered tag package. Implanted tags are designed for deployment on medium to large whales and will be an implanted dart with a tethered tag package. Tethers are approximately 2-6 cm in length . A release device may be incorporated in the tag package to enable recovery of the data logger. The device will either be a radio-activated release device, corrodible magnesium links or both. The radio-activated release device incorporated in the tag package is a small (5 cm x 2.5 cm) cylinder, which contains a piston that compresses cutting the link between the attachment device and the tag package. A VHF radio signal activates the device. Once the tag is released from its attachment, the radio tag is used to locate the tag for recovery. A one to three day corrodible magnesium link may be included as a secondary release device. Although most data loggers will use a suction cup attachment, a spear-type tip with a shock-absorbing stop may be used to attach the tag package to a large whale. The spear tip will be similar to those frequently used by divers with a 3 cm flange and is constructed of stainless steel. The tip penetrates the blubber and the flange secures the tip in the blubber. A rubber stopper mounted on the spear limits the penetration of the spear tip to 7 cm and absorbs some of the impact of the tag package. Careful consideration of the primary research objective will be given before finalizing the tag package, and deployment and attachment system to ensure that the smallest, lightest, hydrodynamically efficient package is deployed.

Data loggers allow for individual whales to be tracked and dive pattern data recorded, which, for example, provides the basic information to estimate dive times required to estimated correction factors for estimating abundance. Data loggers typically have a radio tag that consists of a radio transmitter and an antenna, which allows the animal to be tracked during the tag deployment and later recovery of the tag after the attachment releases. The transmitter operates at 165 MHZ with a 30-millisecond pulse and 150 pulses/minute. Radio tags are 7.6 cm x 1.3 cm with an approximately 40 cm transmitting antenna. The tag with antenna weighs approximately 30 g. Because this tag package must be retrieved in order to recover the data, some tags will incorporate a radio-activated tag release device into the package to allow recovery at a specified time rather than opportunistically. Thus, a data logger (TDR, acoustic or video) tag typically includes the data logger, a radio transmitter, and a tag release device. The time-depth-recorder (TDR) consists of a 512L microcomputer made by Wildlife Computers, Woodinville, Washington. The TDR provides a profile of the diving activity (e.g. position in the water column, dive depth, ascent/descent rates) of the animal. Time and depth are recorded by a time interval specified by the user. TDRs have been used successfully on over 15 species of marine mammals. The current model measures 9.5 cm x 2.5 cm x 1.3 cm and weighs 42 g. The acoustic recording tag measures 19.3 cm X

3.2cm in diameter. The video camera system measures 20.2X7.6cm in diameter and is slightly positive (0kg) in water. The data logger, radio transmitter, and release device are encased within a non-compressible foam housing. The housing is made of a mixture of glass microspheres and polyethylene resin such that the whole tag package is durable, lightweight and buoyant. The material has been tested to 1,000 psi pressure with no change in volume or flotation. Tagging equipment is constantly being improved through reductions in size, weight, and hydrodynamic drag and the NWFSC continues to update its tagging equipment as newer models become available.

Once the tag package is released, it will be recovered and the data downloaded. The dart tip will remain in the whale, to be eventually discharged from the body. Watkins *et al.* (1981) demonstrated that larger darts that penetrated 23 cm into the body migrate out within a few days and the wounds heal rapidly. Furthermore, the successful use of discovery tags in the past indicates that it is unlikely that any long-term adverse effects result from radio tagging.

Satellite and radio tags Satellite tags may be used to collect data on longer-term movements of cetaceans as well as dive time and depth data. Satellite or radio tags will typically employ an implantable attachment although a suction cup may be used in some circumstances. The choice of tag and attachment will depend on the primary research question being addressed. Implanted tags that are proposed have been safely and successfully deployed on numerous species including gray whales (Swartz *et al.* 1987), blue whales (Mate et al.1999; Watkins 1981.) right whales (Mate *et al.* 2000), sperm whales (Mate *et al.* 2003). Deployment durations of a few days to several months are expected.

Approaches will be similar to those used during biopsy activities. During any single encounter, no more than five tag deployment attempts per individual will be made. Satellite tagging activities may be conducted on blue, fin, humpback, sperm whales, or killer whales other than southern resident killer whales. Sex and age classes to be tagged include adult and juvenile males and females but no tagging attempts will be made on calves; however, we are requesting to tag animals accompanying calves. All tags will be deployed with a 150 lb compound crossbow, Pneumatic projector or pole to the anterior dorsal surface of the whales approximately mid-back but slightly off to one side, or the dorsal fin. Please note that dimensions and weights of tags given here may be larger and heavier than those actually used. Implanted tags are designed for deployment on medium to large whales (including but not limited to blue, fin, humpback, sperm whales, or killer whales other than southern resident killer whales) and will either be a partially implanted cylinder, or an implanted dart with a tethered tag package. Tethers will be 2-6cm in length. Tagging equipment is constantly being improved through reductions in size, weight, and hydrodynamic drag and the NWFSC continues to update its tagging equipment as newer models become available. Careful consideration of the primary research objective will be given before finalizing the tag package and deployment system to ensure that the smallest, lightest, hydrodynamically efficient package is deployed.

A spear-type tip with a shock-absorbing stop may be used to attach the tag package. The spear tip will be similar to those frequently used by divers with a 3 cm flange and is constructed of stainless steel. The tip penetrates the blubber and the flange secures the tip in the blubber. A rubber stopper mounted on the spear limits the penetration of the spear tip to 7 cm and absorbs some of the impact of the tag package. The dart tip will remain in the whale, to be eventually discharged from the body. Watkins *et al.* (1981) demonstrated that larger darts that penetrated 23 cm into the body migrate out within a few days and the wounds heal rapidly. Furthermore, the successful use of discovery tags in the past indicates that it is unlikely that any long-term adverse effects result from radio tagging. More recently, long-term deployments on several species of whales (Mate et al. 1999, 200, 2003) attest to the viability and lack of adverse impacts for these types of tag deployments. A release device may be incorporated in the tag package to enable recovery of the data logger. The device will either be a radio-activated release device, corrodible magnesium links or both. The radio-activated release device incorporated in the tag package is a small (5 cm x 2.5 cm) cylinder, which contains a piston that compresses cutting the link between the attachment device and the tag package. A VHF radio signal activates the device. Once the tag is released from its attachment, the radio tag is used to locate the tag for recovery. A one to three day corrodible magnesium link may be included as a secondary release device.

The satellite tags selected for deployment measure no larger than 7.8 cm x 2.0 cm x 1 cm, 77g (SPOT 5 manufactured by Wildlife Computers). Latest generation equipment will be used to reduce size and ongoing research is being conducted to minimize drag and tissue reaction similar to previous research efforts (see Hanson 2001). Each tag will be housed in smaller, but similar, type of non-compressible structure. Research and development has demonstrated that this package can be effectively deployed and reliably collects data. Potentially adverse effects of the tagging operations have been minimized by using the smallest, lightest possible instrument package, by using a smaller spear tip that minimizes penetration into the whale's blubber, by minimizing the velocity of the package at impact, and keeping the dart clean and coated with an antibacterial gel. Scientists and contractors involved in biopsy and tagging activities have had extensive experience with animals in the wild. No known unintended mortality has arisen from these activities when conducted using the established methods and none is expected in the future.

Marking: NA

2. Southern resident Killer whales

Activities under this project may include 1) aerial and boat surveys, including a) photo-identification b) focal follows to collect behavioral and energetic data or fecal material and predation events remains, c) acoustic tracking using a towed passive hydrophone, and d) video-grammetry; 2) collection of biological samples for contaminant, genetic, stable isotope, and fatty acid studies; 3) suction cup tagging with scientific instruments; and 5) health assessment (breath sampling)(Table 2). <u>In any given year, only some of the projects would be conducted so that disturbance to the whales would be limited.</u> Research priorities, consideration of cumulative affects of disturbance to the whales and available funding will be considered in determining which research will be conducted. No individual animal will be approached within 100m more than 10 times in a year. Vessel surveys and photo identification are used for determining abundance, population trends, life history parameters, and distribution. Biological sample collection is an essential tool for determining a population's structure, status and health. Skin and blubber have been used to measure contaminant loads and stress levels, and to investigate genetic relationships and diet. Tagging is an important technique for studying the behavior, ecology and physiology of cetaceans. Tagging activities will focus on determining foraging and dive behavior. Breath sampling is a technique typically used for health assessments. Level B harassment may occur incidental to vessel surveys, photo-identification, acoustic tracking, focal follows for behavior assessment and foraging studies and health assessments. The potential for level A harassment exists in conjunction with biological sample collection (via biopsy) and tagging activities. Cetacean research activities may occur during any month of the year. Our field work will be performed from a variety of different size vessels. Typically vessels will be small (16-40 feet) for focal follows, biological specimen collection, prey and fecal collections and health assessment and these vessels may be also deployed from ocean-going research vessels.

Table 2. Southern resident killer whales- maximum number of annual takes

We are aware of the other researchers that hold General Authorizations and Research Permits for southern resident killer whales in the Pacific Northwest, and will coordinate our efforts with them to avoid duplication in research. **NOTE: This table summarizes all potential projects that may be conducted within the five year period of the permit, however only some of the projects would be conducted in any given year. NOT ALL RESEARCH ACTIVITIES OR TAKES WILL OCCUR IN A SINGLE YEAR**

Species	Regions in which research activities may occur	Photo ID	Focal Follows- behavior, prey,or fecal material	Biopsy	Photo-grammatry	Breath sampling	Data logging tags: time-depth, acoustic, video recorder	Tagging: satellite or radio tag	Incidental harassment for all research activities	Worldwide import, export, reexport and/or salvage of biological samples, specimens or parts
Killer whale, *Orcinus orca*	Pacific Ocean (U.S. EEZ) Eastern North Pacific, Southern Resident	150	50	25	15	5	10	N/A	300	30

Aerial and boat surveys

Aerial Surveys use conventional line-transect sampling and are flown at 700 ft. altitude using a twin-engine, high wing Partenavia or Twin Otter aircraft along the U.S. west coast to determine the distribution and abundance of cetacean populations. These aerial surveys would occur from the coast up to 150 nmi offshore. The aircraft circles high (700-1000 ft) over animals to confirm species identification and to estimate group size. Animals sometimes respond to changes in engine pitch or shadows projected by the aircraft by diving rapidly.

Vessel Surveys from NOAA and chartered vessels could result in Level B harassment by approach. Data are collected during research vessel surveys for seasonal distribution information and the estimation of population abundance. Although procedures may vary slightly depending on the specific objective of the survey, in general, the following protocol is used on NWFSC research vessel surveys. The vessel traverses predetermined track lines within the study area at a constant speed (usually 10 knots). Marine mammal observers stationed on the flying bridge deck of the vessel search the area from directly ahead to abeam of the ship using pedestal-mounted 25X binoculars. At times, depending on the species sighted and the data collecting priorities at the time, the vessel may turn off the track line and approach marine mammals to confirm species identification, observe behavior, collect samples, take photographs and to make group size estimates. Concurrent with these visual observations, small boats may be launched to collect biological samples (skin/blubber biopsy or prey remains, sloughed skin or feces) and 35mm/video photographs (samples and photographs may also be collected from the main vessel). Tagging activities may also be conducted from the small boats during vessel surveys. Small boat approaches are conducted by research crewmembers with extensive experience handling small boats around cetaceans during NWFSC research activities.

Towed passive hydrophone arrays are commonly used for detecting cetaceans during vessel surveys. Using an acoustic array designed to localize vocalizing whales will allow tracking for extended periods during night or inclement weather. These longitudinal data sets would greatly increase data for understanding distribution, behavior budgets, movements and habitat use.

Following visual or acoustic detection, whale groups would be monitored and tracked using a passive hydrophone array towed from a boat. The array is typically towed 600-900 feet behind the vessel. In addition, sonobuoys may be deployed to provide additional acoustic data. Vessel size would vary depending on the location. In inland waters, small vessels, approximately 20-40 ft would be used, whereas in the open ocean large research vessels, up to 200+ feet may be used. Environmental conditions (wind, tide currents) and whale behavior will dictate how the vessel is maneuvered in order to position the acoustic array to best detect and localize whale vocalizations. The most likely scenario will require towing the array off to the side or ahead of the whales. Duration of encounter with whales will vary based on whale behavior, day length and weather conditions. The goal would be to monitor whales for multi-day periods but acoustic tracking would only be required at night or during inclement weather. As a result, these periods are expected to be less than a day. Approaches to within 100 yards would be inadvertent.

Photo-identification activities are primarily conducted from small boats. When photographs are taken from boats, the animals will be approached closely enough to optimize photographic quality (i.e., well-focused images, utilizing at least one half of the slide viewing area). These activities could result in Level B harassment. Distance for optimal approach varies with species; smaller cetaceans may be approached within approximately 5-10 m. Photo-identification is used for stock and individual identification, population abundance and trends, and life history data. Photo-identification of adult and juvenile males and females will occur. If the opportunity arises, females accompanied by calves may be approached for photo-identification, but efforts will cease immediately if there is any evidence that the activity may be interfering with pair bonding, nursing, reproduction, feeding or other vital functions.

Focal Follows: Individual Southern Resident killer whales will be followed from a small boat for the purpose of collecting 1) group behavioral data and individual behavioral data relative to vessel presence, or 2) for the collection of prey remains from predation events and fecal material. Data will be collected continuously from individuals for up to 60 min, and in order to minimize disturbance to individual whales, no more than two focal follows (one hour or less in duration) will be conducted per individual each day. For behavior studies, animals will only be followed more than once each day if the geographic location or characteristics of the vessels (number, type) have changed since the first focal follow. An individual animal will be approached within 100m more than 10 times in a year.

1) Behavioral data relative to vessel presence: Vessel disturbance is one of the identified potential risk factors for Southern Resident killer whales. Although previous studies have demonstrated that vessels may cause minor and ephemeral changes in killer whale behavior, it has not yet been demonstrated that these short-lived behavioral changes affect survival. This study will provide scientific data to assess the behavioral and energetic affects of vessel disturbance to Southern Resident killer whales and the potential of these to influence survival.

Group behavioral data (e.g., pod ID, number of individuals present, group spatial arrangement, etc.) and individual behavioral data (e.g., swim speed, dive duration, surface duration, respiration rates, and occurrence of surface active behaviors, etc.) will be collected from Southern Resident killer whales from a small boat. Data will be collected from adults and juveniles, excluding calves that are less than 3 years old. Data collection will primarily take place during the months of May through October, during the whale-watching and tourist season in the waters around the San Juan Islands and inland waters of Puget Sound.

In order to minimize disturbance to the whales, data will generally be collected at distances greater than or equal to 100 meters, following the 'Be Whale Wise' guidelines. The protocol is to only occasionally approach whales at distances at distances <100 meters but >40 meters when it is necessary for recording individual ID or individual behaviors under suboptimal weather or sea state conditions (e.g. collection of respiration data from a focal female when weather conditions are not optimal). During these occasions, the boat will be operated at the maximal distance that still permits data collection, while maintaining a distance of greater than or equal to 40 meters from the whales. Once conditions change to enable data collection from a greater distance, the boat will be moved to a distance greater than or equal 100 meters. Per Be Whale Wise guidelines, the vessel will always approach from behind and to the side of whales. During the data collection the vessel will be positioned along the side of whales at the periphery of the group. The boat will never intentionally be positioned in the middle of a group of killer whales. The vessel will operate at a slow speed during approaches and whenever it is within 400 meters of the killer whales. Occasionally boat speed will be matched with swimming whales in order to record swimming speed, but this will also most often be done at a distance of 100 meter or greater. If a large increase in speed is necessary to follow the whales, the boat will be driven away from the whales to a distance of 400 meter or greater before the speed is increased. Southern Resident killer whales maydemonstrate minor behavioral changes due to the occasional close encounters of the vessel.

2) Prey remains collection: Collection of fish scales and other remains from predation events near the water surface provides a direct measure of prey selection. Despite potential biases associated with this technique these samples are important because of the paucity of data on prey selection. This information could be important to management of killer whale prey resources. A small, fine mesh net on a long handle (similar to a swimming pool skim net) will be used to collect prey remains from a small boat. Prior to net deployment, whale behavior will be monitored from a distance of several hundred meters. When a whale, or group of whales, begins non-directional swimming or other behavior suggestive of predation, the boat will be repositioned to the location of the whale's initial surfacing. The samples collected will be processed to determine the species of prey, and if possible, its stock. Data collected will include date, time, location, number of animals, whale ID, behavioral activities, and environmental conditions. Individuals that have been identified will not be approached more than once on a given day. The data will be entered into a relational data base. Collaborative efforts will be conducted with other researchers within the Pacific NW region particularly, John Ford, Department of Fisheries and Oceans (Canada).

Fecal samples: Chemical analyses of fecal samples have the potential to provide important information on a variety of parameters including health assessment as has been demonstrated with right whales in the North Atlantic (Rolland et al. in press). In addition to chemical analyses for sexual maturity, pregnancy, and stress, tissue from intestinal sloughing may provide additional genetic information. Collection fecal samples is conducted with a small, fine mesh net on a long handle (similar to a swimming pool skim net) from a small boat while following approximately 100 m behind the whales in their fluke prints. Highly trained scent-detection dogs may be used to locate fecal events. For this method, a small boat will be positioned approximately 100 yards from a group of whales, off to the side or behind the whales. Following detection of a fecal event, the boat would move quickly into the wake of the whale for collection of the material as described above. Archived samples will be analyzed for various hormones to assess health status.

Videogrammetry from a tethered airship: Videogrammetry from a tethered airship, because of its unique perspective, has the potential to provide high quality imagery that will be useful for monitoring whale predation events and other behaviors, quantifying whale/boat interactions, and assessing body condition. This effort would be similar work that has been conducted with right whales, humpback whales, manatees, and killer whales (Lange et al. 2003). High-definition television cameras are mounted in an unmanned tethered airship and used to record images directly below within its 500ft maximum field of view. The airship is unpowered and tethered to a small boat (20-40 ft) and flown at an altitude of 250 ft to 400ft. Environmental conditions (wind, tide currents) and whale behavior will dictate how the vessel is maneuvered in order to position the airship over a group of whales but the most likely scenario will require towing the airship ahead of the whales. These activities are likely to occur for several hours during each day but the number of days per year is expected to be less than 20. Approaches to within 100 yards would be inadvertent and are expected to be infrequent (i.e., less than once per day).

Capture: N/A

Handling/Restraint: N/A

Biological sample collections will occur opportunistically during vessel surveys, or from small boats. Samples will include biopsy sampling (skin/blubber collected by projectile dart), prey remains, sloughed skin or fecal material, and breath.

Tissue Sampling: Tissue sampling will follow an agreed upon NMFS research plan in partnership with Washington Department of Fish and Wildlife and other NMFS Fishery Research Centers. The draft plan was reviewed by Department of Fisheries and Oceans Canada; we asked the agency to collaborate with the other agencies in this project and we are in the process of finalizing the plan, collaborations and other technical details with DFO. Analyses of the tissue samples will be done collaboratively with these and other organizations and researchers. The draft sampling plan describes the research questions that are needed for conservation, identifies what samples would be collected from which whales, and how the sampling would be done over time. The sampling efforts will be done over time, at least 2-3 years. All whales that are approached for sample collection will be identified and photographed for verification of the identification and site of sampling. When the animal is re-sighted later, photographs and records will be taken to document healing of the site. In order to minimize potential sources of variability in the analytical results, all killer whales will be sampled at the same body region, specifically the saddle-patch region on the dorsal flank just behind the dorsal fin. The blubber portion of the biopsy sample will be analyzed for fatty acids and persistent organic pollutants (POPs) whereas the epidermis will be analyzed for stable isotope ratios as described by Herman et al. (2005) and genetics.

Collection of samples using projectile biopsy could result in Level A harassment. Numerous cetaceans have been biopsy sampled. In fact, over a span of seven years (1991-1998) 1,670 biopsy samples from 23 odontocete and five mysticete species were collected using remote biopsy techniques and five mysticete species were collected using remote biopsy techniques during NOAA NMFS Southwest Fisheries Science Center research cruises (Chivers et al. 2000). For species or stocks that are in decline, threatened, or endangered, the information gained from the collection of biopsy samples can be used to identify risk factors (e.g. high contaminant levels, low genetic diversity) as well as provide information that can inform management decisions for protection (e.g. defining stock structure, identifying foraging areas, determining dietary preferences, identifying of harmful contaminants). The Northwest Atlantic right whale is an example of an endangered marine mammal population that has been biopsied in efforts to identify risk factors that are preventing this protected group from recovering. Researchers have shown that biopsy darting for both skin and blubber has no major effect on the behavior of North Atlantic right whales, and each biopsy contains ample skin and blubber for both DNA and organochlorine analyses (Brown *et al.* 1991). In order to assess how contaminants might impede recovery of this population, researchers have biopsied large numbers of free-ranging right whales of both sexes, ranging in age from calf to adult (Brown *et al.* 1991; Woodley *et al.* 1991; Weisbrod *et al.* 2000a). In one study, six individuals were re-biopsied either several days apart or a year apart to determine if seasonal changes in contaminant levels occur (Weisbrod *et al.* 2000a).

In general, the physiological and behavioral impacts of biopsy sampling cetaceans are minor. Experimental studies have demonstrated that physiological damages caused by biopsy are relatively benign (e.g., Geraci and St. Aubin 1982, Palsbøll *et al.* 1991, Medway 1983, Patenaude and White 1995, Gemmel and Majluf 1997). For example, biopsy dart wounds on bottlenose dolphins only appear as small white dots within one month post biopsy, and there are no signs of infection (Weller *et al.* 1997, Krützen *et al.* 2002, Parsons et al. 2003a). Biopsy wounds in killer whales also appear to heal quickly. After a period of a year, small scars may still exist but there is no evidence of wound infection (Barrett-Lennard *et al.* 1996). Unpublished photographs of North Pacific killer whales show the wound closed within just two weeks (J. Durban, pers. comm.) It is unlikely that the small size of the wound produced with standard biopsy darts will produce significant physical trauma to the animal sampled (Aguilar and Borrell 1994a).

Although, the death of one common dolphin following penetration by a biopsy dart has been reported, the death itself was likely due to the combination of several variables, including the malfunction of the stopper on the dart, the location on the body where the biopsy dart was embedded in the animal, the thinness of the individual's blubber layer relative to other animals in the population, handling of the animal after the biopsy event, and the potential predisposition of this individual to catatonia and death during stressful events (Bearzi 2000). Identical methods used in the Bearzi (2000) study have been used with other common dolphins with no or minor, temporary behavioral responses, and despite the many thousands of biopsy samples taken, there are no other accounts of remote biopsy sampling attempts having fatal consequences for any cetacean species in the published literature (Bearzi 2000).

A range of behavioral responses, including no perceptible response, have been observed following skin and blubber biopsy sampling of marine mammals. In an extensive review of the literature (Noren *et al.* in prep.), we have found that the majority of reactions for biopsied marine mammals are no response (up to 88% of individuals biopsied in studies that report responses) or brief, low level reactions, consisting of a startle, immediate dive, horizontal move, increase in speed, or small tail flick (12% to 74% of individuals biopsied, see Weinrich et al. 1991 for definitions of behavioral categories). For example, the immediate responses for resident killer whales following darting consisted of shaking, usually detected by quivering of the dorsal fin, and accelerating (Barrett-Lennard *et al.* 1996). These were short-lived responses and were often barely perceptible, and in some cases, only detected when reviewing video (Barrett-Lennard *et al.* 1996). Strong responses, characterized by a succession of forceful activities (e.g., flight, breaches, tail slaps, numerous trumpet blows, etc.; see Weinrich *et al.* 1991 for definition) rarely happen, occurring in only 0% to 6% of animals biopsied. These strong responses have been observed when biopsy tips remain lodged in the blubber of whales (Weinrich et al. 1991, 1992; Gauthier and Sears 1999) or when there is a momentary entanglement of the retrieval line on flukes (Weinrich *et al.* 1991, 1992). Yet, these are not typical responses because darts have also remained stuck in both whales and dolphins for prolonged periods of time without eliciting visible reactions during the short or long-term (Clapham and Mattila 1993, Barrett-Lennard *et al.* 1996, Parsons *et al.* 2003a).

There is also no clear link between momentary changes in behavior and long-term detrimental effects to marine mammals. In general, being struck by a biopsy dart is a momentary stimulus that typically causes no change or a short-term disturbance in the subject's behavior (Mathews 1986, Weinrich *et al.* 1991, Marsili and Focardi 1996, Hooker *et al.* 2001a, Fossi *et al.* 2003a). These reactions are characteristically very short-lived, approximately 30 secs to 3 min in duration, regardless of the degree of the response (Whitehead *et al.* 1990;Weinrich *et al.* 1991, 1992; Jahoda *et al.* 1996; Gauthier and Sears 1999; Harlin *et al.* 1999; Zolman *et al.* 2001; Berrow et al. 2002; Parsons *et al.* 2003a). In addition, the disturbance is limited to the individual being biopsied, as there is usually no reaction among non-target animals present during biopsy encounters (killer whales, Barrett-Lennard et al. 1996 and bottlenose dolphins, Berrow *et al.* 2002, Parsons *et al.* 2003a). Moreover, even repeated biopsy attempts do not appear to have long-term or detrimental effects (e.g. bottlenose whales, Hooker *et al.* 2001a; humpback whales, Brown *et al.* 1994, including cow/calf pairs, Weinrich *et al.* 1991; resident killer whales, Barrett-Lennard *et al.* 1996; fin, blue and humpback whales, Gauthier and Sears 1999). Finally, there are no indications of any long-term effects, such as avoidance of the sampling area, by species that have been biopsied (e.g., sperm whales, Whitehead *et al.* 1990; killer whales, Barrett-Lennard *et al.* 1996; gray whales, Mathews 1986; humpback whales, Weinrich *et al.* 1991, Clapham and Mattila 1993; bottlenose dolphins, Weller *et al.* 1997; South American fur seals, Gemmel and Majluf 1997).

Potential adverse impacts of this activity will be mitigated by using an experienced collection team as well the encounter duration with a particular animal group will be limited to 45 minutes. No more than three biopsy sample <u>attempts</u> per individual will be made during any single encounter, and no other samples will be collected during this period. Number of approaches for biopsy depends on whether the first approach is successful. Individual animals may be approached up to three times per year for a single biopsy, and no more than 10 times per year for other research data collection. An individual whale would be biopsied once and we will use photoidentification to identify all whales approached and sampled and to distinguish whales that have already been sampled. Information on which whales have been sampled will be shared with other killer whale researchers to ensure the whales are not approached again and resampled. We have been establishing collaborations with other killer whale researchers and organizations to ensure that all sampling will be based on the same research plan (the draft plan we prepared and have had extensively reviewed and modified). If signs of harassment, such as vessel avoidance or other related behaviors, are demonstrated by the whales being approached, activities will be discontinued. The animals to be sampled will either approach the vessel on their own, be approached by the main research vessel during normal survey operations, or be approached by a small boat.

The projectile biopsy sample procedure was developed specifically for use on resident killer whales and has been used to collect over 400 North Pacific killer whale tissue samples since the mid 1990s. The tissue sample will be collected from animals within approximately 5 to 30m of the bow of the vessel or small boat (Palsbøll *et al.* 1991). Skin and blubber will be sampled by biopsy darts that are approximately 6mm in external diameter and up to 35 mm long (the size of a mechnical pencil eraser) (Weller *et al.* 1997, Chivers *et al.* 2000, Möller and Beheregaray 2001, Krützen *et al.* 2002, Hobbs et al. 2003, Hansen et al. 2004, NMML unpubl. data). Biopsies will be collected from the area close behind the dorsal fin. The depth of the penetration is controlled by a cushioned stop (25mm in diameter) of neoprene vacuum hose encircling the biopsy head. Between sample periods, the biopsy tips are thoroughly cleaned with alcohol.

Biological samples may be collected from adults, juveniles, females with calves and calves older than 2 years. Sample collections from southern resident killer whales will follow an agreed upon research plan (see above regarding the draft plan) in collaboration with the Washington Department of Fish and Wildlife, Department of Fisheries and Oceans Canada, other NMFS Science Centers and other researchers. Analyses of the tissue samples will be done collaboratively with these and other organizations and researchers.

To ensure the safety of the animals, biopsy sampling will only be attempted by person experienced in remote biopsy of free-swimming cetaceans. In addition, the research vessel will be driven by a person with prior experience in boat handling for activities near the whales such as photo-identification and biopsy sampling. Approaches to the targeted whale will be made from behind and the vessel will be positioned parallel to the whale's body axis to ensure that the dart strikes the animal with a perpendicular angle. The vessel will remain farther than 100m while the whale is being identified and then the vessel will be slowly repositioned within sampling range until the sample is collected or maximum of 10 minutes. At least one person with extensive experience in the visual identification of the Southern Resident killer whales in the field will be on-board the vessel at all times, for the purpose of confirming IDs of specific individual whales. In addition, one field biologist experience in whale photography will be on-board the research vessel and will be responsible for taking identification photographs before, during and after biopsy of the target whale. Attempts to biopsy dart a whale will only be made when the target whale can safely be hit in the target area with no threat to non-target animals. In order to minimize potential sources of variability in the analytical results, all killer whales will be targeted for sampling from the same body position, specifically the saddle-patch region on the dorsal flank just behind the dorsal fin (Barrett-Lennard *et al.* 1996). Behaviors of target and non-target animals associated with target animals will be monitored and recorded prior to, during, and after biopsy sampling. In addition, an important aspect of the study is documentation of the biopsy wound. Photographs will be taken when the whale is re-sighted to document the wound healing process.

If the sample cannot be processed immediately, the biopsy dart will be placed into a labeled, pre-rinsed 2-oz. jar and put on ice. However processing the sample should begin as soon as possible after retrieving a biopsy dart. A clean surface will be used for processing the biopsy sample (pre-cleaned and solvent-rinsed stainless steel or solid Teflon sheet).

For biopsies in which both blubber and epidermis will be analyzed, the epidermis will be separated from the blubber immediately. The biopsy plug will be removed from the dart using clean forceps and a new scalpel blade to detach the blubber from the dart. The skin will be carefully cut from the blubber, cutting close to the skin-blubber interface. The blubber sample will be transferred to a clean 17-mL Teflon screw-top vial and frozen as quickly as possible (within 3 hrs, if feasible). Until freezing, the samples will be kept in a bag in a cooler with ice. When the biopsy sample is sub-sampled, the skin will be stored on ice. Upon reaching shore, the samples will be transferred to a –80° C freezer and stored until analyzed.

For stranded cetaceans, full-thickness blubber samples (including epidermis) will be collected during necropsies and analyzed for fatty acids, POPs and stable isotope ratios as reported by Herman et al. (2005). A 5" x 5" square blubber sample will be sampled using a clean knife and placed in a pre-rinsed Teflon sheet. The sample will be placed in labeled whirlpak and stored on ice until transfer to a -80° C freezer.

<u>Breath Sampling</u>: Collection of expired breath has the potential to provide valuable information about the health status of individual whales using a non-invasive method. Blood sampling, a primary diagnostic tool for health assessment, generally requires capture and restraint that is difficult for most species and virtually impossible for cetaceans. Remotely sampling blood has had only limited success. Similarly, urine and feces, which can yield valuable health information, are typically not available in a marine setting. Cetaceans must surface to breathe and because exhaled breath is the result of an exchange between pulmonary blood and aveolar air, the exhaled breath represents a potentially non-invasive approach to assessing diseases or metabolic disorders. Exhalant aevolar breath contains many volatile and semi-volatile compounds that are a reflection of biochemical constituents in the circulatory system, which in turn originate from the liver, other organs of internal metabolism or even tissue catabolism.

Metabolic perturbations often have their origins in lipid or liver metabolism. The expired air thus can offer a variety of information about internal metabolism and offers clues about predominant metabolic pathways or shunts. Importantly, because the air and food systems in cetaceans are completely separate, an uncontaminated sample can be obtained of compounds originating along the breathing passages, lungs and possibly the blood. Analyses of algal cultures will provide information on microbes present.

Analytical techniques are available to identify and quantify a wide spectrum of breath-released compounds at parts per million volume (ppmv) or lower. The analyses of breath by gas chromatography/mass spectrometry (gc/ms) have expanded the diversity of metabolic states that can be identified. In some cases, breath analysis is the primary approach to assess disease conditions. Despite some limitations, this approach can serve as a valuable diagnostic tool, particularly in the absence of a blood sample.

Samples will be collected using a specially designed vacuum cylinder, a system previously used on several species (Rasmussen and Riddle 2004). An algal culture plate inside the funnel will be used for bacterial cultures of the breath. Samples will be collected from free ranging whales by positioning a funnel at the end of a 6m pole (which is connected to the vacuum cylinder with plastic tubing) over the blowhole (inadvertent contact may occur) of the surfacing animal and manually opening the cylinder valve during exhalation. The equipment does not touch the animal although in certain rare circumstances there could be brief (< 10 sec) contact. An individual whale may be approached up to 3 times to obtain breath sample. This approach has been successfully used on killer whales (Hanson and Rasmussen, in prep), wild bottlenose dolphins, fur seals, captive manatees, pygmy and dwarf sperm whales, rough tooth dolphins and false killer whales. The vessel approach operations will be similar to those for biopsy and suction cup tag deployments although the minimum distance will be closer (up to 5m).

Scientific instruments

Tagging activities will be conducted opportunistically in conjunction with vessel surveys and from small boats. Only data logger tags, i.e. time depth, acoustic and video recording tags will be used. No implatable tags will be used. Data logging tags will typically employ a suction cup attachment; no implantable tags will be used. Suction cup attached tags have been safely and successfully deployed on wide variety of cetacean species (Hooker and Baird 2001). Below is a detailed description of each type of tag. Approaches will be similar to those used during tissue sampling activities. During any single whale encounter, no more than three tag deployment attempts per individual will be made. Tagging activities may be conducted on adult and juvenile males and females. No tagging attempts will be made on calves (i.e., whales in association with an adult female, or of a size that would be typical to be in association with an adult female) ; however, we are requesting to tag animals accompanying calves. All tags will be deployed with a 150 lb compound crossbow or pole to the anterior dorsal surface of the whales approximately mid-back but slightly off to one side. Tag packages attached via suction cup mount will have a fix or tethered tag package. Tagging equipment is constantly being improved through reductions in size, weight, and hydrodynamic drag and the NWFSC continues to update its tagging equipment as newer models become available. Careful consideration of the primary research objective will be given before finalizing the tag package and deployment system to ensure that the smallest, lightest, hydrodynamically efficient package is deployed. Data loggers allow for individual whales to be tracked and dive pattern data recorded, which provides, among other things, basic information to estimate dive times required to estimated correction factors for estimating abundance. Data loggers typically have a radio tag that consists of a radio transmitter and an antenna which allows the animal to be tracked during the tag deployment and later recovery of the tag after the attachment releases. The transmitter operates at 165 MHZ with a 30-millisecond pulse and 60 pulses/minute. Radio tags are 7.6 cm x 1.3 cm with an approximately 40 cm transmitting antenna. The tag with antenna weighs approximately 30 g. Because this tag package must be retrieved in order to recover the data, some tags will incorporate a radio-activated tag release device into the package to allow recovery at a specified time rather than opportunistically. Thus, a data logger tag typically includes the data logger (TRD, video or acoustic), a radio transmitter, and a tag release device. The time-depth-recorder (TDR) consists of a 512L microcomputer made by Wildlife Computers, Woodinville, Washington. The TDR provides a profile of the diving activity (e.g. position in the water column, dive depth, ascent/descent rates) of the animal. Time and depth are recorded by a time interval specified by the user. TDRs have been used successfully on over 15 species of marine mammals. The current model measures 9.5 cm x 2.5 cm x 1.3 cm and weighs 42 g. The acoustic tag measures 19.3 X3.2cm in diameter. The video tag measures 20.2 X 7.6cm diameter and 1.1 kg in air and 0kg in water. A release device may be incorporated in the tag package to enable recovery of the TDR. The device will either be a radio-activated release device, corrodible magnesium links or both. The radio-activated release device incorporated in the tag package is a small (5 cm x 2.5 cm) cylinder, which contains a piston that compresses cutting the link between the attachment device and the tag package. A VHF radio signal activates the device. Once the tag is released from its attachment, the radio tag is used to locate the tag for recovery. A one to three day corrodible magnesium link may be included as a secondary release device. The entire tag package is an approximately 20 cm x 5 cm cylinder and weighs approximately 500g. The data logger, radio transmitter, and release device are encased within a non-compressible foam housing. The housing is made of a mixture of glass microspheres and polyethylene resin such that the whole tag package is durable, lightweight and buoyant. The material has been tested to 1,000 psi pressure with no change in volume or flotation. Once the tag package is released, it will be recovered and the data downloaded.

Marking*:* NA

Acoustics: NA

3. Import/Export of marine Mammals, Endangered Species or Any Parts Thereof

Biological samples will be received on an opportunistic basis or as part of collaborative studies with international scientists and agencies. Samples will be received from Canada and Japan and other countries as available. All specimens will be collected from legally taken animals under humane conditions (e.g., stranded animals, incidental to fisheries, under permit). Pregnant/lactating females may be sampled as part of a specific study or because its status is unknown but no unweaned or less than 8 mo animals will be sampled.

Marine mammal specimens and biological samples may be taken, salvaged and/or imported/exported/re-exported in conjunction with the activities described in this application. Import/export/re-export of salvaged parts or specimens and biological samples collected by other researchers under their own authorizations is also requested. The total number of parts, specimens or biological samples taken, salvaged and/or imported/exported/re-exported over a five-year period is listed by species in Tables 1 and 2. All parts, specimens, and biological samples will be archived at the NWFSC. Generally, DNA extractions are made promptly on receipt of samples from the field. Extracted DNA will be divided into two aliquots and stored in separate -70C freezers until mtDNA sequence analyses. After that, portions of the DNA samples will be made available to qualified researchers and institutions upon request for analysis of other portions of the genome. Results of our investigations will be submitted for publication to refereed scientific journals and presented in appropriate scientific forums.A list of publications is accessible through the Marine Mammal Program web site and provides an indication of research scope. (http://www.nwfsc.noaa.gov/research/divisions/sd/marinemammal.cfm)

4. Animals from the Wild into Captivity/Research on Captive or Rehabilitating Animals:

No animals will be removed from the wild.

5.Lethal Take:

a. No intentional lethal takes are involved.
b. Unintentional mortality or serious injury: None

D. Resources needed to accomplish objectives:

The primary sponsor for NWFSC studies is NOAA Fisheries, with ongoing collaborations with other fisheries science centers. Other NOAA collaborators are the Olympic Coast National Marine Sanctuary. Other government collaborators are Washington Department of Fish and Wildlife and Department of Oceans and Fisheries, Canada. Depending on the specific project, academic and other research organizations are also frequent collaborators.

Other collaborations:

Robin Baird
Cascadia Research
Waterstreet Bldg. Olympia, WA

Ken Balcomb
Center for Whale Research
Friday Harbor, WA

Rich Osborne
The Whale Museum
Friday Harbor, WA

Glenn van Blaricom/James Ha/Sam Wasser/John Horne
University of Washington
Seattle, WA

E. Effects of the Research and Measure to Minimize Stress, Pain, Suffering, and/or Harassment

Effects: Potential effects from the proposed activities will be short-lived disturbance from biological sample collection, focal follows and tagging.

Alternatives: For activities that involve biological sample collection or tagging of cetaceans, the methods used are considered the least likely to cause stress, pain or suffering, primarily because they do not require capture of the animal. The biopsy or tagging events are short-lived and relatively non-invasive.

Incidental Effects: During past research activities, the reaction of animals to incidental harassment through vessel approach has varied from no reaction to short term responses such as swimming away or diving. To limit any potential affects of incidental harassment, the time spent with animals during these activities is limited to short durations of less than 1 hour.

No long-term adverse effects on the stocks listed in this application are anticipated and no effects on reproductive rates or on continued survival in the wild related to these activities have been identified. Vessel and aerial surveys and activities such as biopsy sampling, photographing or tagging have been conducted on all the species listed and no cumulative response have been documented that indicates any significant, persistent response (i.e., increased avoidance or evasive behavior) in response to vessels or aircraft by any population of animals we study. Some individual animals/species/ecotypes are more wary than other species or their response may be modified by their behavior state.

Aerial and boat survey effects: Small boat approaches are conducted in a manner that minimizes boat noise, does not involve any sudden changes in speed or course, and approaches an animal only from behind while not greatly exceeding the animal's travel speed. The Be Whale Wise Guidelines will be followed except as indicated in the application. We are limiting the time spent with animals, as well as the number of attempts made, to collect photographs, biopsy samples or to deploy tags in order to minimize any incidental harassment or disturbance from the presence of the small boat or the activities themselves. If at any time during these activities there is a negative reaction (e.g., rapidly diving or rapidly swimming away), all efforts to approach the whales will cease. In any given year, only some of these projects would be conducted so that disturbance to the whales would be limited. Research priorities, consideration of cumulative affects of disturbance to the whales, and available funding will be considered in determining which research will be conducted.

***Capture*: NA**

Sample Collection: Biopsy sampling has been used extensively worldwide and has become common and widely accepted method for obtaining tissue samples, especially because the unequivocal value of contaminant studies and molecular genetic tools and analyses are well recognized. The reactions of cetaceans to biopsy and tag attachment has been studied for several species (see Lambertsen 1987, Mate and Harvey 1983, International Whaling Commission 1991, Clapham and Mattila 1993, Goodyear 1993, Brown et al. 1991, Weinrich et al. 1991, Weinrich et al. 1992, Brown et al.1994, Cockcroft 1994, Barrett-Lennard 1996, Jahoda et al. 1996, Weller et al. 1997, Baird 1998, Mate et al. 1998, Gauthier and Sears 1999, Hooker et al. 2001, Clapham et al. unpublished ms.). Potential impacts from biopsy sampling and tagging may include behavioral disturbance, injury or infection. Disturbance may result from the biopsy itself or from the approach of the small boat. The most common reactions to biopsy sampling and tagging have been reported to include no reaction, a flinch or startle, or a tail flick and/or a rapid dive. In our experience, reactions by individuals of various species to biopsy sampling and tagging generally have been low-level and short-lived, with reactions ranging from no visible response to a "startled" reaction sometimes followed by an animal swimming away or diving. For bow riding dolphins sampled from the main research vessel, an individual animal will often continue to ride the bow after the biopsy sample has been collected. In our experience, individual animals are more likely to respond to the approach of the small boat than to the biopsy itself. There have been no documented cases of infection or injury to large whales resulting from biopsy sampling or tagging (Clapham et al. unpublished ms.). Bearzi et al. (2000) reported on the death of a common dolphin following penetration of a biopsy dart and subsequent handling. The authors concluded that the biopsy dart did not produce a lethal wound, but that the biopsy darting and subsequent handling (perhaps in combination with potential pre-existing health conditions of the animal) produced physical and/or physiological consequences that were fatal to the animal. There is no evidence that the biopsy procedure or associated boat approaches, if conducted responsibly and by experienced researchers, has any significant impact on cetacean populations. It is clear from many years of work with this and other baleen whale species that biopsy approaches at worst result in temporary and minor disturbance in behavior of an individual, with no impact after the biopsy collection procedure is complete (Brown et al. 1991, Weinrich et al. 1991, Clapham et al. 1993). Studies to date indicate no long-term consequences on survival or fecundity. Though this technique is not completely devoid of risk, it is not likely to produce any long-term, deleterious effects on individual animals or populations of cetaceans

Because the activities proposed here have been conducted for many years and have become standard practices nationally and internationally in marine mammal research, we believe that the proposed activities pose little to no risk and do not involve large degrees of uncertainty in their likely effects.

Information from stranded killer whales on the west coast of the US will be cross-referenced with dorsal fin photos that are in the ID catalog. We will work closely with stranding network coordinators and participants to provide identifications of stranded animals.

Scientific Instruments:

Suction Cup attachments: Suction-cup attached data logging devices provide continuous information on the sub-surface behavior of cetaceans. Tagging attempts for a particular individual will be discontinued on a particular day if the individual exhibits a strong adverse response. Reaction intensity is defined in Weinrich et al. (1991), accounting for both duration and intensity of reactions. Suction cup attachments should not cause long-term or damage to tagged animals because the tags are in place for short periods (hour to days) and the suction cup slides on the skin as the animal swims. Tagged individuals have been observed after tags have fallen off and no skin damage has been apparent (Baird unpubl. data). Adult and sub-adult Pantropical spotted dolphins have continued to bow ride on the tagging boar, travel with their groups and behave in similar manner as other dolphins in the group (Baird unpubl. data).

Spear-type implanted attachments (species other than southern resident killer whales): Watkins *et al.* (1981) demonstrated that larger darts that penetrated 23 cm into the body migrate out within a few days and the wounds heal rapidly. Furthermore, the successful use of discovery tags in the past indicates that it is unlikely that any long-term adverse effects result from radio tagging. More recently, long-term deployments of these tags on several species of whales (Mate et al. 1999, 200, 2003) attest to the viability and lack of adverse impacts for these types of tag deployments.

Acoustics: NA

V. NEPA Considerations

1. Will your research involve equipment or techniques that are new, or may be considered innovative or experimental? If yes, are they likely to be adopted by other researchers in the future?

   We are using the latest, smallest, lightest and hydrodynamically efficient tags.   New attachment systems for tagging cetaceans are under development in collaboration with NMFS Stranding Office, SEFSC and PIFSC. The attachment is being modified to be less invasive while still providing extended retention durations. The external portion of the tag will be designed with the benefit of computer flow analyses to reduce drag. The tag attachment will be tested on dorsal fin material from necropsies and then thoroughly tested on non-listed cetacean species before use on any listed species. An improved attachment system would likely be used by other researchers once it is thoroughly tested.

   The use of ultrasound to measure blubber thickness in freely swimming cetaceans may be perceived as somewhat invasive because it requires touching the surfacing animal with a probe. However, the acoustic system, which consists of 0.5MHz ultrasound transducer on a cantilevered 12m pole, has been used safely to measure blubber thickness on several endangered Atlantic Right Whales (Moore et al. 2001). Furthermore, disturbance through contact is expected to be minimal because a contact duration of only one second is required for a good signal for this measurement.

   Breath Sampling has been done previously on several specie using a specially designed vacuum cylinder s (Rasmussen and Riddle 2004). Samples were collected successfully from free-ranging killer whales (Hanson and Rasmussen, in prep).

2. Does your activity involve the collection, handling or transport of potentially infectious agents or pathogens (e.g., biological specimens such as blood) and/or does your activity involve the use or transport of hazardous substances (e.g., toxic chemicals)? If so, provide a description of protocols to be used for safe specimen and/or chemical handling, storage and shipment to ensure human safety from injury or zoonotic disease transmission. Does your proposed research involve animal handling or dangerous work conditions? If so, explain and provide protocols that would be follow to ensure human safety.

   Collection will include blood and fecal samples from stranded animals and collection from live animals of fecal, breath and tissues. NOAA Environmental Compliance Regulations will be followed in the handling of all potentially infectious agents and pathogens as well as toxic chemicals. Research on small boats is potentially hazardous. NOAA Small Boat Handling Regulations are used at all times. These include submitting a float plan prior to initiating boat operations, canceling or postponing research operations when weather and swell conditions reduce the ability to conduct research safely, and reporting to a designated person when operations are complete. This designated person will contact the Coast Guard if the research party has not returned within the expected time period and is unreachable. In addition NOAA boats are equipped with safety equipment, including first aid kits, flares, PFDs, radios, and EPIRBs.

3. Would any of your activities occur in or near unique geographic areas such as wetlands, National Marine Sanctuaries, Marine Protected Areas, State National Parks or wilderness areas, wildlife refuges, wild and scenic rivers, designated critical habitat for endangered species, essential fish habitat, etc. If so, would any aspect of your activities impact the physical environment, such as by direct alteration of substrate (e.g., anchoring vessels or buoys)?

   Studies in the Olympic Coast, Cordell Bank, Monterey Bay and Gulf of Farallones National Marine Sanctuary include vessel surveys and potentially biopsy sampling and aerial surveys. These will be conducted under a valid Sanctuary permit.

4. Are you aware if the types of research techniques to be employed could be perceived to be controversial by the public in any way? If so, to what degree would it be considered controversial and why?

   Any invasive research on marine mammals can be perceived as controversial by the public. Some of the public will oppose any research that involves close approaches, or tissue sampling. This is particularly true for highly visible marine mammal populations i.e., southern resident killer whale population, because some feel that this populations is already harassed by whale-watching and private vessels and it had a large population decline in abundance. While these techniques are generally not considered controversial in the scientific community, the intense public interest in some species (i.e., southern resident killer whales) has increased the level of scrutiny regarding research on this population. Tissue sampling methods that will be used on this killer whale population were developed specifically for use on resident killer whales to reduce potential physiological and behavioral affects of sampling. In fact, the method has been used to safely collect over 400 biopsy samples from North Pacific killer whales. Tissue sampling of this population, particularly old animals, has been recommended by the Pacific Scientific Review Group in order to ensure genetic and contaminant information are not lost. Sampling of the southern resident killer whales will be done under an approved NMFS sampling plan in collaboration with Alaska and Southwest Fisheries Science Centers and our co-manager, Washington Department of Fish and Wildlife. The plan has been reviewed and is supported by our co-manager, Department of Fisheries and Oceans (Canada) and has been reviewed by NMFS and other scientists. It is based on critical research needs for conservation identified by leading killer whale scientists in the US and Canada and supports conservation needs identified in the NMFS Draft Conservation Plan (2005). Outreach is being conducted with the public to provide information on the research program, including tissue-sampling techniques, to reduce misconceptions and any controversy associated with the research on the killer whale population. Cumulative affects of small boat approaches may be raised as a public concern. We are working with other researchers to coordinate all research on southern resident killer whales to minimize boat approaches. We also will consider research priorities, cumulative affects of disturbance to the whales, and available funding in determining which research will be conducted. In any given year, only some of these projects would be conducted so that disturbance to the whales would be limited.

5. Could our proposed actions affect entities listed in or eligible for listing in the National Register of Historic Places or cause loss or destruction of scientific, cultural or historic resources?

   None of the proposed actions would affect Historical Places or cause loss or destruction of these resources.

VI. Previous Permits and Other Permits:

A. Previous Permits: Previous permits issued to the NWFSC by the NMFS include General Authorization 781-1725-00.

B. Other Permits: The NWFSC has obtained a permit to conduct research activities in Olympic Coast National Marine Sanctuary (Permit issued by the Superintendent of the OCNMS in 2005). Permits will be obtained from the US Fish and Wildlife Service to authorize under CITES the import/export activities included in this application.

VII. Literature Cited

See Appendix II

VIII. Certification and Signature

"I hereby certify that the foregoing information is complete, true, and correct to the best of my knowledge and belief. I understand that this information is submitted for the purpose of obtaining a permit under one or more of the following statutes and the regulations promulgated thereunder, as indicated in Section I. of this application:

The Endangered Species Act of 1973 (16 U.S.C. 1531-1543) and regulations (50 CFR 222.23(b)); and/or

The Marine Mammal Protection Act of 1972 (16 U.S.C. 1361-1407) and regulations (50 CFR Part 216); and/or

The Fur Seal Act of 1966 (16 U.S.C. 1151-1175).

I also understand that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or to penalties provided under the Endangered Species Act of 1973, the Marine Mammal Protection Act of 1972, or the Fur Seal Act of 1966, whichever are applicable."

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Linda L. Jones, PhD
Director, Marine Mammal Program
Northwest Fisheries Science Center

Appendix I. Curriculum vitae

CURRICULUM VITAE

LINDA L. JONES

Northwest Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
2725 Montlake Blvd. E
Seattle, Washington 98112

EDUCATION

Ph.D. Biological Oceanography - 1978
Scripps Institution of Oceanography
University of California, San Diego

B.S. Zoology - 1964
San Diego State University

Federal Executive Institute: Leadership in a Democratic Society

PROFESSIONAL EXPERIENCE

Senior Scientist, Marine Mammal Research
Northwest Fisheries Science Center, 2004-present
NOAA Fisheries
Seattle, WA

Affiliate Professor
College of Ocean and Fisheries Science
University of Washington - 1984 to present

Deputy Science Director
Northwest Fisheries Science Center, 1992-2004
National Marine Fisheries Service
Seattle, WA

Acting Science Director 1993
Northwest Fisheries Science Center

National Marine Fisheries Service
Seattle, WA

Scientific Editor
Fishery Bulletin, U.S. 1989-1992
National Marine Fisheries Service
Alaska Fisheries Science Center
Seattle, WA

Program Manager
High Seas Fisheries Interaction Program, 1988-1992
National Marine Mammal Laboratory
Alaska Fisheries Science Center
Seattle, WA

Acting Program Manager
Arctic Ecosystem Program 1988-1992
National Marine Mammal Laboratory
Alaska Fisheries Science Center
Seattle, WA

Cetacean Research Program Manager
National Marine Mammal Laboratory 1984-87

Endangered and Small Cetacean Task Leader
National Marine Mammal Laboratory -1981 to 1984

Dall's Porpoise Project Leader
National Marine Mammal Laboratory - 1979 to 1981

Special Assistant to Scientific Program Director
U.S. Marine Mammal Commission - 1977 to 1979

AWARDS AND RECOGNITION

NOAA Aquanaut, Manned Undersea Science and Technology Program, 1976
NMFS Outstanding Employee of the Year Nomination -1981
NMFS Outstanding Achievement Award-1981
Commendation from the Governor of Alaska for work on negotiating agreements under the High Seas Driftnet Act

NMFS Unit Citation - for outstanding contribution for scientific support throughout 13 rounds of bilateral negotiations and for developing and implementing the scientific monitoring program in the Japanese squid fishery within two months of signed agreement.
Department of Commerce Silver Medal - for extraordinary contribution to the work of the Special Act Award for NMFS Charter Team on Agency Image and External Communications.

Department of Energy Federal Energy and Water Management Award, 1995

Federal Executive Institute, Leadership for a Democratic Society Program, 1998

NOAA Bronze Medal for work in building NOAA Environmental Compliance Program, 1999

NOAA Administrator's Award for work in transition of the west coast groundfish program to the NWFSC- 2003

Promotion 1981 -to Endangered and Small Cetacean Task Leader
Promotion 1984 - to Cetacean Program Manager
Sustained Superior Performance Award, 1988
Outstanding Performance Rating, 1991, 1997
Commendable Performance Rating, 1992,1993, 1995
Quality Step Increase, 1998, 2000

JONES, LINDA L.

COMMITTEES AND SPECIAL ASSIGNMENTS

U.S. member, Biological Oceanography Committee, PICES. 1992- present

Co-convener, PICES International Symposium on Effects of Contaminants on Marine Organisms, 1998.

Invited reviewer, SWFSC Program Review at Pacific Fisheries Environmental Laboratory, 2000

NMFS OMI Restructuring Team, 1998

NOAA Facility Consolidation Study Team, 1997

NMFS Charter Team on Agency Image and External Communication, 1994-1995

Co-convener of Sea Grant workshop on Marine Fish Culture and Enhancement on the West Coast, 1993

North Pacific Anadromous Fisheries Commission - Part of U.S. team which developed the Scientific Committee structure and terms of reference for the new Commission. 1992-1993

U.S. Leader, Scientific Subcommittee on Marine Mammals, International North Pacific Fisheries Commission. 1979-1992

Scientific Advisor, U.S. Section, International North Pacific Fisheries Commission. 1980-1992.

NMFS Scientific Publications Advisory Committee. 1989-1994

Editor, *Fishery Bulletin* and *NOAA Technical Reports*, 1989-1992

Scientific Delegate and Invited Expert, International Whaling Commission. 1983-1986, 1988, 1992.

Advisory Committee for U.S. research program on high seas gillnet fisheries. 1986-1992

Convener, International Workshop on Age Determination in Dall's Porpoise. 1986.

Moderator, Salmon Fisheries-Marine Mammal Interaction Panel, Workshop on Biological Interactions among Marine Mammals and Commercial Fisheries in southeastern Bering Sea, 1983.

TEACHING EXPERIENCE

University of California, San Diego
Society and the Sea, undergraduate - 1975, 1977
Oceans, undergraduate - 1974

Scripps Institution of Oceanography
Statistics, graduate level(2 quarters lectures and teaching assistantship) - 1974

University of Baja California, School of Marine Science
Course Coordinator and lecturer
General Ecology - 1972
Marine Ecology - 1972

University of Washington
Biology of Marine Mammals - 1986, 1987, 1988
Seminars in Institute of Marine Studies, Institute of Environmental Studies, Department of Oceanography and College of Fisheries, at least one lecture annually.

Volunteer Teaching Projects:
  Artists Unlimited, Seattle, - studio sessions
  San Diego Museum of Natural History
  Museum of History and Industry, Seattle

STUDENT SUPERVISION
R.C. Ferrero, "An Analysis of Conflicts between the State of Alaska and the Federal Government regarding the Management of Marine Mammals", M.M.A., University of Washington. 1985.

B.J. Turnock, "Effects of Movement on Density Estimates of Dall's Porpoise from Line Transect Methodology". M.S., University of Washington. 1987.

E. Miller, "Characterization of the Behavior and Movements of Dall's Porpoise in Puget Sound, Washington". M.S. University of Washington. 1989.

PUBLICATIONS

Lyon, R.L., Flake, H.W. and L.J. Ball (nee Jones). 1970. Laboratory tests of 55 insecticides on Douglas-fir tussock moth larvae. Economic Entomology 63:513-518. Also included in: "Readings in Entomology". T.M. Peters, ed.

Jones, L.L. 1976. Larval settling responses of the acorn barnacle symbiotic with sponges and the effect of conditioning. Abstracts and Symposia of the Annual Meeting, Western Soc. Naturalists.

Jones, L.L. 1978. Life history parameters and host selection behavior of a sponge symbiont, Membranobalanus orcutti (Pilsbry) (Cirripedia). Ph.D. dissertation. University of California. 112pp.

Jones, L.L. and T.C. Newby. 1980. Marine Mammal Studies, 1979. Int. N. Pac. Fish. Comm. Ann. Rep. 1979:74-78.

Jones, L.L. 1980. Cooperative U.S.-Japan research program on Dall's porpoise. Cetus 2(4):3.

Ainley, D.G., DeGange, A.R., Jones, L.L. and R.Beach. 1982. Mortality of seabirds in high seas salmon gillnets. Fish. Bull. 79(4):800-806.

Jones, L.L. and G. C. Bouchet. 1982. Research by the United States: Marine mammal studies, 1981. Int. N. Pac. Fish. Comm. Ann. Rep. 1981:121-131.

Jones, L.L. and G.C. Bouchet. 1983. Research by the United States: Marine mammal studies, 1982. Int. N. Pac. Fish. Comm. Ann. Rep. 1982:134-140.

Jones, L.L. 1983. Incidental take of Dall's porpoise and harbor porpoise by Japanese salmon driftnet fisheries in the western North Pacific. Rep. Int. Whal. Comm. 34:531-538.

Miyazaki, N., Jones, L.L. and R. Beach. 1984. Some observations on the schools of dalli- and truei-type Dall's porpoise in the northwestern North Pacific Ocean. Sci. Rep. Whales Res. Inst. (Japan) 35:93-105.

Kasuya, T. and L.L. Jones. 1984. Behavior and segregation of the Dall's porpoise in the northwestern North Pacific Ocean. Sci. Rep. Whales Res. Inst. (Japan) 35:107-128.

Loughlin, T.R. and L.L. Jones. 1984. Review of existing data base and of research and management programs for marine mammals in the Bering Sea. pp. 79-100. IN: Proceedings Workshop on Biological Interactions among Marine Mammals and Commercial Fisheries in the Southwestern Bering Sea.

Jones, L.L. and R.C. Ferrero. 1985. Observations of net debris and associated entanglements in the North Pacific Ocean. pp.183-196. IN: Proceedings of Workshop on the Fate and Impact of Marine Debris. R.S. Shomura and H.O. Yoshida, eds. NOAA TM-NMFS-SWFC-54.

Winans, G.A. and L.L. Jones. 1988. Electrophoretic variability in the Dall's porpoise (Phocoenoides dalli) in the North Pacific Ocean and Bering Sea. J. Mammal. 69(1):14-

21.

Jones, L.L. and A.R. DeGange. 1988. Interactions between seabirds and fisheries in the North Pacific Ocean. IN: Interspecific Interactions of birds and other Marine Vertebrates: Commensalism, Competition and Predation. J.Berger, ed., Columbia Univ. Press.

Au, W.W.L. and L.L. Jones. 1991. Acoustic reflectivity of nets: implications concerning incidental take of dolphins. Mar. Mamm. Sci.7(3):258-273.

Fiscus, C.H. and L.L. Jones. 1992. Cephalopods from the stomachs of Dall's porpoise (*Phocoenoides dalli*) from the northwestern Pacific and Bering Sea, 1978-1982. Int. Whal. Commn. Spec. Rep.

Walker, W.A. and L.L. Jones. 1993. Food habits of northern right whale dolphin, Pacific white-sided dolphin, and northern fur seal caught in high seas driftnet fisheries of the North Pacific, 1990. IN: Symposium on Biology, Distribution and Stock Assessment of Species Caught in the High Seas Driftnet Fisheries in the North Pacific Ocean.

Jones, L.L. and R.C. Hobbs. 1993. Impacts of high seas driftnet fisheries on marine mammal populations in the North Pacific. IN: Symposium on Biology, Distribution and Stock Assessment of Species Caught in the High Seas Driftnet Fisheries in the North Pacific Ocean.

Fiscus, C.H. and L.L. Jones. 1998. A note on cephalopods from the stomachs of Dall's porpoise (*Phocoenoides dalli)* from the Northwestern Pacific and Bering Sea, 1978-1982. J. Cetacean Res. Manage. 1(1):101-107.

Jones, L.L. 1999. Dall's Porpoise, *Phocoenoides dalli*. IN: Smithsonian Book of North American Mammals. D.E. Wilson and S. Ruff, eds. pp.297-298

Jones, Linda; Hanson, M. Bradley and Dawn Noren. 2003. Research on Southern Resident population of killer whales in the Pacific Northwest of the United States. 15th Biennial Conference on the Biology of Marine Mammals, the Society for Marine Mammalogy, 81.

Norris, Thomas; Hanson, Brad; Noren, Dawn and Linda Jones. 2004. Acoustic surveys of killer whales during winter along the Pacific Northwest coast. The Journal of the Acoustical Society of America 116: 2589.

REPORTS

Nerini, M., Jones, L.L. and H.W. Braham. 1980. Gray whale feeding ecology. Final rep. to NOAA OCSEAP (RU593). Contract No. R7120828. Nat. Mar. Mammal Lab., Seattle, Wa.

Boucher, G.C., Consiglieri, L.D. and L.L. Jones. 1980. Report on the distribution and preliminary analyses of abundance of Dall's porpoise. Submitted to Sci. Subcomm. Ad Hoc Comm. on Marine Mammals, Int. N. Pac. Fish. Comm. 27pp.

Consiglieri, L.D., Braham, H. and L.L. Jones. 1980. Distribution and abundance of marine mammals in the Gulf of Alaska from the Platforms of Opportunity Program, 1978-1979. Quar. Rep. Outer Continental Shelf Env. Assess. Prog.

Jones, L.L., Beach, R., Coe, J. and W.A. Walker. 1980. Report on studies conducted aboard the dedicated vessel, Hoyo Maru No.67, May-August 1979. Submitted to Sci. Subcomm. Ad Hoc Comm. on Marine Mammals, Int. N. Pac. Fish. Comm. 16pp.

Jones, L.L. 1980. Estimates of the incidental take of northern fur seals in Japanese gillnets in the North Pacific, 1975-1979. Background paper submitted to the Int. N. Pac. Fur Seal Comm., 23rd Ann. Meeting. 15pp.

Jones, L.L. 1982. Incidental take of northern fur seals in Japanese gillnets in the North Pacific Ocean in 1981. Background paper submitted to the Int. N. Pac. Fur Seal Comm., 25th Ann. Meeting. 16pp.

Johnson, J.H. and L.L. Jones. 1982. The humpback whale problem in Glacier Bay, southeast Alaska: A status report. Submitted to Sci. Comm. Int. Whaling Comm. SC/34/PS10. 9pp.

Braham, H.W., Jones, L.L., Bouchet, G.C. and A.T. Actor. 1983. Distribution of sightings of Dall's porpoise and harbor porpoise in the eastern North Pacific. Submitted to Sci. Comm. Int. Whaling Comm.. SC/35/SM8. 19pp.

Jones, L.L., Gosho. M.E., Kasuya, T. and N. Miyazaki. 1985. Variability of readers and method of preparation in Dall's porpoise age determination. Submitted to Sci. Subcomm., Ad Hoc Comm. on Marine Mammals, Int. N. Pac. Fish. Comm. 25pp.

Gosho, M.E. and L.L. Jones. 1987. Progress report on the age structure, growth and age at sexual maturity of Dall's porpoise. Submitted to Sci. Subcomm. Ad Hoc Comm. on Marine Mammals, Int. N. Pac. Fish. Comm. 27pp.

Jones, L.L., Bouchet, G.C. and B.J. Turnock. 1987. Comprehensive report on the incidental take, biology and status of Dall's porpoise. Submitted to Sci. Subcomm., Ad Hoc Comm. on Marine Mammals, Int. N. Pac. Fish. Comm. 78pp.

Jones, L.L., Gosho, M.E., Rice, D.W., Wolman, A., Muto M.M. and W.A. Walker. 1988. Report on the biology of male Dall's porpoise in the western North Pacific and Bering Sea. Submitted to Scientific Meeting, Sub-committee on Marine Mammals, Int. N. Pac. Fish. Comm. 25pp.

Jones, L.L. 1988. Distribution and incidental take of marine mammals in the area of the high seas squid driftnet fishery. Submitted to the Scientific Meeting, Sub-committee on Marine

Mammals, Int. N. Pac. Fish. Comm. 25pp.

Jones, L.L. and J.M Coe(eds). 1989. Report of the Secretary of Commerce to the Congress on the nature, extent and effects of driftnet fishing in waters of the North Pacific Ocean pursuant to Section 4005 of Public Law 100-220, the Driftnet Impacts Monitoring, Assessment, and Control Act of 1987.

Michael J. Ford

Curriculum Vitae – June 2005

Contact information

Northwest Fisheries Science Center
Conservation Biology Division
2725 Montlake Blvd E
Seattle, WA 98112

phone: 206 860-5612
fax: 206 860-3335
email: mike.ford@noaa.gov
http://www.nwfsc.noaa.gov/research/divisions/cbd/index.cfm

Education

- Ph.D. -- Population Genetics, Cornell University, Ithaca, New York, 1995
- B.S. -- Biological Sciences, with Honors and Distinction, Stanford University, Palo Alto, California, 1991

Research interests

- Using population genetics to solve problems in conservation biology
- Effects of natural selection on genetic variation
- Estimating population parameters using genetic data
- Genetic and ecological effects of salmon hatcheries

Employment history

2003-present	Director, Conservation Biology Division, Northwest Fisheries Science Center (NWFSC)
2000-2003	Program Manager, Genetics & Evolution, Conservation Biology Division, NWFSC
1997-2000	Research Geneticist, Conservation Biology Division, NWFSC
1995-1007	National Research Council Research Associate, NWFSC

Current position

Director of the Conservation Biology Division at the Northwest Fisheries Science Center. The Division consists of 45 Federal employees and an approximately equal number of students, post-doctoral fellows and contractors. Many of the challenges society faces regarding biodiversity and the protection of endangered species require the development of novel approaches for determining how human and natural factors influence the viability of marine species. To meet these challenges, we have assembled a group of biologists from a broad spectrum of scientific disciplines, including risk analysis, genetics, evolutionary biology, ecology and population biology. As a group, the CB Division is dedicated to conducting the research necessary to help address critical conservation needs, with the primary focus on the recovery of ESA-listed Pacific salmon populations and other depressed marine species.

Awards, Honors and Fellowships

- NOAA Administrator's Award for scientific leadership, 2005.
- Stevens Phelps Memorial Award for best genetics paper in an AFS journal, 2002.
- NMFS Special Act Awards for Outstanding Scientific Contributions, 1998, 2000, 2002, 2003.
- NOAA Bronze Medal for helping to develop the Viable Salmonid Population concept, October, 2000.
- Howard Hughes Medical Institute Pre-Doctoral Fellowship, 1991-1995
- Graduated with Honors and Distinction, Stanford University, 1991

Professional Activities

Working groups

- Science advisor panel for Pallid sturgeon recovery team, 2005 – present.
- NMFS ex-officio member of the Independent Science Advisory Board, 2003 – present.
- ICES work group on the Application of Genetics in Fisheries and Mariculture, 2004 – present.
- Cherry Point herring Biological Review Team, 2004 – 2005.
- Southern Resident Killer whale Biological Review Team, 2004.
- Leader, Salmon and Steelhead Hatchery Assessment Group, 2003.
- Co-Chair, Upper Columbia River Quantitative Analysis group, 2000.
- Puget Sound Comprehensive coho hatchery working group, 1998.
- Puget Sound Comprehensive Chinook hatchery working group, 1999.

Reviews

- *Evolution, Genetics, Canadian Journal of Fisheries and Aquatic Sciences, Transaction of the American Fisheries Society, Conservation Biology, Molecular Ecology, Molecular Biology and Evolution, Journal of Fish Biology, Journal of Applied Ecology*
- National Science Foundation
- Sea Grant

Doctoral Student Committees

- Eric Iwamoto, School of Fisheries, University of Washington
- Kathleen O'Malley, Oregon State University

Grants

- Estimating fitness of hatchery and wild spring Chinook salmon in the Wenatchee River. Bonneville Power Administration, $414,000/year (2004-2007)
- Population structure of White River Chinook and chum salmon. Puyallup Tribe cooperative agreement, $60,800 (2003)
- Estimating fitness of hatchery and wild coho salmon in Minter Creek, Washington. Hatchery Science Review Group, ~$110,000/year (2000-2004)
- Population genetics of rockfish, NMFS Protected Resources Division, $25,000 (2002)
- Population structure of Pacific hake. NMFS Protected Resources Division, $74,000 (2001)

Presentations (1999 to 2005)

- Salmon conservation research at the NWFSC's Conservation Biology Division. Office of Science and Technology Division, National Marine Fisheries Service. May 12, 2005, Silver Spring, MD.
- Why we are here – a history of salmon hatchery issues under the ESA. Symposium on defining complex conservation units under the ESA. March 29 2005, Seattle, WA.
- Reproductive success of hatchery and natural coho salmon. Annual presentation to the Hatchery Science Review Group, February 22, 2005, Seattle, WA.
- Population structure of Oregon Coast coho, Oregon Chapter American Fisheries Society Annual Meeting, February 16 2005, Corvallis Oregon.
- Using Molecular Markers to Study Natural Selection, Society for the Conservation of Freshwater Mollusks, National Center for Conservation Training, Sheppardstown, WV, June 2004 (invited)
- Evolutionarily Significant Units and the US Endangered Species Act, BC Seafood Alliance Annual Meeting, Vancouver, British Columbia, January 2004 (invited)
- The Biology Behind the Hatchery Debate, Northwest Environment Training Center, Seattle, WA, October 2003 (invited)
- Fitness and Selection of Natural and Hatchery Salmon, National AFS Meeting, Quebec, August 2003 (invited)
- Molecular Approaches to Studying Natural Selection, Washington State University, Vancouver Campus, April 2003 (invited)
- Estimating the relative fitness of hatchery and natural coho salmon. Hatchery Science Review Group Annual Presentation, January 2003 (invited)
- Relative Fitness of Hatchery and Natural Coho Salmon Spawning in Minter Creek, Washington. 20th Annual Lowell Wakefield Symposium on the Genetics of Subpolar fish and invertebrates. May 29-30, 2002, Juneau, AK.
- Molecular Methods of Estimating Hatchery and Natural Fish Reproductive Success. Annual Western Division AFS. April 30, 2002, Spokane, WA. (invited)

- Selection during supportive breeding -- should we worry about domestication selection? Captive Broodstock Workshop of the Pacific Aquaculture Caucus. June 25, 2002. (invited)
- Risks and Benefits of hatcheries to wild salmon populations. Presentations to the Recovery Science Review Panel, July 2000 and March 2001.
- Learning about natural selection from DNA sequences: applications to molecular ecology and conservation biology. NWFSC Monthly seminar series, June 27, 2001, Seattle, WA. (invited)
- Molecular ecology of flies and fish: understanding past and present population processes. UW School of Fisheries Seminar, April 28, 2001, Seattle, WA. (invited)
- Estimating reproductive success of hatchery and wild salmon in Minter Creek, Washington. Hatchery Science Review Group Symposium, Seattle. Feb. 2001. (invited)
- Overview of the NWFSC's G&E Program. West Coast Salmon Genetics Meetings, Bodega Bay, CA, October, 2001. (invited)
- Estimating hatchery and wild salmon reproductive success in Minter Creek, WA. West Coast Salmon Genetics Meetings, Bodega Bay, CA, October, 2001.
- Using genetic markers to estimate hatchery and wild salmon fitness. Pacific Fisheries Biologists Meeting, Ocean Shores. December, 2000. (invited)
- Risks and benefits of artificial propagation of Pacific salmon. Cornell University. March 2000. (invited)
- Molecular evolution of transferrin within and among salmonids. Cornell University. March 2000. (invited)
- The precautionary principle and genetic hazards to natural populations from artificial propagation. Stock Assessment Workshop, Key Largo, Florida, 1999.

Peer Reviewed Publications

Ford MJ, Teel D, VanDoornik D, Kuligowski D and Lawson P. 2004. Genetic population structure of central Oregon coastal coho salmon (Oncorhynchus kisutch). Conservation Genetics, 5:797-812

Kuligawski DR, Ford MJ, Berejikian B. Patterns of genetic relatedness in a population of steelhead (*Oncorhynchus mykiss*). Transactions of the American Fisheries Society, in press.

Waples R.S., Ford M.J. and Schmitt D.S. Empirical results of salmon supplementation a preliminary assessment. T. Bert, ed. *Ecological and Genetic Implications of Aquaculture Activities*. Kluwer Academic Publishers, in press.

Ford, M.J. 2004. Conservation units and preserving diversity. In, *Salmonid Perspectives on Evolution*. A. Hendry and S. Stearns, eds. Oxford University Press.

Iwamoto, E., M.J. Ford, and R.G. Gustafson. 2004. Genetic population structure of Pacific hake, Merluccius productus, in the Pacific Northwest. Environ. Biol. Fish. 69: 187-199.

Van Doornik D.M., Ford M.J., and Teel D.J. 2002. Patterns of temporal genetic variation in

coho salmon: estimates of the effective proportion of 2-year-olds in natural and hatchery populations. Trans Am Fish Soc 1007-1019.

Ford, M.J. 2002. Applications of selective neutrality tests to molecular ecology, invited review. Molecular Ecology 11:1245-1262.

Ruckelshaus M., McElhany P., Ford M.J. 2002. Recovering species of conservation concern: Are populations expendable? In: S. Levin and P. Kareiva (eds.). *Expendable Species*. Princeton University Press.

Ford, M.J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology 16:815-825.

Ford M.J. 2001. Molecular evolution of transferrin: evidence for positive selection in salmonids. Mol. Biol. Evol. 18:639-647

Ford M.J. 2000. Effects of natural selection on patterns of DNA sequence variation at the transferrin, somatolactin, and p53 genes within and among chinook salmon (*Oncorhynchus tshawytscha*) populations. Mol. Ecol. 9:843-855.

Ford M.J., Thornton P.J., and Park L.K. 1999. Natural selection promotes divergence of transferrin among salmonid species. Mol. Ecol. 8:1055-1061.

Ford M.J. 1998. Testing models of migration and isolation among populations of chinook salmon (*Oncorhynchus tshawytscha*). Evolution 52:539-557.

Willett C.S., Ford M.J. and Harrison R.G. 1997 Inferences about the origin of a field cricket hybrid zone from a mitochondrial DNA phylogeny. Heredity 79:484-494.

Ford M.J. and Aquadro C.F. 1996. Selection on X-linked genes during speciation in the *Drosophila athabasca* complex. Genetics 144:689-703.

Ford M.J., Yoon C.K., and Aquadro C.F. 1994. Molecular evolution of the *period* locus in *Drosophila athabasca*. Mol. Biol. Evol. 11(2):169-182.

Ford M.J., and Mitton J.B. 1993. Population structure of the pink barnacle, *Tetraclita squamosa rubescens*, along the California coast. Mol. Mar. Biol. Biotech. 2(3):147-153.

Reports

Krahn, M. M., M. J. Ford, W. F. Perrin, P. R. Wade, R. P. Angliss, M. B. Hanson, B. L. Taylor, G. M. Ylitalo, M. E. Dahlheim, J. E. Stein, R. S. Waples. 2004. 2004 Status Review of Southern Resident Killer Whales (Orcinus orca) under the Endangered Species Act. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-62, 73 p.

Berejikian, B.A. and M.J. Ford. 2004. Review of relative fitness of hatchery and natural salmon. US Dept of Commerce, NOAA Tech. Memo., NMFS-NWFSC-61.
(On-line at http://www.nwfsc.noaa.gov/publications/index.cfm)

Ford MJ, Lundrigan TA, Moran PC. 2004. Population genetics of Entiat River Spring Chinook salmon. NOAA Technical Memorandum NMFS-NWFSC-60.

Ford MJ. 2004. How old are the Southern Residents? Report for the Cetacean Taxomony Workshop, La Jolla, CA, April 2004.

Ford MJ, Van Doornik DM, Teel DJ. 2003. Genetic population structure of Oregon Coastal Coho salmon -- a preliminary analysis. Report to the Oregon Coastal Technical Recovery Team. May 6th, 2003.

Fuss H and Ford MJ. 2002. Differences in natural production between hatchery and wild coho salmon. Annual report to the Hatchery Scientific Work Group, June, 2002.

Fuss H, Sharpe C, Hulett P, Ford MJ, Hard JJ, LaHood E. 2001. Differences in natural production between hatchery and wild coho salmon in Minter Creek, Washington: Annual report to the Hatchery Science Review Group, June, 2001.

Ford M.J., Budy P., Busack C., et al. 2001. Upper Columbia River Steelhead and Spring Chinook Salmon: Population Structure and Biological Requirements. Final Report, March 2001.

McElhany P., Ruckelshaus M.H., Ford M.J., Wainwright T.C., and Bjorkstedt, E.P. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. NOAA Tech. Memo. NMFS-NWFSC-42

M. Bradley Hanson

<u>Professional Address</u>

National Marine Fisheries Service
Northwest Fisheries Science Center
2725 Montlake Blvd. E.
Seattle, Washington 98112

<u>Education</u>

B.A. University of Washington, 1978.
M.S. University of Washington, 1988.
Ph.D. University of Washington, 2001.

<u>Work Experience</u>

2003-Present: Wildlife Biologist (Research), Marine Mammal Program, Northwest Fisheries Science Center, Seattle, Washington.

1992 - 2003: Wildlife Biologist (Research), California Current Ecosystem Program, Alaska Fisheries Science Center, National Marine Mammal Laboratory, Seattle, Washington

1990 - 1991: Wildlife Biologist (Management), Protected Resources Management Division, Alaska Regional Office, National Marine Fisheries Service, Juneau, Alaska.

1989: Wildlife Biologist (Management), Protected Species Management Branch, Southwest Regional Office, National Marine Fisheries Service, Terminal Island, California.

Summer 1988: Associate Faculty, Biology of Bottlenose Dolphins in Mobile Bay, Alabama, School for Field Studies, Beverly, Massachusetts.

Winter 1988: Biological Tech., Investigated Killer whale/black cod fishery interactions in the Bering Sea, Alaska Ecosystem Program, Alaska Fisheries Science Center, National Marine Mammal Laboratory, Seattle, WA.

Summer 1987: Assistant Scientist, Kodiak Island shipboard marine mammal surveys, Envirosphere, Bellevue, Washington.

Spring 1987: Research Biologist II, Black bear management in the North Cascades Washington, University of Washington, Seattle, Washington.

1986: Assistant Scientist, Bering Sea aerial marine mammal surveys, Envirosphere, Bellevue, Washington.

Spring 1986: Co-Consultant to National Marine Fisheries Service, Southwest Fisheries Center, Review of U. S. harbor seal population studies, University of Washington, Seattle, Washington.

Spring 1985: Co-Consultant to Transmountain Pipeline Company, Evaluation of sensitive species and areas adjacent to northwest Washington pipeline corridor, University of Washington, Seattle, Washington.

1984-1985: Research Biologist II, Development of an EIS for a proposed mine in Northwestern Montana grizzly bear habitat, University of Washington, Seattle, Washington.

1983: Research Biologist I, Shipboard and aerial surveys of Antarctic whales and seals, University of Washington, Seattle, Washington

1982 - 1986: Teaching Assistant, Marine Mammalogy (Fish 475), University of Washington, Seattle, Washington.

1981 - 1982: Research Biologist I, Evaluation of habitat and den use by black bears in Southeast Alaska relative to timber harvest, University of Washington, Seattle, Washington.

Summer 1980: Co-Principal Investigator, Photo-identification of humpback whales in Prince William Sound, Alaska, American Cetacean Society, Los Angeles, California.

1980: Volunteer, Animal Care Department, Seattle Aquarium, Seattle, Washington and Vancouver Public Aquarium, Vancouver, British Columbia, Canada

1977 - 1983: Response Team Member, Recovery, rehabilitation, or necropsy of stranded marine mammals, Marine Animal Resource Center, Seattle, Washington.

Spring 1976: Research Assistant, Monitored movements of radio-tagged killer whales in Puget Sound, Washington, University of Washington, Seattle, Washington.

Memberships Professional Associations

The Society for Marine Mammalogy

Publications and Reports

Carretta, J.V., K.A. Forney, M. M. Muto, J. Barlow, J. Baker, B. Hanson, and M. S. Lowry. 2005. U.S. Pacific Marine Mammal Stock Assessments: 2005. NOAA-TM-NMFS-SWFSC-375. 316pp.

Baird, R.W., M.B. Hanson, and L.M. Dill. 2005. Factors influencing the diving behaviour of fish-eating killer whales: sex differences and diel and interannual variation in diving rates. Can. J. Zool. 83(2): 257-267.

Maniscalco, J.M., K. Wynne, K.W. Pitcher, M.B. Hanson, S.R. Melin, and S. Atkinson. 2004. The Occurrence of California Sea Lions (*Zalophus californianus*) in Alaska. Aquatic Mammals 2004, 30(3), 427-433.

Norman, S.A., Raverty, S., McLellan, B., Pabst, A., Ketten, D., Fleetwood, M., Gaydos, J.K., Norberg, B., Barre, L., Cox, T., Hanson, B., and Jeffries, S. 2004. Multidisciplinary investigation of stranded harbor porpoises (*Phocoena phocoena*) in Washington State with an assessment of acoustic trauma as a contributory factor (2 May – 2 June 2003). U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-NWR-34, 120 p.

Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.P. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2004. 2004 Status review of southern resident killer whales (*Orcinus orca*) under the Endangered Species Act. U.S. Dept. Commer., NOAA Tech. Memo. NMFS NWFSC- 62, 73 p.

Willis, P.M., Crespi, B.J., Dill, L.M., Baird, R.W., and Hanson, M.B. 2004. Natural hybridization between Dall's porpoises (Phocoenoides dalli) and harbour porpoises (*Phocoena phocoena*). Canadian Journal of Zoology 82:828-834.

Norman, S.A, C.E. Bowlby, M.S. Brancato, J. Calambokidis, D. Duffield, P.J. Gearin, T.A. Gornall, M.E. Gosho, B. Hanson, J. Hodder, S.J. Jeffries, B. Lagerquist, D.M. Lambourn, . Mate, B. Norberg, R.W. Osborne, J.A. Rash, S. Riemer and J. Scordino. 2004. Cetacean strandings in Oregon and Washington between 1930 and 2002. J. Cetacean Res. Manage. 6(1):87–99.

Krahn, M.M., Wade, P.R., Kalinowski, S.T., Dahlheim, M.E., Taylor, B.L., Hanson, M.B., Ylitalo, G.M., Angliss, R.P., Stein, J.E. and Waples, R.S. 2002. Status Review of Southern Resident killer whales (*Orcinus orca*) under the Endangered Species Act. NOAA Tech. Memo. NMFS-NWFSC-54, National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service, Seattle, WA. xxii + 134pp.

Baird, R.W., J.F. Borsani, M.B. Hanson, and P.L. Tyack. 2002. Diving and night-time behavior of long-finned pilot whales in the Ligurian Sea. Mar. Ecol. Prog. Ser. 237:301-305.

Hanson, M.B. 2001. An evaluation of the relationship between small cetacean tag design and attachment durations: a bioengineering approach. Unpubl. Ph.D.

dissertation, Univ. of Washington, Seattle, WA. 208 pp.

Hanson, M.B., R.W. Baird and R.L. DeLong. 1999. Movements of a tagged harbor porpoise in inland Washington waters from June 1998 to January 1999. Pp. 85-96, In: A.L. Lopez and D.P. DeMaster (eds.), Marine Mammal Protection Act and Endangered Species Act Implementation Program 1998. AFSC Processed Rept. 99-08. 305 pp.

Walker, W.A., and M.B. Hanson. 1999. Biological observations on Stejneger's beaked whale, *Mesoplodon stejnegeri*, from strandings on Adak Island, Alaska. Mar. Mamm. Sci. 15(4):1314-1329.

Hanson, M.B., and R.W. Baird. 1998. Dall's porpoise reactions to tagging attempts using a remotely deployed suction-cup tag. Mar. Tech. Soc. J. 32(2):18-23.

Hanson, M.B. 1998. Design considerations for telemetry tags for small cetaceans. Pp. 37-50, In: P.S. Hill, B. Jones, and D.P. DeMaster (eds.), Marine Mammal Protection Act and Endangered Species Act Implementation Program 1997. AFSC Processed Rept. 98-10. 246 pp.

Hanson, M.B., A.J. Westgate, and A.J Read. 1998. Evaluating small cetacean tags by measuring drag in a wind tunnel. Pp. 51-62, In: P.S. Hill, B. Jones, and D.P. DeMaster (eds.), Marine Mammal Protection Act and Endangered Species Act Implementation Program 1997. AFSC Processed Rept. 98-10. 246 pp.

Baird, R.W., and M.B. Hanson. 1998. A preliminary analysis of the diving behavior Dall's porpoise in the transboundary waters of British Columbia and Washington. Pp. 99-110, In: P.S. Hill, B. Jones, and D.P. DeMaster (eds.), Marine Mammal Protection Act and Endangered Species Act Implementation Program 1997. AFSC Processed Rept. 98-10. 246 pp.

Hanson, M.B., R.W. Baird and R.L. DeLong. 1998. Movements of tagged Dall's porpoises in Haro Strait Washington. Pp. 111-120, In: P.S. Hill, B. Jones, and D.P. DeMaster (eds.), Marine Mammal Protection Act and Endangered Species Act Implementation Program 1997. AFSC Processed Rept. 98-10. 246 pp.

Walker, W.A., M.B. Hanson, R.W Baird, and T.J. Guenther. 1998. Food habits of the harbor porpoise, *Phocoena phocoena*, and Dall's porpoise, *Phocoenoides dalli*, in the inland waters of British Columbia and Washington. Pp. 63-76, In: P.S. Hill, B. Jones, and D.P. DeMaster (eds.), Marine Mammal Protection Act and Endangered Species Act Implementation Program 1997. AFSC Processed Rept. 98-10. 246 pp.

Baird, R.W., and M.B. Hanson. 1997. Dall's porpoise diving behavior and reactions to tagging attempts using a remotely deployed suction-cup tag, August 1996. Pp.43-

54, In: P.S. Hill and D.P. DeMaster (eds.), Marine Mammal Protection Act and Endangered Species Act Implementation Program 1996. AFSC Processed Rept. 97-10. 255 pp.

Baird, R.W., and M.B. Hanson. 1997. Status of the northern fur seal, *Callorinus ursinus*, in Canada. Can. Field Nat. 111(2):263-269.

Gearin, P. J., S.J. Jefferies, M.E. Gosho, J.R. Thomason, R.L. DeLong, M. Wilson, D. Lambourn, B. Hanson, S. Osmek, S. R. Melin. 1996. Capture and marking California sea lions in Puget Sound, Washington during 1994-95: Distribution, abundance and movements. Unpubl. Rept. On file NMML, NMFS, Seattle, WA.

Bengtson, J.L., A.S. Blix, I.L. Boyd, M.F. Cameron, M.B. Hanson, and J.L. Laake. 1995. Antarctic pack ice seal research, February-March 1995. U.S. Antarctic Journal, 30:191-193.

Osmek,S., B. Hanson, J.L. Laake, S.Jeffries, and R.L. DeLong. 1995. Harbor porpoise, *Phocoena phocoena*, population assessment studies for Oregon and Washington in 1994. Pp. 141-172, *In* D.P. DeMaster, H.W. Braham and S.P. Hill. Marine mammal assessment program: status of stocks and impacts of incidental take1994. Annual report submitted to the NMFS, Office of Protected Resources, Silver Spring, Maryland. Available through the NMFS, AFSC, National Marine Mammal Lab, Seattle, WA.

Credle, V.R., D.P. DeMaster, M.M. Merklein, M.B. Hanson, W.A. Karp, and S.A. Fitzgerald (editors). 1994. NMFS (National Marine Fisheries Service) observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U. S. Dept. of Comm., NOAA Tech. Mem. NMFS-OPR-94-1, 96 pp.

Hanson, M.B., L.J. Bledsoe, B.C. Kirkevold, C.J. Casson, and J.W. Nightingale. 1993. Behavioral budgets of captive sea otter mother-pup pairs during pup development. Zoo Bio. 12:459-477.

Hanson, M.B., L J. Bledsoe, B.C. Kirkevold, C.J. Casson, and J.W. Nightingale. 1991. Behavioral budgets and patterns of captive sea otter mother-pup pairs during pup development. Unpubl. rep., Institute of Museum Services, Washington, D.C. 53 pp.

Erickson, A.W., and M.B. Hanson. 1990. Continental estimates and population trends of Antarctic ice seals. Pp. 253-264, in: K. R. Kerry and G. Hempel (eds.), Antarctic Ecosystems, Ecological Change and Conservation. Springer-Verlag, Berlin, Germany.

Erickson, A.W., L.J. Bledsoe, and M.B. Hanson. 1989. Bootstrap correction for diurnal activity cycle in census data for Antarctic seals. Mar. Mamm. Sci. 5(1):29-56.

Hanson, M.B. 1988. Habitat use and den ecology of black bears on Mitkof Island, Alaska. Unpubl. M.S. Thesis, Univ. of Washington, Seattle, WA. 145 pp.

Innes, S., and B. Hanson. 1988. Behavior and biology of the bottlenose dolphin (Tursiops truncatus) around the Ft. Morgan Peninsula, Alabama. Unpubl. rep., School for Field Studies, Beverly, Massachusetts. 22 pp.

Erickson, A.W., and M.B. Hanson. 1987. An assessment of the effectiveness of abating bear damage to forest plantations by translocation and deterrent feeding of bears. Unpubl. rep., USDA Forest Service, Darrington Ranger District, Darrington Washington. 98 pp.

Erickson, A.W., M.B. Hanson, and C.C. Clampitt. 1986. An assessment of the impact of the Rock Creek Mining Project on the grizzly bear population in the Cabinet Mountains, Montana. Unpubl. rep., ASARCO Inc., Wallace, Idaho. 217 pp.

Ribic, C.A., L.J. Bledsoe, and M.B. Hanson. 1986. Assessment of aerial counts of harbor seals (Phoca vitulina) as population estimates with correction factors. Unpubl. rep., NMFS, Southwest Fisheries Center, LaJolla, California. 130 pp.

Hanson, M.B., and A.W. Erickson. 1985. Odontocete sightings along the Antarctic coast and in the South Atlantic Ocean. Antarctic Journal of the United States, 20(2):16-19.

Reinke, J., B. Hanson, and C. Miller. 1985. A survey of humpback whales in southwestern Prince William Sound during June and July, 1980. Unpubl. rept., NMFS, National Marine Mammal Laboratory, Seattle, Washington. 19 pp.

Erickson, A.W., M.B. Hanson, and D.M. Kehoe. 1983. Population densities of seals and whales observed during the 1983 circumnavigation of Antarctica by the U.S.C.G.C. POLAR STAR. Antarctic Journal of the United States, 1983 Review, 18(5):163-166.

Erickson, A.W., M.B. Hanson, and J.J. Brueggman. 1982. Black bear denning and habitat study, Mitkof Island, Alaska. Unpubl. rep. USFS, Petersburg Ranger District, Petersburg Alaska. 114 pp.

Papers presented

The annual movement pattern of a Dall's porpoise in the eastern north Pacific Ocean revealed by radio-telemetry. With R.L. DeLong. Fourteenth Biennial Conference on the Biology of Marine Mammals, Vancouver B.C., 89 November – 3 December 2001.

Evaluating the relationship between small cetacean tag design and attachment durations: A bioengineering approach. With W. Xu. Thirteenth Biennial Conference on the Biology of Marine Mammals, Maui, Hawaii, 29 November – 3 December 1999.

Short-term Movements and Dive Behavior of Tagged Dall's Porpoise in Haro Strait, Washington. With R.W. Baird, and R.L. DeLong. World Marine Mammal Science Conference, Monaco, 20-24 January, 1998.

Evaluating small cetacean tags by measuring drag in wind tunnels. With A.J. Westgate, and A.J. Read. Forum on Wildlife Telemetry, 21-23 Sept. 1997, Snowmass, Colorado.

Body composition of California sea lion pups using bioelectrical impedance analysis. With J.L. Laake, R.L. DeLong, S R. Melin, and J.R. Thomason. Eleventh Biennial Conference on the Biology of Marine Mammals, Orlando, Florida, December 1995.

Morphological evaluation of the harbor porpoise dorsal fin as an attachment site for telemetry devices. With F.A. Leaf, T.R. Spraker, S.D. Osmek, and R L. DeLong. Eleventh Biennial Conference on the Biology of Marine Mammals, Orlando, Florida, December 1995.

Behavioral budgets of captive sea otter mother-pup pairs during pup development. With L J. Bledsoe, B.C. Kirkevold, C.J. Casson, and J.W. Nightingale. Ninth Biennial Conference on the Biology of Marine Mammals, Chicago, Illinois, December 1991.

Behavioral activities of two transient pod killer whales during a radio-tagging project in northern Puget Sound. With A.W. Erickson. Third International Orca Symposium, Victoria, B. C., March 1990.

Den ecology of black bears on Mitkof Island, Alaska. With A.W. Erickson, and C.A. Ribic. Eighth International Conference on Bear Research and Management, Victoria, B. C., February 1989.

Habitat utilization of two radio tagged transient killer whales (Orcinus orca). With A.W. Erickson and F.L. Felleman. Seventh Biennial Conference on the Biology of Marine Mammals, Miami, Florida, December 1987.

Bootstrap correction for diurnal activity cycle in census data for Antarctic seals. With A.W. Erickson, and L.J. Bledsoe. Seventh Biennial Conference on the Biology of Marine Mammals, Miami, Florida, December 1987.

Testimony Experience

1991, Humane Society of the United States v. Mosbacher, Wilson, and Fox: Provided a written deposition to the U.S. Attorney as the National Marine Fisheries Service representative overseeing the subsistence harvest of northern fur seals on the Pribilof Islands, Alaska.

Dawn Noren, Ph.D.

Education

2002	University of California, Santa Cruz. Ph.D. Ecology and Evolutionary Biology
1999	University of California, Santa Cruz. M.A. Ecology and Evolutionary Biology
1997	University of California, Santa Cruz. M.S. Marine Sciences
1994	University of Maryland, College Park. B.S. Biology, Magna Cum Laude.

Field Research Skills

Have experience living in remote field camps and being on small and large ships for extended periods of time. Proficient in handling, restraining, and weighing marine mammals, including harbor seals, northern elephant seals, Steller sea lions, and bottlenose dolphins. Proficient in using ultrasound to measure blubber thickness of harbor seals, northern elephant seals, Steller sea lions, and bottlenose dolphins. Skilled in taking blood and blubber samples from phocids and otariids, measuring body composition using tritium and the hydrogen isotope dilution method, measuring metabolism with flow-through respirometry techniques, and recording behavioral observations of cetaceans and pinnipeds. Experienced in identifying marine mammal species and individual members of the Southern Resident killer whale population from land and ship based platforms.

Teaching Experience

9/99 - 12/99 **UCSC Reader**, Dep. of Ocean Sciences, University of California, Santa Cruz. Graded exams for Life in the Sea undergraduate class.

9/95 - 6/99 **UCSC Teaching Assistant**, Dep. of Ocean Sciences and Biology, University of California, Santa Cruz. Taught sections of students; graded papers, quizzes, and tests; prepared and ran labs; and conducted review sessions.
Winter 2000 - Biology 141 Field Methods in Animal Biology, Dr. Jennifer Burns (Instructor)
Winter 1999 - Biology 141 Field Methods in Animal Biology, Dr. Dan Crocker (Instructor)
Fall 1998 - Biology 139 Biology of Marine Mammals, Dr. Dan Costa (Instructor)
Spring 1998 - Biology 133/233 Exercise Physiology, Dr. Terrie Williams (Instructor)
Winter 1998 - Biology 132 Comparative Vertebrate Physiology, Dr. Terrie Williams (Instructor)
Fall 1997 - Biology 20B Development and Physiology, Dr. Jane Silverthorne, Dr. Dan Crocker (Instructors)
Winter 1997 - Biology 132 Comparative Vertebrate Physiology, Dr. Terrie Williams (Instructor)
Spring 1996 - Biology 11 Structure and Function of Organisms, Dr. Patrick Elvander, Dr. Leo Ortiz (Instructors)
Winter 1996 - Marine Sciences 80A Life in the Sea **(Head Teaching Assistant)**, Dr. David Lohse (Instructor)
Fall 1995 - Marine Sciences 80A Life in the Sea, Dr. Mary Silver (Instructor)

9/96 - 6/97 **UCSC Ocean Sciences Board Student T.A. Coordinator**, Dep. of Ocean Sciences, University of

California, Santa Cruz. Led meetings to inform teaching assistants of their responsibilities and resources available to them, gave advice on being a proficient T.A., and acted as a liaison between teaching assistants and the Ocean Sciences Board.

Research and Related Work Experience

5/03-present **Research Fishery Biologist**, NOAA/NMFS/Northwest Fisheries Science Center. Develop research programs for marine mammals, particularly Southern Resident killer whales (SRKW), in the Pacific Northwest. Organize and participate in scientific workshops and meetings on pertinent SRKW research concerns. Write statements of work to be filled by government contractors and review research proposals and permit applications. Collaborate with other NMFS agencies, Washington Department of Fish and Wildlife (WDFW), universities and independent researchers on killer whale research projects. Monitor program budget and research project budgets. Conducting a study on the behavioral energetic responses to vessel interactions with Southern Resident killer whales and participating in the research on the distribution and habit use patterns of Southern Resident killer whales. Conducting a study on the energetic costs of surface active behaviors in bottlenose dolphins in collaboration with Terrie Williams at UCSC. Conducting a study that measures the domoic acid tissue load and metabolic changes in coho salmon that have consumed domoic acid as well as modeling the potential domoic acid dose to killer whales that consume salmon during a bloom. Manage 2 term employees, 1 contractor, and 1 volunteer.

4/02 – 4/03 **National Research Council (NRC) Postdoctoral Research Associate,** National Marine Mammal Laboratory, NOAA/NMFS/Alaska Fisheries Science Center, Seattle, Washington. Conducted research on Steller sea lion diving and foraging ecology. Particpated in tagged and branded animal re-sight cruises and underwater captures of Steller sea lion juveniles. Assisted with morphometric measurements, including ultrasonic measurements of blubber thickness, and collected physiological samples, including blood and blubber. Developed a model investigating how individual juvenile Steller sea lions utilize their energy reserves during fasting, how long individuals of differing body condition can survive until they must successfully find prey, and how the proportion of time spent in the water influences energy reserve utilization patterns and maximum fasting duration. Participated in an interdisciplinary modeling workshop with investigators that are modeling Steller sea lion bioenergetics, population structure, and prey dynamics. Participated in an interdisciplinary workshop on fatty acids in marine mammals and their prey.

9/95 - 3/02 **Graduate Student Research**, Dep. of Marine Sciences and Dep. of Biology, University of California, Santa Cruz.

Body energy reserve utilization during the postweaning fast of northern elephant seals (*Mirounga angustirostris*) pups: implications for survival (9/97 - 3/02). Project resulted in a Ph.D. degree in Ecology and Evolutionary Biology. Conducted research at Año Nuevo, CA on northern elephant seals. Wrote proposals and budgets for research grants. Acquired multiple grants to fund the project, ordered supplies, and maintained budget for research expenses. Field duties included: tagging northern elephant seal weaned pups, population censuses of Año Nuevo rookery, reading tags and maintaining tag records, monitoring animal behavior, performing necropsies and collecting tissue samples, manually restraining pups, chemically sedating pups (utilizing Ketamine and Valium), weighing animals, taking morphometric measurements, measuring blubber thickness with a portable ultrasound unit, measuring body composition with tritium, taking blood samples, taking blubber biopsies, and translocating animals to Long Marine Laboratory in Santa Cruz, CA to measure oxygen consumption using flow through respirometry. Trained and supervised field teams of undergraduates (approximately 50 students total for two years of research). Laboratory duties included: blood serum distillations for calculating body composition using the hydrogen isotope dilution method, lipid extraction from blubber samples, transesterification of lipids, and determining fatty acids in blubber samples with gas chromatography.

Balancing the conflicting physiological demands of thermoregulation and diving in the

Atlantic bottlenose dolphin, Tursiops truncatus (9/95 - 6/97). Project resulted in a M.S. degree in Marine Sciences. Duties included: setting up experimental design to compare the effects of exercise on the dive response of bottlenose dolphins in the Bahamas, measuring blubber thickness with a portable ultrasound unit, and taking heat flow and skin temperature of dolphins at the water surface and at depth. Much of the research for this project was done underwater while on SCUBA.

Other research experiences: assisted cetacean necropsies, assisted experiments on how apnea affects blood gas parameters of Pacific white sided dolphins in captivity, surveyed Monterey Bay for marine birds and mammals, assisted harbor seal captures, and assisted handling and chemically sedating adult female elephant seals for physiological studies.

9/95 -3/02 **Stranding Program Volunteer**, Long Marine Laboratory, University of California, Santa Cruz. Assisted necropsies and sample collections on dolphins, pinnipeds, and beaked whale. Assisted rescue efforts for live stranding of gray whale calf.

10/00 - 12/00 **Marine Mammal Observer**, SRS Technologies, Newport Beach, California. Counted and observed behaviors of marine mammals, primarily CA sea lions and harbor seals, from land and boat based platforms for the San Francisco-Oakland Bridge pile installation demonstration. Primary focus of project was to quantify pinniped disturbance from the pile driving operations.

9/99 - 6/00 **Graduate Research Assistant**, Dep. of Biology, University of California, Santa Cruz. Collaborated with researchers at California State University, Monterey Bay to develop interactive web-site on elephant seals (http://kibak.monterey.edu/~seal) to be used nationwide in high school science curricula. Reviewed curricula drafts and student activities, researched elephant seal facts, answered questions about elephant seal research, provided details about my research project, and conducted interviews with other researchers. Provided information and assistance to an undergraduate from Cal State Monterey, and trained her with hands-on northern elephant seal research at Año Nuevo.

6/97 - 7/97 **Graduate Research Assistant**, Dep. of Biology, University of California, Santa Cruz. Assisted Steller sea lion conservation research at a remote island field camp in southeast Alaska (Forester Island) in collaboration with the Alaska Dept. of Fish and Game. Duties included: manually restraining pups, taking morphometric measurements of adult females and pups, taking blubber thickness measurements of adult females and pups using portable ultrasound unit, taking heat flow and skin temperature data, performing necropsies, and collecting tissue samples.

11/03 - 7/94 **Marine Animal Rescue Program Volunteer**, National Aquarium, Baltimore, Maryland. Trained in rescue and revival methods for stranded sea turtles, pinnipeds, and cetaceans. Aided rehabilitation efforts of pygmy sperm whale and loggerhead sea turtle. Fed and gave medications to animals. Maintained sanitary environment.

9/93 - 6/94 **UMCP Undergraduate Research Assistant**, Dr. Susan Carter-Porges' behavioral endocrinology lab, University of Maryland, College Park. Cared for animals, injected hormones and sedatives, performed surgeries, ran choice experiments with Illinois prairie voles, collected data for studies on effects of hormones on sex behaviors and parental care in voles.

9/93 - 12/93 **Mammalogist Intern**, National Aquarium, Baltimore, Maryland. Prepared food, fed animals, aided in medical drills and procedures on pinnipeds and cetaceans, kept record of animal behaviors, evaluated dolphin shows, observed and assisted training exercises.

1/93 **Aquarist Intern**, National Aquarium, Baltimore, Maryland. Prepared food, fed animals, helped maintain and repair exhibits and tanks, operated filtration systems, kept records, accompanied supervisor on collecting trip.

Professional Organizations

Society for Integrative and Comparative Biology
Society for Marine Mammalogy

Honors, Awards, Scholarships, and Grants

2005	NOAA NMFS Northwest Fisheries Science Center Internal Grant for Scientific Research
2002	SICB: Physiology of Plasticity Symposium Travel Award
2002	National Research Council (NRC) Post-Doctoral Research Associateship Award
2000 - 2001	GANN Department of Biology, UCSC Graduate Full Fellowship
1998, 1999, 2000	Friends of Long Marine Laboratory Student Research Award Grant
1998, 2000	American Museum of Natural History Lerner-Gray Fund for Marine Research Grant
1999	Society for Marine Mammalogy Student Travel Grant to the 13th Conference on the Biology of Marine Mammals
1998, 1999	CA Natural Reserve System Mildred E. Mathias Graduate Student Research Grant
1998, 1999	Friends of Long Marine Laboratory Student Research Award Grant
1997, 1999	UCSC Graduate Student Association Travel Grant
1997, 1998	Dr. Earl H. and Ethel M. Myers Oceanographic and Marine Biology Trust Grant
1997	Outstanding Teaching Assistant Award (University of California, Santa Cruz)
1996, 1997	UCSC Marine Science Research/Travel Grant
1995, 1996, 1997	Honorable Mention Department of Defense Fellowship Competition
1995	University of California, Santa Cruz Regent's Fellowship
1994	Graduated Magna Cum Laude (University of Maryland, College Park)
1994	University of Maryland Honors Citation
1994	National Dean's List
1992 - 1994	Academic All-American Award (presented at NCAA Women's National Water Polo Championships)
1990 - 1994	University of Maryland Full Scholarship
1990 - 1994	Maryland Distinguished Scholar Scholarship
1990	Robert C. Byrd Scholarship

Scientific Publications

Sherman-Cooney R.A., Ortiz R.M., **Noren D.P.**, Pagarigan L., Ortiz C.L., Talamantes F. (2005) Estradiol and Testosterone Concentrations Increase with Fasting in weaned pups of the northern elephant seal (Mirounga angustirostris). Physiological and Biochemical Zoology 78(1):55-59.

Noren D.P. and Mangel M. (2004) Energy reserve allocation in fasting northern elephant seal pups: Interrelationships between body condition and fasting duration. Functional Ecology 18: 233-242.

Ortiz R.M., **Noren D.P.**, Ortiz C.L, Talamantes F. (2003) GH and ghrelin and growth hormone increase with fasting in a naturally adapted species, the northern elephant seal (*Mirounga angustirostris)*. Journal of Endocrinology 178: 533-539.

Noren D.P., Crocker D.E, Williams T.M., Costa D.P. (2003) Energy reserve utilization of northern elephant seal (*Mirounga angustirostris*) pups during the postweaning fast: Size does matter. The Journal of Comparative Physiology (B) 173: 443-454.

Noren D.P. (2002) Thermoregulation of weaned northern elephant seal (*Mirounga angustirostris*) pups in air and water. Physiological and Biochemical Zoology 75: 513-523.

Noren D.P. (2002) Body energy reserve utilization during the postweaning fast of northern elephant seals *Mirounga angustirostris*): Implications for survival. Ph.D. Dissertation, University of California, Santa Cruz, 151pp.

Ortiz R.M., **Noren D.P.**, Litz B., Ortiz C.L. (2001) A new perspective on adiposity in a naturally obese mammal. American Journal of Physiology - Endocrinology and Metabolism 281: E1347-E1351.

Noren D.P., Williams T.M., Berry P., Butler E. (1999) Thermoregulation during swimming and diving in bottlenose dolphins, *Tursiops truncatus*. The Journal of Comparative Physiology (B) 169: 93-99.

Williams T.M., **Noren D.**, Berry P., Estes J.A., Allison C., Kirtalnd J. (1999) The diving physiology of bottlenose dolphins (*Tursiops truncatus*) III. Thermoregulation at depth. The Journal of Experimental Biology 202: 2763-2769.

Noren D.P. (1997) Balancing the conflicting demands of thermoregulation and diving in the Atlantic bottlenose dolphin, *Tursiops truncatus*. M.S. Thesis, University of California, Santa Cruz, 49pp.

Papers in Prep

Noren, D.P., Mocklin, J.A., Jones, L. A review of biopsy techniques: Information gained and the behavioral and physiological effects of biopsying marine mammals (To be submitted to Marine Mammal Science)

Noren, D.P., Rea, L., Loughlin, T. Fasting capabilities of weaned juvenile Steller sea lions: influence of body condition and environment (To be submitted to Functional Ecology)

Noren D.P., Iverson S., Goebel M., Costa D.P., Williams T.M. Physical and biochemical changes in the blubber of northern elephant seal (*Mirounga angustirostris*) pups during the Ppostweaning fast (To be submitted to Journal of Comparative Physiology).

Noren D.P. The influence of body condition and length of the postweaning fast on haul-out behavior during the first foraging trip of northern elephant seal (*Mirounga angustirostris*) pups (To be submitted as a not to Marine Mammal Science).

Williams, T.M. and **Noren, D.P.** The effect of exercise on heat flow from the extremities and thermoregulation of the intra-abdominal testes of the bottlenose dolphin (*Tursiops truncatus*) (To be submitted to Physiological Zoology).

Noren D.P. and Ortiz, R.M. Plasma metabolites indicate variation in energy reserve utilization during the postweaning fast of northern elephant seals (Submission journal TBA)

Scientific Meeting Presentations and Abstracts

Noren, Dawn P. and Ortiz, Rudy M. (2005) Plasma metabolites indicate variation in energy reserve utilization in fasting northern elephant seal pups. The FASEB Journal 19(4): A192 (Abstract 131.11).

Norris, Thomas; Hanson, Brad; **Noren, Dawn**; Jones, Linda (2004) Acoustic surveys of killer whales during winter along the Pacific Northwest coast. The Journal of the Acoustical Society of America 116: 2589.

Noren, Dawn P. (2003) Fasting capabilities of weaned juvenile Steller sea lions: Influence of body condition and daily foraging duration. 15th Biennial Conference on the Biology of Marine Mammals, the Society for Marine Mammalogy, 120.

Jones, Linda; Hanson, M. Bradley; **Noren, Dawn P.** (2003) Research on Southern Resident population of killer whales in the Pacific Northwest of the United States. 15th Biennial Conference on the Biology of Marine Mammals, the Society for Marine Mammalogy, 81.

Sherman, Rebecca A.; Pagarigan, Lauren; **Noren, Dawn P**.; Ortiz, C. Leo; Ortiz, Rudy M.; Talamantes, Frank. (2003). Reproductive hormone concentrations in fasting, postweaned northern elephant seal (Mirounga angustirostris) pups. 15th Biennial Conference on the Biology of Marine Mammals, the Society for Marine Mammalogy, 150.

Noren, D.P. (2003) Fasting capabilities in weaned juvenile Steller sea lions: Influence of body condition and activity. Marine Science in the northeast Pacific: Science for Resource Dependent Communities Pacific Joint Scientific Symposium.

Noren, D.P. (2003) Differential energy reserve utilization during the postweaning fast of northern elephant seals: Implications for the first year of life. Society for Integrative and Comparative Biology Annual Meeting and Exhibition, Phenotypic Plasticity Symposium, 261-262 (Abstract MS2.1).

Sherman, R.A.; Pagarigan, L.; **Noren, D.P.**; Ortiz, R.M.; Ortiz, C.L.; Talamantes, F. (2003) Reproductive hormoneconcentrations in fasting, postweaned northern elephant seal (Mirounga angustirostris) pups. Experimental Biology '03 Meeting, San Diego, CA, April 11-15.

Sherman, R.A.; Pagarigan, L.; **Noren, D.P.**; Ortiz, R.M.; Ortiz, C.L.; Talamantes, F. (2003) Reproductive hormoneconcentrations in fasting, postweaned northern elephant seal (Mirounga angustirostris) pups. Society for Integrative and Comparative Biology Annual Meeting and Exhibition, 302 (Abstract P2.129).

Noren, D.P.; Williams, T.M.; Crocker, D.E.; Costa, D.P. (2001) Energy reserve utilization in northern elephant seal pups during the postweaning fast: does size matter? 14th Biennial Conference on the Biology of Marine Mammals, the Society for Marine Mammalogy, 156-157.

Noren, D.P. and Williams, T.M. (2001) Effects of environmental regime and body condition on resting metabolic rates in northern elephant seal pups: does RMR measured in ambient air represent true RMR? Society for Integrative and Comparative Biology Annual Meeting and Exhibition, 321 (Abstract P1.66B).

Noren, D.P.; Williams, T.M.; Haun, J.E.; Pabst, D.A. (1999) The effect of exercise on heat flow from the extremities and thermoregulation of the intra-abdominal testes of the bottlenose dolphin (*Tursiops truncatus*). 13th Biennial Conference on the Biology of Marine Mammals, the Society for Marine Mammalogy, 135-136.

Noren, Dawn P. and Williams, Terrie M. (1996) Balancing thermoregulatory and exercise demands during diving in the Atlantic bottlenose dolphin, *Tursiops truncatus*. APS Intersociety Meeting, the Integrative Biology of Exercise, The Physiologist 39(5): A-28 (Abstract 10.17).

Invited Presentations, Last Five Years

3/05	American Cetacean Society, Puget Sound Chapter, *Marine Mammal Tricks: How are They Specialized to Live in the Marine Environment?*
9/04	US-Russia Marine Mammal Meeting, *Killer Whales of the Pacific Northwest, USA*
4/04	Highline Community College Marine Science and Technology (MaST), *Killer Whales of the Pacific Northwest.*
6/03	American Meterological Society's Series of Programs on Ocean and Fisheries Topics for Pre-College Teachers, *Marine Mammals: What Are They and How Do They Live in Their Environment?*
2/03	Northwest Fisheries Science Center, NMFS Seminar, *Bioenergetics of Cetaceans and Pinnipeds: Physiological Capacities and Responses to Environmental Pressures.*
10/02	National Marine Mammal Laboratory, NMFS Seminar, *Body Energy Reserve Utilization During the Postweaning Fast of Northern Elephant Seals (Mirounga angustirostris): Implications for Survival.*
11/99	Docent Training Seminar, Año Nuevo, California State Park, *Body Reserve Utilization Strategies During the Postweaning Fast of Northern Elephant Seals (Mirounga angustirostris): Implications for Survivorship.*

APPENDIX II : Literature Cited

Aguilar, A. and A. Borrell. 1994. Abnormally high polychlorinated biphenyl levels in striped dolphins (Stenella coeruleoalba) affected by the 1990-1992 Mediterranean epizootic. Sci. Total Environ 154(154): 237-247.

Angliss, R.P. and K.L. Lodge. 2004. Alaska Marine Mammal Stock Assessments, 2003. U.S. Dep. Commer., NOAA Tech.Memo. NMFS-AFSC-144, 108pp.

Bain, D. E. 2002. A model linking energetic effects of whale watching to killer whale (*Orcinus orca*) population dynamics. Friday Harbor Laboratories, University of Washington, Friday Harbor, Washington.

Baird, R.W. 1998. An interaction between Pacific white-sided dolphins and a neonatal harbor porpoise. Mammalia 62:129-134.

Baird, R.W. 2000. The killer whale - foraging specializations and group hunting. Pages 127-153 in Cetacean societies: field studies of dolphins and whales. Edited by J. Mann, R.C. Connor, P.L. Tyack and H. Whitehead.

Baird, R. W. 2001. Status of killer whales, *Orcinus orca*, in Canada. Canadian Field-Naturalist 15:676–701.

Baird, R.W., M.B. Hanson, and L.M. Dill. 2005. Factors influencing the diving behaviour of fish-eating killer whales: sex differences and diel and interannual variation in diving rates. Can. J. Zool. 83(2): 257-267.

Barrett-Lennard, L.G., T.G. Smith and G.M. Ellis. 1996. A cetacean biopsy system using lightweight pneumatic darts, and its effect on the behavior of killer whales. Marine Mammal Sci. 12 (1): 14-27.

Barrett- Lennard, L.G. 2000. Population structure and mating patterns of killer whales (*Orcinus orca*) as revealed by DNA analysis. Doctoral. University of British Columbia, Vancouver, British Columbia.

Bearzi, G. 2000. First report of a common dolphin (*Delphinus delphis*) death following penetration of a biopsy dart. *J. Cetacean Res. Manage.* 2(3): 217-221.

Benoit-Bird, K.J. and W.W.L. Au. 2003. Prey dynamics affect foraging by a pelagic predator (*Stenella longirostris)* over a range of spatial and temporal scales. Behav.Ecol. Sociobiol. 53:364-373.

Berrow, S. D., Whooley, P. and Ferriss, S. 2002. Irish Whale and Dolphin Group cetacean sighting review (1991-2001). Irish Whale & Dolphin Group. 34 pp.

Brown, M.W., Kraus, S.D. and Gaskin, D.E. 1991. Reaction of North Atlantic right whales (*Eubalaena glacialis*) to skin biopsy sampling for genetic and pollutant analysis. Rep. int. Whal. Commn, Special Issue 13:81-89.

Brown, M.W., Corkeron, P.J., Hale, P.T., Schultz, K.W. and Bryden, M.M. 1994. Behavioral responses of east Australian humpback whales *Megaptera novaeangliae* to biopsy sampling. *Mar. Mamm. Sci.* 10(4):391-400.

Candy, J. R., and T. P. Quinn. 1999. Behavior of adult Chinook salmon (*Oncorhynchus tshawytscha*) in British Columbia coastal waters determined from ultrasonic telemetry. Can. J. Zool. 77:1161–1169.

Carretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, and M.S. Lowry. 2005. U.S. Pacific Marine mammal Stock Assessments: 2004. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-TM-NMFS-SWFSC-375, 316p.

Chivers, S. J., K. Danil and A. E. Dizon. 2000. Projectile biopsy sampling of cetacean species. International Whaling Commission Scientific Committee paper SC/52/O 22, 7pp.
Clapham, P.J. and Mattila, D.K. 1993. Reactions of humpback whales to skin biopsy sampling on a West Indies breeding ground. *Mar. Mamm. Sci.* 9(4):382-391.
Cockcroft, V.G. 1994. Biopsy sampling from free-ranging bottlenose dolphins. pp. 32-33. *In:* G. Notarbartolo di Sciara, P.G.H. Evans and E.Politi (eds.) Methods for the study of bottlenose dolphins in the wild. European Cetacean Society Newsletter 23 (Special Issue).
Erbe, C. 2002. Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca)*, based on acoustic impact model. Mar.Mamm. Sci 18(2):394-418.
Ford, J.K.B., and G. M. Ellis. 2005. Prey selection and food sharing by fish-eating 'resident' killer whales (*Orcinus orca*) in British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. 2005/041.
Ford, J. K. B., G. M. Ellis, L. G. Barrett-Lennard, A. B. Morton, R. S. Palm and K. C. Balcomb III. 1998. Dietary specialization in two sympatric populations of killer whales (*Orcinus orca*) in coastal British Columbia and adjacent waters. Canadian Journal of Zoology 76:1456-1471.
Foote, A. D., R. W. Osborne and A. R. Hoelzel. 2004. Whale-call response to masking boat noise. Nature 428:910.
Fossi, M. C., L. Marsili, G. Neri, A. Natoli, E. Politi, and S. Panigada. 2003*a*. The use of a non-lethal tool for evaluating toxicological hazard of organochlorine contaminants in Mediterranean cetaceans: new data 10 years after the first paper published in MPB. Marine Pollution Bulletin 46:972-982.
Gauthier, J., and Sears, R. 1999. Behavioral response of four species of balaenopterid whales to biopsy sampling. *Mar. Mamm. Sci.* 15(1):85-101.
Gemmell, N. J. and P. Majluf. 1997. Projectile biopsy sampling of fur seals. Marine Mammal Science 13:512-516.
Geraci, J. R. and D. J. St. Aubin. 1982. Study of the effects of oil on cetaceans. Final report prepared for U. S. Department of the Interior, BLM Washington, DC, Contract #AA 551-CT9-29. 274 pp.
Goodyear, J. D. 1993. A sonic/radio tag for monitoring dive depths and underwater movements of whales. J. Wildl. Manage. 57: 503-513.
Gordon, J. and Moscrop, A. 1996. Underwater Noise Pollution and its significance for whales and dolphins. In: *The Conservation of whales and dolphins: Science and Practice.* Simmonds, M. P. and Hutchinson, J. D. (eds.): John Wiley and sons, Chichester.
Hansen, L. J., L. H. Schwacke, G. B. Mitchum, A. A. Hohn, R. S. Wells, E. S. Zolman and P. A. Fair. 2004. Geographic variation in polychlorinated biphenyl and organochlorine pesticide concentrations in the blubber of bottlenose dolphins form the US Atlantic coast. Science of the Total Environment 319:147-172.
Hanson, M.B. 2001. An evaluation of the relationship between small cetacean tag design and attachment durations: a bioengineering approach. Unpubl. Ph.D. dissertation, Univ. of Washington, Seattle, WA. 208 pp.
Hanson, M. B., and L.E.L. Rasmussen. In prep. Capturing killer whale breath: a novel method for health assessment in free-ranging marine mammals.
Harlin, A. D., B. Würsig, C. S. Baker and T. M. Markowitz. 1999. Skin swabbing for genetic analysis: application to dusky dolphins (Lagenorhynchus obscurus). Marine Mammal

Science 15:409-425.
Herman, D.P, Burrows, D.G., Wade, P.R., Durban, J.W. , Matkin, C.O., LeDuc, R.G., Barrett-Lennard, L.G. and M.M.Krahn. 2005. Feeding ecology of eastern North Pacific killer whales, *Orcinus orca,* from fatty acid, stable isotope and organochlorine analyses of blubber biopsies. Mar. Ecol. Prog. Ser. 302:275-291.
Hobbs, K. E., D. C. G. Muir, R. Michaud, P. Béland, R. J. Letcher and R. J. Norstrom. 2003. PCBs and organochlorine pesticides in blubber biopsies from free-ranging St. Lawrence River Estuary beluga whales (Delphinapterus leucas), 1994-1998. Environmental Pollution 122:291-302.
Hoelzel, A.R., A. Natoli, M.E. Dahlheim, C. Olavarria, R.W. Baird, and N.A. Black. 2002. Low worldwide genetic diversity in the killer whale (Orcinus orca): implications for demographic history. Proceedings of the Royal Society of London, Series B 269:1467-1473.
Hoelzel, A.R. 2004. Report on killer whale population genetics for the BRT review on the status of the Southern Resident population. Unpubl. report to BRT. (Available from L. Barre, NOAA Fisheries, NWR, 7600 Sand Point Way NE, Seattle, WA 98115
Hooker, S.K., and R.W. Baird. 2001. Diving and ranging behaviour of odontocetes: a methodological review and critique. Mammal Review 31:81-105
Hooker, S.K., Baird, R.W., Al-Omar, S., Gowans, S. and Whitehead, H. 2001. Behavioral reactions of northern bottlenose whales to biopsy and tagging procedures. Fish. Bull. US. International Whaling Commission. 1991. Report of the *ad-hoc* working group on the effect of biopsy sampling on individual cetaceans. *Rep. int. Whal. Commn,* Special Issue 13:23-27.
Iverson, S.J., C. Field, W.D. Bowen, and W. Blanchard. 2004. Quantitative fatty acid signature analysis: A new method of estimating predator diets. Ecol. Monogr. 74(2): 211-135

IWC. 1991. Report of the Scientific Committee. Rep Int. Whal. Commn. 41:51-219.
Jarman, W. M., R. J. Norstrom, D. C. G. Muir, B. Rosenberg, M. Simon, and R. W. Baird. 1996. Levels of organochlorine compounds, including PCDDS and PCDFS, in the blubber of cetaceans from the west coast of North America. Mar. ollut. Bull. 32:426-436.
Jahoda, M., Airoldi, S., Azzellino, A., Biassoni, N., Borsani, J.F., Cianfanelli, L., Lauriano, G., Notarbartolo di Sciara, G., Panigada, S., Vallini, C. and Zanardelli, M. 1996. Behavioural reactions to biopsy-darting on Mediterranean fin whales. *European Research on Cetaceans* 10:43-47.
Jelinski, D. E., C. C. Kreuger, and D. A. Duffus. 2002. Geostatistical analyses of interactions between killer whales (*Orcinus orca*) and recreational whale-watching boats. Applied Geography 22:393-411.
Kelly, J.F. 2000. Stable isotopes of carbon and nitrogen in the study of avian and mammalian trophic ecology. Can. J. Zool. 78(1): 1-27.
Krahn, M.M., D.G. Burrows, J.E. Stein, P.R. Becker, M.M. Schantz, D.C.G. Muir, T.M. O'Hara, and T. Rowles. 1999. White whales (Delphinapterus leucas) from three Alaskan stocks—concentrations and patterns of persistent organochlorine contaminants in blubber. Journal of Cetacean Research and Management, 1(3): 239-249.
Krahn, M.M., et al. 2002 Status Review of Southern Resident killer whales (*Orcinus orca*) under the Endangered Species Act U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-54, 133p.

Krahn, M.MFord, M.J. Perrin, W.F., Wade, P.R., Angliss, R.P., Hanson, M.B., Taylor, B.L., Ylitalo, G.M, Dahlheim, M.E., Stein, J.W. and Waples, R.S. 2004. 2004 Status Review of Southern Resident Killer Whales (Orcinus orca) under the Endangered Sjpecies Act. NOAA Technical Memorandum NMFS-NWFSC-62. 73 pp

Krahn, M.M., D.P. Herman, D.G. Burrows, P.R. Wade, J.W. Durban, M. Dahlheim, R.G. LeDuc, L.G. Barrett-Lennard, and C.O. Matkin. 2005. Use of chemical profiles in assessing the feeding ecology of eastern North Pacific killer whales. Paper presented by Margaret Krahn to the International Whaling Scientific Committee, May 2005, Ulsan, Korea.

Krützen, M., L. M. Barré, L. M. Möller, M. R. Heithaus, C. Simms, and W. B. Sherwin. 2002. A biopsy system for small cetaceans: darting success and wound healing in Tursiops Spp. Marine Mammal Science 18:863-878.

Lambertsen, R.H. 1987. Biopsy system for large whales and its use for cytogenetics. J. Mammal. 68: 443-445.

Lange, W. D. Wright, D. Wiley, and D. Hartley. 2003 High definition imaging techniques for marine mammal research. Abstract, 13th Biennial Conference on the Biology of Marine Mammals, Greensboro NC, 13-19 December 2003.

Lusseau, D. 2003. Male and female bottlenose dolphins *Tursiops* spp. have different strategies to avoid interactions with tour boats in Doubtful Sound, New Zealand. Marine Ecology Progress Series. 257:267-274.

Marsili, L. and S. Focardi. 1996. Organochlorine levels in subcutaneous blubber biopsies of fin whales (Balaenoptera physalus) and striped dolphins (Stenella coeruleoalba) from the Mediterranean Sea. Environmental Pollution 91:1-9.

Mate, B. R., and J. T. Harvey. 1983. A new attachment device for radio-tagging large whales. J. Wildl. Manage. 47:868-872.

Mate, B. R., R. Gisiner, and J. Mobley. 1998. Local and migratory movements of Hawaiian humpback whales tracked by satellite telemetry. Can. J. Zool. 76:863-868.

Mate, B.R., B.A. Lagerquist, and J. Calambokidis. 1999. The movements of North Pacific blue whales off Southern California and their southern fall migration. Marine Mammal Science. 15(4):1246-1257.

Mate, B.R., G.K. Krutzikowsky, and M.H. Winsor. 2000. Satellite-monitored movements of radio-tagged bowhead whales in the Beaufort and Chukchi seas during the late-summer feeding season and fall migration. Canadian Journal of Zoology. 78:1168-1181

Mathews, E. A. 1986. Multiple use skin biopsies collected from free-ranging gray whales (Eschrichtius robustus): sex chromatin analysis, collection and processing for cell culture, microbiological analysis of associated organisms, behavioral responses of whales to biopsying, and future prospects for using biopsies in genetic and biochemical studies. M.S. thesis, University of California at Santa Cruz, 118p.

Medway, W. 1983. Evaluation of the safety and usefulness of techniques and equipment used to obtain biopsies from free-swimming cetaceans. Report MMC-82/01 to the U.S. Marine Mammal Commission p. 14.

Möller, L. M. and L. B. Beheregaray. 2001. Coastal bottlenose dolphins from southeastern Australia are Tursiops aduncus according to sequences of the mitochondrial DNA control region. Marine Mammal Science 17:249-263.

Moore, M.J., Miller, C.A., Morss, M.S., Arthur, R., Lange, W.A., Prada, K.G., Marx, M.K., and Frey, E.A. 2001. Ultrasonic measurement of blubber thickness in right whales. Journal of Cetacean Research and Management. 2:301-309.

Muir, D.C.G., C.A. Ford, B. Rosenberg, R.J. Norstrom, M. Simon, and P. Beland. 1996. Persistent organochlorines in beluga whales (Delphinapterus leucas) from the St. Lawrence River Estuary—I. Concentrations and patterns of specific PCBs, chlorinated pesticides and polychlorinated dibenzo-p-dioxins and dibenzofurans. Environmental Pollution, 93: 219-34.

Ng, S.L and S. Leung. 2003. Behavioral response of Indo-Pacific humpback dolphin (*Sousa chinensis*) to vessel traffic. Marine Environmental Research. 56:555-567.

National Marine Fisheries Service. 2005. Proposed Conservation Plan for Southern Resident Killer Whales (Orcinus orca). National Marine Fisheries Service, Northwest Region, Seattle, Washington. 183pp

Nichol, L.M. and D.M. Shackleton. 1996. Seasonal movements and foraging behavior of northern resident killer whales (*Orcinus orca*) in relation to the inshore distribution of salmon (*Oncorhynchus spp.*) in British Columbia. Canadian Journal of Zoology 74: 983-991.

Noren, D.P., J.A. Mocklin, L. Jones. in prep. A Review of Biopsy Techniques: Information Gained and the Behavioral and Physiological Effects of Biopsying Marine Mammals

Nottestad, L. and B.E. Axelsen. 1999. Herring schooling manoeuvres in response to killer whale attacks. Can. J. Zool. 77:1540-1546.

Nowacek, S.M., Wells, R.S., and A.R. Solow. 2001. Short-term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. Marine Mammal Science. 17:673-688.

NRC. 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. Committee on Characterizing Biologically Significant Marine Mammal Behavior, National Research Council. ISBN: 0-309-09449-6, 142 pages.

Olson. A.F. and T.P. Quinn. 1993. Vertical and horizontal movements of adult chinook salmon, *Oncorhynchus tshawytscha*, in the Columbia River. Fish. Bull. 91:171-178.

Osborne, R. W. 1999. A historical ecology of Salish Sea "resident" killer whales (*Orcinus orca*), with implications for management. Ph.D. thesis. University of Victoria, B.C., Canada.

Osborne, R., K. Koski, and R. Otis. 2002. Trends in whale watching traffic around Southern Resident killer whales. The Whale Museum, Friday Harbor, Washington.

Palsbøll, P. J., F. Larsen and E. S. Hansen. 1991. Sampling of skin biopsies from free-ranging large cetaceans in west Greenland: Development of new biopsy tips and bolt designs. Report of the International Whaling Commission (Special Issue 13):71-79.

Parsons, K.M., J.W. Durban and D.E. Claridge. 2003. Comparing two alternative methods for sampling small cetaceans for molecular analysis. Marine Mammal Science 19(1): 224-231. (has an "a" after year in text)

Patenaude, N. J. and B. N. White. 1995. Skin biopsy sampling of beluga whale carcasses: Assessment of biopsy darting factors for minimal wounding and effective sample retrieval. Marine Mammal Science 11:163-171.

Philbrick, V. A., P. C. Fiedler, L. T. Ballance, and D. A. Demer. 2003. Report of ecosystem studies conducted during the 2001 Oregon, California, and Washington (ORCAWALE) marine mammal survey on the research vessels *David Starr Jordan* and *McArthur*. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-349, 50 p. NTIS No. PB2003-103526.

Quinn, T. P., and B. A. terHart. 1987. Movements of adult sockeye salmon (*Oncorhynchus nerka*) in British Columbia coastal waters in relation to temperature and salinity stratification: Ultrasonic telemetry results. Can. Spec. Publ. Fish. Aquat. Sci. 96:61-77.

Quinn, T. P., B. A. terHart, and C. Groot. 1989. Migratory orientation and vertical movements of homing adult sockeye salmon, *Oncorhynchus nerka*, in coastal waters. Animal Behaviour. 37:587-599.

Rasmussen, L.E.L. and Riddle, H.S. (2004) Elephant Breath: Clues about health, metabolism and social signals JEMA 15:24-33.

Rayne, S., I. Mikonomou , P. Ross , G.M . Ellis, and L.G. Barrett - Lennard. 2004. PBDEs, PBBs, and PCNs in Three Communities of Free-Ranging Killer Whales (Orcinus orca) from the Northeastern Pacific Ocean. Environ. Sci. Technol. 38:4293-4299.

Richardson, W.J., C.R. Greene, Jr.,, C.I. Malme and D.H.Thomson. 1995. Marine Mammal and Noise. Academic Press. 576 pp.

Rolland, R. M., Hunt, K. E., Kraus, S. D., and Wasser, S. K. in press. Assessing reproductive status of right whales (Eubalaena glacialis) using fecal hormone metabolites. General and Comparative Endocrinology.

Ross, P.S., G.M. Ellis, M.G. Ikonomou, L.G. Barrett-Lennard, and R.F. Addison. 2000. High PCB concentrations in free-ranging Pacific killer whales, Orcinus orca: effects of age, sex, and dietary preference. Marine Pollution Bulletin 40:504-515.

Ruggerone, G. T., T. P. Quinn, I. A. McGregor, and T. D. Wilkenson. 1990. Horizontal and vertical movements of adult steelhead trout, *Oncorhynchus mykiss*, in the Dean and Fisher Channels, British Columbia. Can. J. Fish. Aquat. Sci. 47:1963-1969.

Stasko, A.B., R.M. Horrall, and A.D. Hasler. 1976. Coastal movements of adult Fraser River sockeye salmon (Oncorhynchus nerka) observed by ultrasonic tracking. Trans. Am. Fish. Soc. 105: 64-71.

Swartz, S.L. M.L. Jones, J. Goodyear, D.E. Withrow, and R.V. Miller. 1987. Radio-telemetric studies of gray whale migration along the California coast: a preliminary comparison of day and night migration rates. Rep Int Whal Comm 37: 295-299.

Tynan, C.T., D.G. Ainley, J.A. Barth, T.J. Cowles, S.D. Pierce, L.B. Spear. 2005 (in press). Cetacean distributions relative to ocean processes in the northern California Current System. Deep Sea Research. 52:145-167.

Watkins, W.A. 1981. Reaction of three species of whales *Balaenoptera physalus, Megaptera novaeangliae*, and *Balaenoptera edeni* to implanted radio tags.

Weinrich, M.T., Lambertsen, R.H., Baker, C.S., Schilling, M.R. and Belt, C.R. 1991. Behavioral responses of humpback whales (*Megaptera novaeangliae*) in the Southern Gulf of Maine to biopsy sampling. *Rep. int. Whal. Commn*, Special Issue 13:81-89.

Weinrich, M.T, Lambertsen, R.H., Belt, C.R., Schilling, M.R., Iken, J.H. and Syrjala, S.E. 1992. Behavioral responses of humpback whales (*Megaptera novaeangliae*) to biopsy procedures. Fish. Bull. 90: 588-598.

Weisbrod, A. V., D. Shea, M. J. Moore and J. J. Stegeman. 2000a. Organochlorine exposure and bioaccumulation in the endangered Northwest Atlantic right whale (Eubalaena glacialis) population. Environmental Toxicology and. Chemistry 19:654-666.

Weller, D.W., Cockcroft, V.G., Würsig, B., Lynn, S.K. and Fertl, D. 1997. Behavioral responses of bottlenose dolphins to remote biopsy sampling and observations of surgical biopsy wound healing. *Aquat. Mammal.* 23:49-58.

Whitehead, H., J. Gordon, E. A. Matthews and K. R. Richard. 1990. Obtaining skin samples

from living sperm whales. Marine Mammal Science 6:316-326.
Wiles, G. J. 2004. Washington State status report for the killer whale. Washington Dept. Fish and Wildlife.
Williams, R., Trites, A.W., and D.E. Bain. 2002a. Behavioural responses of killer whales (*Orcinus orca*) to whale-watching boats: opportunistic observations and experimental approaches. J. Zool. Lond. 256:255-270.
Williams, R., D. E. Bain, J. K. B. Ford, and A. W. Trites. 2002b. Behavioural responses of male killer whales to a 'leapfrogging' vessel. J. Cetacean Res. Manage. 4:305–10.
Woodley, T. H., M. W. Brown, S. D. Kraus and D. E. Gaskin. 1991. Organochlorine levels in North Atlantic right whale (Eubalaena glacialis) blubber. Archives of Environmental Contamination and Toxicology 21:141-145.
Ylitalo G.M., C.O Matkin, J. Buzitis, M.M Krahn, L.L. Jones, T. Rowles, and J.E. Stein. 2001. Influence of life-history parameters on organochlorine concentrations in free-ranging killer whales (Orcinus orca) from Prince William Sound, AK. Science of the Total Environment 281: 183-203.
Zolman, E., L. Hansen and J. Geiges. 2001. Behavioral responses of Atlantic bottlenose dolphins (Tursiops truncatus) to remote biopsy sampling. Abstract in 14th Biennial Conference on the Biology of Marine Mammals, Vancouver, BC, Canada, Nov. 26-Dec. 4, 2001.

Species	Location of take	Level B harassment: aerial and vessel surveys, photo-id, photogrammetry, incidental harassment, focal follows, collection of prey and fecal material	Biopsy	Breath Samples	Ultrasound--Year 1	Ultrasound--Beginning Year 2	Implantable Tags	Suction Cup Tags	Worldwide import, export, re-export and/or salvage of biological samples, specimens, and parts
Minke whale (*Balaenoptera acutorostrata*)	Pacific Ocean (U.S. EEZ and International waters)	90	10	0	0	0	10	0	10
Blue whale (*Balaenoptera musculus*)	Pacific Ocean (U.S. EEZ and International waters)	60	10	0	0	0	15	0	5
Fin whale (*Balaenoptera physalus*)	Pacific Ocean (U.S. EEZ and International waters)	35	10	0	0	0	10	0	5
Baird's beaked whale (*Berardius bairdii*)	Pacific Ocean (U.S. EEZ and International waters)	45	5	0	0	0	5	5	5
Short-beaked common dolphins (*Delphinus delphis*)	Pacific Ocean (U.S. EEZ and International waters)	40	10	0	0	0	0	0	5
Gray whale (*Eschrichtius robustus*)	Pacific Ocean (U.S. EEZ)	90	5	5	0	5	15	0	20
Short-finned pilot whale (*Globicephala macrorhynchus*)	Pacific Ocean (U.S. EEZ and International waters)	45	10	5	0	0	20	0	5
Risso's dolphin (*Grampus griseus*)	Pacific Ocean (U.S. EEZ and International waters)	45	10	0	0	0	0	0	5
Pygmy sperm whale (*Kogia breviceps*)	Pacific Ocean (U.S. EEZ and International waters)	45	10	0	0	0	0	0	5

Species	Location of take	Level B harassment: aerial and vessel surveys, photo-id, photogrammetry, incidental harassment, focal follows, collection of prey and fecal material	Biopsy	Breath Samples	Ultrasound--Year 1	Ultrasound--Beginning Year 2	Implantable Tags	Suction Cup Tags	Worldwide import, export, re-export and/or salvage of biological samples, specimens, and parts
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)	Pacific Ocean (U.S. EEZ and International waters)	405	50	5	0	0	0	5	10
Northern right whale dolphin (*Lissodelphis borealis*)	Pacific Ocean (U.S. EEZ and International waters)	405	50	5	0	0	0	5	10
Humpback whale (*Megaptera novaeangliae*)	Pacific Ocean (U.S. EEZ and International waters)	340	25	10	0	5	20	0	5
Mesoplodon beaked whales (*Mesoplodon* spp.)	Pacific Ocean (U.S. EEZ and International waters)	90	10	0	0	0	0	0	10
Harbor porpoise (*Phocoena phocoena*)	Pacific Ocean (U.S. EEZ and International waters)	270	50	0	0	0	0	12	10
Dall's porpoise (*Phocoenoides dalli*)	Pacific Ocean (U.S. EEZ and International waters)	350	50	10	0	0	0	12	10
Sperm whale (*Physeter macrocephalus*)	Pacific Ocean (U.S. EEZ and International waters)	180	20	0	0	0	10	0	10
Striped dolphin (*Stenella coeruleoalba*)	Pacific Ocean (U.S. EEZ and International waters)	620	20	0	0	0	0	0	10

Species	Location of take	Level B harassment: aerial and vessel surveys, photo-id, photogrammetry, incidental harassment, focal follows, collection of prey and fecal material	Biopsy	Breath Samples	Ultrasound--Year 1	Ultrasound--Beginning Year 2	Implantable Tags	Suction Cup Tags	Worldwide import, export, re-export and/or salvage of biological samples, specimens, and parts
Cuvier's beaked whale (*Ziphius cavirostris*)	Pacific Ocean (U.S. EEZ and International waters)	130	10	0	0	0	0	0	10
Killer Whale (*Orcinus orca*) offshore	Pacific Ocean (U.S. EEZ and International waters)	135	25	5	0	0	12	0	10
Killer Whale (Transients)	Pacific Ocean (U.S. EEZ and International waters)	275	50	10	0	0	30	0	10
Killer Wlale (AK resident)	Pacific Ocean (U.S. EEZ and International waters)	120	10	20	10	25	15	0	10
Southern Resident	Pacific Ocean (U.S. EEZ and International waters)	515	25	5	0	0	0	10	30