U.S. PACIFIC DRAFT MARINE MAMMAL STOCK ASSESSMENTS: 2016

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Stock assessment reports and appendices revised in 2016 are highlighted; all others will be reprinted as they appear in the 2015 Pacific Region Stock Assessment Reports (Carretta *et al.* 2016c).

PINNIPEDS

CALIFORNIA SEA LION (*Zalophus californianus californianus*): U.S. Stock x
HARBOR SEAL (*Phoca vitulina richardii*): California Stock x
HARBOR SEAL (*Phoca vitulina richardii*): Oregon & Washington Coast Stock x
HARBOR SEAL (*Phoca vitulina richardii*): Washington Inland Waters Stocks (Hood Canal, Southern Puget Sound, and Northern Washington Inland Waters) x
NORTHERN ELEPHANT SEAL (*Mirounga angustirostris*): California Breeding Stock x
GUADALUPE FUR SEAL (*Arctocephalus townsendi*) 1
NORTHERN FUR SEAL (*Callorhinus ursinus*): California Stock x
HAWAIIAN MONK SEAL (*Neomonachus schauinslandi*) 7

CETACEANS - U.S. WEST COAST

HARBOR PORPOISE (*Phocoena phocoena vomerina*): Morro Bay Stock x
HARBOR PORPOISE (*Phocoena phocoena vomerina*): Monterey Bay Stock x
HARBOR PORPOISE (*Phocoena phocoena vomerina*): San Francisco-Russian River Stock x
HARBOR PORPOISE (*Phocoena phocoena vomerina*): Northern California/Southern Oregon Stock x
HARBOR PORPOISE (*Phocoena phocoena vomerina*): Northern Oregon/Washington Coast Stock x
HARBOR PORPOISE (*Phocoena phocoena vomerina*): Washington Inland Waters Stock 16
DALL'S PORPOISE (*Phocoenoides dalli dalli*): California/Oregon/Washington Stock 25
PACIFIC WHITE-SIDED DOLPHIN (*Lagenorhynchus obliquidens*): California/Oregon/Washington, Northern and Southern Stocks 30
RISSO'S DOLPHIN (*Grampus griseus*): California/Oregon/Washington Stock 36
COMMON BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): California Coastal Stock 41
COMMON BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): California/Oregon/Washington Offshore Stock 47
STRIPED DOLPHIN (*Stenella coeruleoalba*): California/Oregon/Washington Stock 52
SHORT-BEAKED COMMON DOLPHIN (*Delphinus delphis delphis*): California/Oregon/Washington Stock 57
LONG-BEAKED COMMON DOLPHIN (Delphinus capensis capensis): California Stock 64
NORTHERN RIGHT-WHALE DOLPHIN (*Lissodelphis borealis*): California/Oregon/Washington 70
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Offshore Stock x
KILLER WHALE (*Orcinus orca*): Eastern North Pacific Southern Resident Stock 75
SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): California/Oregon/Washington 82
BAIRD'S BEAKED WHALE (*Berardius bairdii*): California/Oregon/Washington Stock x
MESOPLODONT BEAKED WHALES (*Mesoplodon* spp.): California/Oregon/Washington Stocks x
CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): California/Oregon/Washington Stock x
PYGMY SPERM WHALE (*Kogia breviceps*): California/Oregon/Washington Stock 88
DWARF SPERM WHALE (*Kogia sima*): California/Oregon/Washington Stock 93
SPERM WHALE (*Physeter macrocephalus*): California/Oregon/Washington Stock x
GRAY WHALE (*Eschrichtius robustus*): Eastern North Pacific Stock and Pacific Coast Feeding Group x
GRAY WHALE (*Eschrichtius robustus*): Western North Pacific Stock x
HUMPBACK WHALE (*Megaptera novaeangliae*): California/Oregon/Washington Stock 98
BLUE WHALE (*Balaenoptera musculus musculus*): Eastern North Pacific Stock x
FIN WHALE (*Balaenoptera physalus physalus*): California/Oregon/Washington Stock 107
SEI WHALE (*Balaenoptera borealis borealis*): Eastern North Pacific Stock 114
MINKE WHALE (*Balaenoptera acutorostrata scammoni*): California/Oregon/Washington 119
BRYDE'S WHALE (*Balaenoptera edeni*): Eastern Tropical Pacific x

CETACEANS – HAWAII & WESTERN PACIFIC

ROUGH-TOOTHED DOLPHIN (*Steno bredanensis*): Hawaii Stock x
ROUGH-TOOTHED DOLPHIN (*Steno bredanensis*): American Samoa Stock x

RISSO'S DOLPHIN (*Grampus griseus*): Hawaii Stock x
COMMON BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): Hawaiian Islands Stock Complex (Kauai / Niihau, Oahu, 4-Island, Hawaii Island, and Hawaii Pelagic Stocks x
PANTROPICAL SPOTTED DOLPHIN (*Stenella attenuata attenuata*): Hawaiian Pelagic, Hawaii Island, Oahu, 4 Islands Stocks x
SPINNER DOLPHIN (*Stenella longirostris longirostris*): Hawaii Pelagic, Hawaii Island, Oahu / 4 Islands, Kauai / Niihau, Kure / Midway, and Pearl and Hermes Reef Stocks x
SPINNER DOLPHIN (*Stenella longirostris longirostris*): American Samoa Stock x
STRIPED DOLPHIN (*Stenella coeruleoalba*): Hawaii Stock x
FRASER'S DOLPHIN (*Lagenodelphis hosei*): Hawaii Stock x
MELON-HEADED WHALE (*Peponocephala electra*): Hawaiian Islands and Kohala Resident Stocks x
PYGMY KILLER WHALE (*Feresa attenuata*): Hawaiian Stock x
FALSE KILLER WHALE (*Pseudorca crassidens*): Hawaiian Islands Stock Complex_Main Hawaiian Islands Insular, Northwestern Hawaiian Islands, and Hawaii Pelagic 125
FALSE KILLER WHALE (*Pseudorca crassidens*): Palmyra Atoll Stock x
FALSE KILLER WHALE (*Pseudorca crassidens*): American Samoa Stock x
KILLER WHALE (*Orcinus orca*): Hawaiian Stock x
SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Hawaii Stock x
BLAINVILLE'S BEAKED WHALE (*Mesoplodon densirostris*): Hawaii Stock x
CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Hawaii Stock x
LONGMAN'S BEAKED WHALE (*Indopacetus pacificus*): Hawaii Stock x
PYGMY SPERM WHALE (*Kogia breviceps*): Hawaii Stock x
DWARF SPERM WHALE (*Kogia sima*): Hawaii Stock x
SPERM WHALE (*Physeter macrocephalus*): Hawaii Stock x
BLUE WHALE (*Balaenoptera musculus musculus*): Central North Pacific Stock x
FIN WHALE (*Balaenoptera physalus physalus*): Hawaii Stock x
BRYDE'S WHALE (*Balaenoptera edeni*): Hawaii Stock x
SEI WHALE (*Balaenoptera borealis borealis*): Hawaii Stock x
MINKE WHALE (*Balaenoptera acutorostrata scammoni*): Hawaii Stock x
HUMPBACK WHALE (*Megaptera novaeangliae)*: American Samoa Stock x

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PREFACE

Under the 1994 amendments to the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) are required to publish Stock Assessment Reports for all stocks of marine mammals within U.S. waters, to review new information every year for strategic stocks and every three years for non-strategic stocks, and to update the stock assessment reports when significant new information becomes available.

Pacific region stock assessments include those studied by the Southwest Fisheries Science Center (SWFSC, La Jolla, CA), the Pacific Islands Fisheries Science Center (PIFSC, Honolulu, HI), the National Marine Mammal Laboratory (NMML, Seattle, WA), and the Northwest Fisheries Science Center (NWFSC, Seattle, WA). The 2016 Pacific marine mammal stock assessments include revised reports for 23 Pacific marine mammal stocks under NMFS jurisdiction, including eight "strategic" stocks: Hawaiian monk seal, Guadalupe fur seal, Southern Resident killer whale, California/Oregon/Washington humpback whale, California/Oregon/Washington fin whale, Eastern North Pacific sei whale, Main Hawaiian Islands Insular false killer whale, and Hawaii Pelagic false killer whale. New abundance estimates are available for 16 U.S. west coast stocks (Guadalupe fur seal, Washington Inland Waters harbor porpoise, California/Oregon/Washington stocks of Dall's porpoise, Pacific white-sided dolphin, Risso's dolphin, coastal and offshore stocks of common bottlenose dolphin, striped dolphin, short- and long-beaked common dolphin, northern right whale dolphin, short-finned pilot whale, pygmy sperm whale, fin whale, Eastern North Pacific sei whale and Southern Resident killer whales. New information on fishery-related serious injury and mortality has been updated for those stocks where possible. Updated estimates of stock abundance are also available for the Hawaiian monk seal.

New abundance estimates for several species along the U.S. west coast are considerably higher than previous estimates (Barlow 2016). This is attributed to two factors: 1) estimates of the trackline detection probability, *g(0)* are lower than in previous surveys, because new Beaufort sea state-specific estimates of *g(0)* have been calculated that better reflect differing probabilities of detection with increasing wind and swell (Barlow 2015); and 2) warm-temperate species such as short-beaked common dolphin, long-beaked common dolphin, and striped dolphin were encountered more frequently during a 2014 line-transect survey compared to previous years, due to anomalous warm-water conditions in the California Current (Barlow 2016, Cavole *et al*. 2016).

Human-caused mortality and injury documentation is often based on stranding data, where raw counts are negatively-biased because only a fraction of carcasses are detected (Williams *et al*. 2011), even for extremely coastal species (Wells *et al*. 2015) . Carretta *et al*. (2016a) estimated that only 25% of California coastal bottlenose dolphin carcasses are recovered / documented, and given the extremely coastal habits of the population, Carretta *et al*. (2016a) argue that carcass recovery rates for this population represent a maximum rate, compared to more pelagic dolphin and porpoise species in the region. Therefore, for U.S. west coast stock assessment reports involving dolphins and porpoises, human-related deaths and injuries counted from mainland beach strandings are multiplied by a factor of 4 to account for the non-detection of most carcasses. Species / stocks for which the stranding correction factor has been applied include: California coastal bottlenose dolphin, Washington Inland waters harbor porpoise, Risso's dolphin, striped dolphin, and short-beaked and long-beaked common dolphin. This carcass recovery correction factor has not been applied to large whale serious injuries and mortalities, because the method of detection for most large whale entanglement and vessel strike cases are opportunistic offshore sightings, and it is currently unknown what fraction of injured or dead large whales are detected at sea or ashore.

New estimates of human-caused mortality and serious injury are included for U.S. west coast stocks that interact with the California swordfish drift gillnet fishery (Carretta *et al*. 2016b). Estimates are model-based and are based on inclusion of 25 years of bycatch data, in contrast to previous ratio estimates of bycatch that relied on within-year data only (Carretta *et al*. 2014). The main effects of implementing model-based bycatch estimation are that resulting estimates are less volatile inter-annually, have better precision, and are less prone to biases associated with rare bycatch events and low observer coverage (Carretta and Moore 2014). Model-based estimates also result in positive estimates of bycatch even in years when no bycatch of a particular species is recorded by fishery observers.

This is a working document and individual stock assessment reports will be updated as new information on marine mammal stocks and fisheries becomes available. Background information and guidelines for preparing stock assessment reports are reviewed in Wade and Angliss (1997). The authors solicit any new information or comments which would improve future stock assessment reports.

Draft versions of the 2016 stock assessment reports were reviewed by the Pacific Scientific Review Group at the February 2016 meeting.

These Stock Assessment Reports summarize information from a wide range of original data sources and an extensive bibliography of all sources is given in each report. We recommend users of this

document refer to and cite *original* literature sources cited within the stock assessment reports rather than citing this report or previous Stock Assessment Reports.

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Revised ~~12/15/2000~~ 8/12/2016

GUADALUPE FUR SEAL (*Arctocephalus townsendi*)

STOCK DEFINITION AND GEOGRAPHIC RANGE

Commercial sealing during the 19th century reduced the once abundant Guadalupe fur seal to near extinction in 1894 (Townsend 1931). Prior to the harvest it ranged from Monterey Bay, California, to the Revillagigedo Islands, Mexico (~~Fleischer 1987,~~ Hanni *et al*. 1997, Repenning *et al.* 1971; Figure 1). The prehistoric distribution of Guadalupe fur seals during the Holocene was apparently quite different from today, as the archeological record indicates Guadalupe fur seal remains accounted for 40%-80% of all pinniped bones at the California Channel Islands (Rick *et al*. 2009). —The live capture of two adult males (and killing of ~ 60 more animals) at Guadalupe Island in 1928 established the ~~specie's~~ continued existence of the species (~~Wedgeforth 1928~~, Townsend 1931)~~; however, they were not seen again until 1954 (Hubbs 1956)~~. Guadalupe fur seals pup and breed mainly at Isla Guadalupe, Mexico. In 1997, a second rookery was discovered at Isla Benito del Este, Baja California (Maravilla-Chavez and Lowry 1999) and a pup was born at San Miguel Island, California (Melin and DeLong 1999). Since 2008, individual adult females, subadult males, and between one and three pups have been observed annually on San Miguel Island (NMFS, unpublished data). The population at Isla Benito del Este is now well-established, though very few pups are observed there. Population increases at Isla San Benito are attributed to immigration of animals from Isla Guadalupe (Aurioles-Gamboa *et al.* 2010, García-Capitanachi 2011). Along the U.S. west coast, strandings occur almost annually in California waters and animals are increasingly observed in Oregon and Washington waters. In 2015, stranding rates of Guadalupe fur seals along the entire coast of California were 8 times the historical average, and NMFS declared an unusual mortality event[1]. Most strandings involved animals less than 2 years old with evidence of malnutrition. Individuals have stranded or been sighted ~~as far north as Blind Beach, California (38º 26' 10" N, 123º 07' 20" W);~~ inside the Gulf of California and as far south as Zihuatanejo, Mexico (~~17º 39' N, 101º 34'W;~~ Hanni et al. 1997 and Aurioles-Gamboa and Hernadez-Camacho 1999) and another in 2012, at Cerro Hermoso, Oaxaca, Mexico (Esperon-Rodriguez and Gallo-Reynoso 2012). Recent video records of pinnipeds hooked in the mouth from international waters west of the California Current involving the shallow set Hawaii longline fishery were independently reviewed by pinniped experts and at least one animal in early 2016 was identified as a Guadalupe fur seal. Guadalupe fur seals that stranded in central California and treated at rehabilitation centers were fitted with satellite tags and documented to travel as far north as Graham Island and Vancouver Island, British Columbia, Canada (Norris *et al.* 2015). Some satellite-tagged animals traveled far offshore outside the U.S. EEZ to areas 700 nmi west of the California / Oregon border. The population is considered to be a single stock because all are recent descendants from one breeding colony at Isla Guadalupe, Mexico.

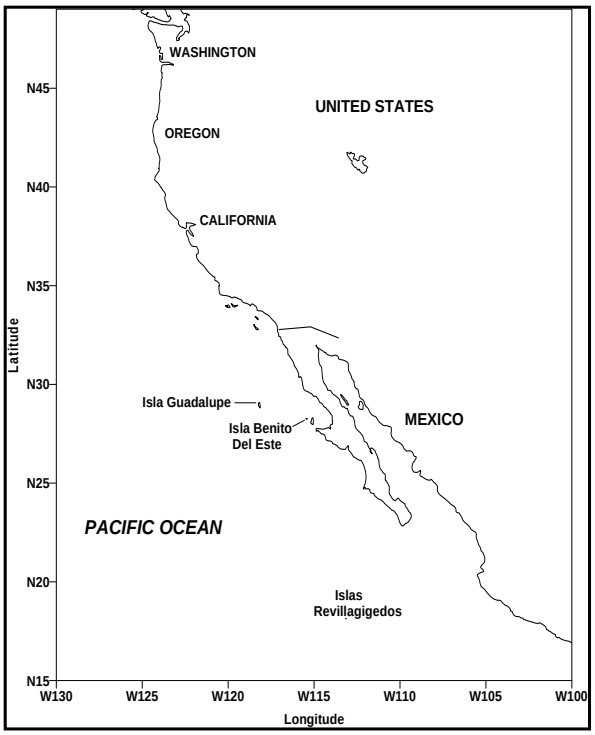

Figure 1. Geographic range of the Guadalupe fur seal, showing location of two rookeries at Isla Guadalupe and Isla Benito Del Este.

POPULATION SIZE

[1] http://www.nmfs.noaa.gov/pr/health/mmume/guadalupefurseals2015.html

The size of the population prior to the commercial harvests of the 19th century is not known, but estimates range from 20,000 to 100,000 animals (~~Wedgeforth 1928, Hubbs 1956,~~ Fleischer 1987). ~~The population was estimated by Gallo (1994) to be about 7,408 animals in 1993. The population estimate was derived by multiplying the number of pups (counted and estimated) by a factor of 4.0.~~ Surveys conducted between 2008 and 2010 resulted in a total estimated population size of approximately 20,000 animals, with ~17,500 at Isla Guadalupe and ~2,500 at Isla San Benito (García-Capitanachi 2011, ~~–~~Aurioles-Gamboa 2015). These estimates are corrected for animals not seen during the surveys.

Minimum Population Estimate

All the individuals of the population cannot be counted because all age and sex classes are never ashore at the same time and some individuals that are on land are not visible during the census. ~~Sub-sampling portions of the rookery indicate that only 47-55% of the seals present (i.e., hauled out) are counted during the census (Gallo 1994). The 1993 count of all age classes plus the estimate of missed animals was 6,443 (Gallo 1994). The minimum size of the population in Mexico can be estimated as the actual count of 3,028 hauled out seals [The actual count data were not reported by Gallo (1994); this number is derived by multiplying the estimated number hauled out by 47%, the minimum estimate of the percent counted]. In the United States, a few Guadalupe fur seals are known to inhabit California sea lion rookeries in the Channel Islands (Stewart et al. 1987).~~ Direct counts of animals at Isla Guadalupe and Isla San Benito during 2010 resulted in a minimum of 13,327 animals ~~at Isla Guadlupe~~ and 2,503 animals respectively ~~at Isla San Benito~~, for a minimum population size of 15,830 animals (García-Capitanachi 2011).

Current Population Trend

Counts of Guadalupe fur seals have been made sporadically since 1954. Records of Guadalupe fur seal counts through 1984 were compiled by Seagars (1984), Fleischer (1987), and Gallo (1994). The count for 1988 was taken from Torres et al. (1990). More recent counts from 1977-2010 are summarized in García-Capitanachi (2011). ~~A few of these counts were made during the breeding season, but the majority were made at other times of the year (Figure 1).~~ Also, the counts that are documented in the literature generally provide only the total of all Guadalupe fur seals counted (i.e., the counts are not separated by age/sex class). The counts that were made during the breeding season, when the maximum number of animals are present at the rookery, were used to examine population growth (Gallo 1994, García-Capitanachi 2011). The natural logarithm of the counts was regressed against year to calculate the growth rate of the population. These data indicate that~~ the population of~~ Guadalupe fur seals are ~~is~~ increasing ~~exponentially~~ at an average annual growth rate of ~~13.7~~10.3% (~~Gallo 1994;~~ Figure 2).

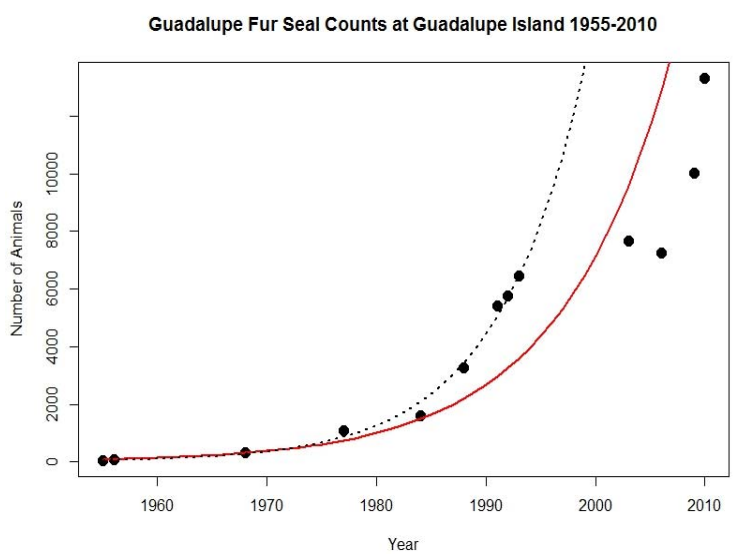

Figure 2. Counts of Guadalupe fur seals at Guadalupe Island, Mexico, and the estimated population growth curves derived from counts made during the breeding season. Direct counts of animals are shown as black dots. An estimated annual growth rate of 13% is based on counts made between 1955 and 1993 (black dashed line). The estimated growth rate over the period 1955-2010 is approximately 10% annually (solid red line).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Reported annual growth rates of 21% at Isla San Benito over an 11-year period are too high and likely result from immigration from Isla Guadalupe (Esperón-Rodríguez and Gallo-Reynoso 2012). The maximum net productivity rate can be assumed to be equal to the maximum annual growth rate observed between 1955 and 1993 ~~over the last 30 years~~ (13.7%) because the population was at a very low level and should have

been growing at nearly its maximum rate (Gallo 1994). Based on direct counts of animals at Guadalupe Island between 1955 and 2010, the estimated annual population growth rate is 10.3%.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) for this stock is calculated as the minimum population size (~~3,028~~ 15,830) times one half the ~~default~~ maximum net growth rate ~~for pinnipeds~~ observed for this species (½ of ~~12~~ 13.7%) times a recovery factor of 0.5 (for a threatened species, Wade and Angliss 1997), resulting in a PBR of ~~91~~ 542 Guadalupe fur seals per year. The vast majority of this PBR would apply towards incidental mortality in Mexico as most of the population occurs outside of U.S. waters.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Table 1. Summary of available information on the incidental mortality and injury of Guadalupe fur seals in commercial fisheries and other unidentified fisheries that might take this species (~~Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999, M. Perez per. comm, Appendix 1~~). ~~Mean annual takes are based on 1994-98 data unless noted otherwise.~~

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality and Serious Injury	Estimated Mortality and Serious Injury (CV ~~in parentheses~~)	Mean Annual Takes (CV ~~in parentheses~~)
CA driftnet fishery for sharks and swordfish	~~1994~~ ~~1995~~ ~~1996~~ ~~1997~~ ~~1998~~ 2010-2014	observer	~~17.9%~~ ~~15.6%~~ ~~12.4%~~ ~~22.8%~~ ~~20.2%~~ 22%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	~~0~~[1] 0
CA set gillnet fishery for halibut/white seabass and other species ~~and angel shark~~	~~1994~~ ~~1995~~ ~~1996~~ ~~1997~~ ~~1998~~ 2010-2014	observer ~~extrapolated estimates (1995-98)~~	~~7.7%~~ ~~0%~~ ~~0%~~ ~~0%~~ ~~0%~~ 9%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	~~0~~ ~~0~~[2] ~~0~~[2] ~~0~~[2] ~~0~~[2] 0	~~0~~[2] 0
Unidentified fishery interactions	2010-2014	strandings	n/a	16	≥ 16	≥ 3.2
~~**WA, OR, CA ground fish trawl fishery (At-sea processing Pacific whiting fishery only)**~~	~~1994~~ ~~1995~~ ~~1996~~ ~~1997~~ ~~1998~~	~~observer~~	~~53.8%~~ ~~56.2%~~ ~~65.2%~~ ~~65.7%~~ ~~77.3%~~	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~0~~
Minimum total annual takes						~~0~~ ≥3.2

~~[1] Only 1997-98 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).~~
~~[2] The CA set gillnets were not observed after 1994; mortality was extrapolated from effort estimates and previous entanglement rates.~~

~~Drift and set gillnet fisheries may cause incidental mortality of Guadalupe fur seals in Mexico and the United States. In the United States there have been no reports of mortality or injuries for Guadalupe fur seals (Barlow et al.1994, Julian 1997, Julian and Beeson 1998, Cameron and Forney 1999. No information is available for human-caused mortality or injuries in Mexico. However, 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. Quantitative data are available only for the Mexican swordfish drift gillnet fishery (Sosa-Nishizaki et al. 1993). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2,700, with an observed rate of marine mammal~~

~~bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-93 (0.15 marine mammals per set), but species specific information is not available for the Mexican fisheries. There are currently efforts underway to convert the Mexican swordfish driftnet fishery to a longline fishery (D. Holts, pers. comm.). The number of set gillnets used in Mexico is unknown.~~ No Guadalupe fur seals have been observed entangled in California gillnet fisheries between 1990 and 2014 (Julian and Beeson 1998, Carretta *et al*. 2004, Carretta *et al*. 2016b), although stranded animals have been found entangled in gillnet of unknown origin (see 'Other mortality' below). Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki *et al*. 1993), but no recent bycatch data from Mexico are available.

One confirmed interaction of a mouth-hooked Guadalupe fur seal in the Hawaii shallow set longline fishery has been reviewed by U.S. west coast pinniped experts from video taken at sea in early 2016. Two additional videos of unidentified pinnipeds that were hooked in the mouth in 2015 in the same fishery were also reviewed. These interactions occurred outside of the U.S. EEZ, west of the California Current.

Other mortality and serious injury

~~Juvenile female Guadalupe fur seals have stranded in central and northern California with net abrasions around the neck, fish hooks and monofilament line, and polyfilament string (Hanni et al. 1997).~~ There were 16 records of deaths and/or serious injuries to Guadalupe fur seals from stranding data for the most recent 5-year period of 2010-2014 (Carretta *et al*. 2016a). These strandings included entanglement in marine debris and gillnet of unknown origin, and shootings. The average annual observed human-caused mortality and serious injury of Guadalupe fur seals for 2010-2014 is 3.2 animals annually (16 animals / 5 years). Observed human-caused mortality and serious injury for this stock very likely represents a fraction of the true impacts because not all cases are documented. No correction factors to account for undetected mortality and injury are currently available for pinnipeds along the U.S. west coast.

STATUS OF STOCK

~~The state of California lists the Guadalupe fur seal as a fully protected mammal in the Fish and Game Code of California (Chap. 8, sec. 4700, d), and it is listed also as a threatened species in the Fish and Game Commission California Code of Regulations (Title 14, sec. 670.5, b, 6, H).~~ The Endangered Species Act lists ~~it~~ the Guadalupe fur seal as a threatened species, which automatically qualifies this stock as ~~a~~ "depleted" and "strategic" stock under the Marine Mammal Protection Act. There is insufficient information to determine whether ~~the~~ fishery mortality in Mexico exceeds the PBR for this stock, but given the observed growth of the population over time, this is unlikely. The total U.S. fishery mortality and serious injury for this stock (3.2 animals per year) is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The population is growing at approximately ~~13.7~~ 10% per year.

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HAWAIIAN MONK SEAL (*Neomonachus schauinslandi*)

STOCK DEFINITION AND GEOGRAPHIC RANGE

Hawaiian monk seals are distributed throughout the Northwestern Hawaiian Islands (NWHI), with subpopulations at French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, Kure Atoll, and Necker and Nihoa Islands. They also occur throughout the main Hawaiian Islands (MHI). Genetic variation among monk seals is extremely low and may reflect a long-term history at low population levels and more recent human influences (Kretzmann *et al*. 1997, 2001, Schultz *et al*. 2009). Though monk seal subpopulations often exhibit asynchronous variation in demographic parameters (such as abundance trends and survival rates), they are connected by animal movement throughout the species' range (Johanos *et al*. 2013). Genetic analysis (Schultz *et al*. 2011) indicates the species is a single panmictic population. The Hawaiian monk seal is therefore considered a single stock. Scheel et al. (2014) established a new genus, *Neomonachus*, comprising the Caribbean and Hawaiian monk seals, based upon molecular and skull morphology evidence.

POPULATION SIZE

The best estimate of the total population size is ~~1,112~~ 1,272, which is ~~This estimate is~~ the sum of ~~estimated~~ abundance estimates throughout the species' range (Table 1). ~~at the six main Northwestern Hawaiian Islands subpopulations, an extrapolation of counts at Necker and Nihoa Islands, and an estimate of minimum abundance in the main Hawaiian Islands~~. In ~~2013~~ 2014, for the ~~second~~ third consecutive year, NWHI field camps were shorter in duration relative to historic field effort levels. The low effort at some sites certainly resulted in negatively-biased abundance estimates and a degradation of the long-term monk seal demographic database. The number of individual seals identified is used as the population estimate at NWHI sites where total enumeration is achieved, according to the criteria established by Baker *et al*. (2006). Where total enumeration is not achieved, capture-recapture estimates from Program CAPTURE are used (Baker 2004; Otis *et al*. 1978, Rexstad & Burnham 1991, White *et al*. 1982). When no reliable estimator is obtainable in Program CAPTURE (i.e., the model selection criterion is < 0.75, following Otis *et al*. 1978), the total number of seals identified is the best available estimate. Sometimes capture-recapture estimates are less than the known minimum abundance (Baker 2004), and in these cases, the total number of seals actually identified is used. In ~~2013~~ 2014, total enumeration was ~~not~~ achieved only at Kure Atoll, ~~for any subpopulation,~~ and capture-recapture estimates were obtained for Laysan Island and Midway Atoll. At French Frigate Shoals, Lisianski Island and Pearl and Hermes Reef, capture-recapture estimates were either not obtainable or were lower than known minimum abundance. Consequently, only minimum abundance was available for ~~French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll and Kure Atoll~~ those sites. ~~Abundance at these six NWHI subpopulations was estimated to be 781 (including 104 pups).~~ Counts at Necker and Nihoa Islands are conducted from zero to a few times per year. A new method for estimating non-pup abundance uses the empirical distribution of the ratio of beach counts to total population size at other NWHI subpopulations to correct beach counts at Necker and Nihoa Islands. This method is described in a manuscript currently in preparation (Harting *et al*. in prep.) and the resulting estimates are presented in Table 1. Pups are born over the course of many months and have very different haulout patterns compared to older animals. Therefore, pup production at Necker and Nihoa Islands is estimated as the mean of the total pups observed in the past 5 years, excluding counts occurring early in the pupping season when most have yet to be born. ~~Abundance is estimated by correcting the mean of all beach counts accrued over the past five years. The mean (±SD) of all counts (excluding pups) conducted between 2009 and 2013 was 15.9 ± 5.6 at Necker Island and 32.3 ± 5.7 at Nihoa Island. The relationship between mean counts and total abundance at the reproductive sites indicates that total abundance can be estimated by multiplying the mean count by a correction factor of 2.89 (NMFS unpubl. data). Resulting estimates (plus the average number of pups known to have been born during 2009-2013) are 50.0 ± 16.2 at Necker Island and 102.1 ± 16.5 at Nihoa Island~~ There were no counts conducted at Necker Island in 2014, so two beach counts conducted in 2013 were used to estimate abundance (no change in abundance since 2013 assumed). Three counts were conducted at Nihoa Island in 2014.

~~Complete, systematic surveys for monk seals in the MHI were conducted in 2000 and 2001 (Baker and Johanos 2004).~~ In the MHI, NMFS ~~continues to~~ collects information on seal sightings reported throughout the year by a variety of sources, including a volunteer network, the public, and directed NMFS observation effort. In recent years, a small number of surveys of Ni'ihau and nearby Lehua Islands have been conducted through a collaboration between NMFS, Ni'ihau residents and the U.S. Navy. Total MHI monk seal abundance is estimated by adding the

~~The total~~ number of individually identifiable seals documented in ~~2013~~ 2014 ~~was~~ on all MHI other than Ni'ihau and Lehua to an estimate for these latter two islands based on counts expanded by a haulout correction factor. A recent telemetry study (Wilson *et al*., in prep.) found that MHI monk seals (N=23) spent a greater proportion of time ashore than Harting *et al*. (in prep) estimated for NWHI seals. Therefore, the total non-pup estimate for Ni'ihau and Lehua Islands was the total beach count at those sites (less three individual seals already counted at other MHI) divided by the mean proportion of time hauled out in the MHI (Wilson *et al*., in prep). The total pups observed at Ni'ihau and Lehua Islands were added to obtain the total (Table 1). ~~179, the current best minimum abundance estimate for the MHI~~

Table 1. Total and minimum estimated abundance of Hawaiian monk seals by location in 2014. The estimation method is indicated for each site.

	Total			**Minimum**			
Location	**Non-pups**	**Pups**	**Total**	**Non-pups**	**Pups**	**Total**	**Method**
French Frigate Shoals	136	38	174	136	38	174	Minimum count
Laysan	188	35	223	181	35	216	Capture-recapture
Lisianski	129	11	140	129	11	140	Minimum count
Pearl and Hermes Reef	119	16	135	119	16	135	Minimum count
Midway	55	8	63	53	8	61	Capture-recapture
Kure	62	13	75	62	13	75	Total enumeration
Necker	63	5	68	50	5	55	Haulout correction
Nihoa	110	9	119	87	9	96	Haulout correction
MHI (without Ni'ihau/ Lehua)	132	15	147	132	15	147	Minimum count
Ni'ihau/Lehua	108	20	128	86	20	106	Haulout correction
Total	*1102*	*170*	***1272***	*1035*	*170*	***1205***	

Minimum Population Estimate

The total numbers of seals ~~(781)~~ identified at the ~~six main~~ NWHI subpopulations other than Necker and Nihoa, and in the MHI other than Ni'ihau and Lehua, ~~reproductive sites is~~ are the best estimates of minimum population size at those sites. Minimum population sizes for Necker and Nihoa Islands are estimated as the lower 20th percentiles ~~(based on the formula provided by Wade and Angliss (1997)~~ of the non-pup abundance distributions generated using the Harting *et al*. (in prep.) haulout correction, plus the pup estimate. The mean proportion of time non-pups spent hauled out in the MHI was 0.370 (sd = 0.089, CV = 0.241) (Wilson *et al*. in prep.). Minimum abundance at Ni'ihau and Lehua Islands were calculated by applying the formula in Wade and Angliss (1997) to the Ni'ihau and Lehua non-pup estimate with a CV of 0.241, plus the observed pup tally. ~~are 38.3 and 89.3, respectively.~~ The minimum abundance estimates for each site and for all sites combined (1,205) are presented in Table 1.~~estimate for the MHI in 2013 is 179 seals. The minimum population size for the entire species is the sum of these estimates, or 1,088 seals.~~

Current Population Trend

In past years, ~~The~~ the total stock ~~population trend cannot be assessed currently~~ abundance was not adequately assessed~~,~~. However, in 2014, a range-wide total abundance estimate was generated using new methods for correcting beach counts at rarely visited sites (Necker, Nihoa and Ni'ihau/Lehua). Maintaining the commitment to conduct future counts at these latter sites will allow for the eventual estimation of total population trend. The following describes trends within different portions of the monk seal's range. The trend in ~~total~~ abundance at the six most-studied NWHI subpopulations estimated with a log-linear regression of estimated abundance on year for the past 10 years (~~2004~~ 2005-~~2013~~ 2014) yields a decline of ~~3.4%~~ -2.8 yr^{-1} (95% CI = ~~4.3~~ -3.7% to ~~2.4~~ -1.9% yr^{-1}). This rate of decline has been moderating in recent years. Sporadic beach counts at Necker and Nihoa Islands suggest

either stability or some positive growth over the past decade. The MHI monk seal population appears to be increasing. ~~Based on~~ Using life table analysis, Baker *et al*. (2011) estimated ~~with~~ an intrinsic population growth rate (λ) ~~estimated at~~ of 6.5% per year based on data available through 2008. ~~simulation modeling (Baker *et al*. 2011).~~ An updated analysis using MHI monk seal data through 2014 yields an estimated growth rate of 5.2% per year. However, the realized growth rate may differ considerably from λ, depending upon the unknown current age and sex structure. Given the uncertainties in these regional trends, it is not known whether the total stock abundance is decreasing, stable or possibly increasing. A reliable conclusion regarding population trend will only be apparent after more annual range-wide abundance estimates have accrued. ~~While these sites have historically comprised a small fraction of the total species abundance, the decline of the six main NWHI subpopulations, coupled with apparent growth at Nihoa and the MHI may mean that these latter three sites now substantially influence the total abundance trend. The MHI, Necker and Nihoa Islands estimates, uncertain as they are, comprised 30% of the stock's estimated total abundance in 2013. NMFS is developing a method for estimating total abundance (and its uncertainty) at Necker and Nihoa Islands using beach counts. Efforts to obtain regular, high-quality data on Ni'ihau are ongoing.~~

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Trends in abundance vary considerably among subpopulations. Mean non-pup beach counts are used as a long-term index of abundance for years when data are insufficient to estimate total abundance as described above. Prior to 1999, beach count increases of up to 7% annually were observed at Pearl and Hermes Reef, and this is the highest estimate of the maximum net productivity rate (R_{max}) observed for this species.

POTENTIAL BIOLOGICAL REMOVAL

Using current minimum population size (1,205), R_{max} (0.07) and a recovery factor (F_r) for ESA endangered stocks (0.1), would yield a Potential Biological Removal (PBR) of 4.2. However, ~~Potential biological removal (~~PBR~~)~~ is designed to allow stocks to recover to, or remain above, the maximum net productivity level (MNPL) (Wade 1998). An underlying assumption in the application of the PBR equation is that marine mammal stocks exhibit certain dynamics. Specifically, it is assumed that a depleted stock will naturally grow toward OSP (Optimum Sustainable Population), and that some surplus growth could be removed while still allowing recovery. The Hawaiian monk seal population is far below historical levels and has~~, on average, declined 3.4% a year~~ since 2004 ~~at the six most studied NWHI, which comprise some 70% of total abundance~~ undergone a prolonged decline in abundance. Thus, past reports have concluded that the stock's dynamics do not conform to the underlying model for calculating PBR such that PBR for the Hawaiian monk seal ~~is~~ has been undetermined. Given what appears to be an easing of the decline in the NWHI and continued growth in the MHI, this situation may have changed. If future monitoring reveals that the population is exhibiting positive growth, a valid PBR could be determined.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Human-related mortality has caused two major declines of the Hawaiian monk seal (Ragen 1999). In the 1800s, this species was decimated by sealers, crews of wrecked vessels, and guano and feather hunters (Dill and Bryan 1912; Wetmore 1925; Bailey 1952; Clapp and Woodward 1972). Following a period of at least partial recovery in the first half of the 20th century (Rice 1960), most subpopulations again declined. This second decline has not been fully explained, but long-term trends at several sites appear to have been driven both by variable oceanic productivity (represented by the Pacific Decadal Oscillation) and by human disturbance (Baker *et al*. 2012, Ragen 1999, Kenyon 1972, Gerrodette and Gilmartin 1990). Currently, human activities in the NWHI are limited and human disturbance is relatively rare, but human-seal interactions, have become an important issue in the MHI. Intentional killing of seals in the MHI is a relatively new and alarming issue (Table 2).

Table ~~1~~2. Intentional and potentially intentional killings of MHI monk seals, and anthropogenic mortalities not associated with fishing gear ~~of Hawaiian monk seals in the MHI~~ since ~~2009~~ 2010. ~~No such killings were observed in 2013.~~

Year	Age/sex	Island	Cause of Death	Comments
~~2009~~	~~Subadult male~~	~~Kauai~~	~~Gunshot wound~~	

	~~Adult female~~	~~Kauai~~	~~Gunshot wound~~	~~Pregnant~~
	~~Adult male~~	~~Molokai~~	~~Gunshot wound~~	
2010	Juvenile female	Kauai	Multiple skull fractures, blunt force trauma	Intent unconfirmed
2011	Adult male	Molokai	Skull fracture, blunt force trauma	Intent unconfirmed
	Juvenile female	Molokai	Skull fracture, blunt force trauma	Intent unconfirmed
2012	Juvenile male	Kauai	Gunshot wound	
	Subadult male	Kauai	Skull fracture	Intent unconfirmed
2014	Adult male	Oahu	Suspected trauma	Intent unconfirmed
	Pup female	Kauai	Skull fracture, blunt force trauma	Likely intentional
	Pup male	Kauai	Dog attack/bite wounds	4 other seals injured during this event

In July 2014, single or multiple dogs on Kauai attacked and injured at least five monk seals, one of which, a nursing pup, died from its wounds. The other four injured seals all recovered, one of which was a female nursing pup that required subsequent treatment for a bite-caused abscess. Four months later this same pup was killed on Kauai when its skull was crushed, likely by a human using a rock that was found nearby. An adult male on Oahu also died from what appeared to be trauma in 2014, but the carcass was too decomposed to draw conclusions about the cause of death. It is extremely unlikely that all carcasses of intentionally killed monk seals are discovered and reported. Studies of the recovery rates of carcasses for other marine mammal species have shown that the probability of detecting and documenting most deaths (whether from human or natural causes) is quite low (Peltier *et al*. 2012; Williams *et al*. 2011; Perrin *et al*. 2011; Punt and Wade 2010).

Fishery Information

Fishery interactions with monk seals can include direct interaction with gear (hooking or entanglement), seal consumption of discarded catch, and competition for prey. Entanglement of monk seals in derelict fishing gear, which is believed to originate outside the Hawaiian archipelago, is described in a separate section. Fishery interactions are a serious concern in the MHI, especially involving nearshore fisheries managed by the State of Hawaii. In 2014, 14 seal hookings ~~s~~ were ~~observed hooked~~ documented, 13 of which ~~all of which~~ either were captured and had the hooks removed, or the hooks detached without intervention. A yearling male seal was found dead as result of hooking and the necropsy revealed that a 'J' hook had perforated the esophagus and part of one lung, causing pneumothorax and acute death. ~~One juvenile female seal was observed with a fishing spear embedded in the skin and fat of her forehead. The seal was captured and the spear removed.~~ The~~se~~ remaining 13 hookings ~~and the spearing case~~ were all classified as non-serious injuries, although 9 ~~7~~ of these would have been deemed serious had they not been mitigated ~~by human intervention~~. Several incidents involved hooks used to catch ulua (jacks, *Caranx* spp.). Nearshore gillnets became a more common source of mortality in the 2000s, with three seals confirmed dead in these gillnets (2006, 2007, and 2010), and one additional seal in 2010 may have also died in similar circumstances but the carcass was not recovered. No gillnet-related mortality or injuries have been documented since 2010. Most reported hookings and gillnet entanglements have occurred since 2000 (NMFS unpubl. data). The MHI monk seal population appears to have been increasing in abundance during this period (Baker *et al*. 2011). No mortality or serious injuries have been attributed to the MHI bottomfish handline fishery (Table 3). Published studies on monk seal prey selection based upon scat/spew analysis and video from seal-mounted cameras revealed evidence that monk seals fed on families of bottomfish which contain commercial species (many prey items recovered from scats and spews were identified only to the level of family; Goodman-Lowe 1998, Longenecker *et al*. 2006, Parrish *et al*. 2000). Quantitative fatty acid signature analysis (QFASA) results support previous studies illustrating that monk seals consume a wide range of species (Iverson *et al*. 2011). However, deepwater-slope species, including two commercially targeted bottomfishes and other species not caught in the fishery, were estimated to comprise a large portion of the diet for some individuals. Similar species were estimated to be consumed by seals regardless of location, age or gender, but the relative importance of each species varied. Diets differed considerably between individual seals. These results highlight the need to better understand potential ecological interactions with the MHI bottomfish handline fishery.

Table 3. Summary of mortality, serious and non-serious injury of Hawaiian monk seals due to fisheries and calculation of annual mortality rate. n/a indicates that sufficient data are not available. Percent observer coverage for the deep and shallow-set components, respectively, of the pelagic longline fishery, are shown. Total non-serious

injuries are presented as well as, in parentheses, the number of those injuries that would have been deemed serious had they not been mitigated (*e.g.*, by de-hooking or disentangling). Data for MHI bottomfish and nearshore fisheries are based upon incidental observations (i.e., hooked seals and those entangled in active gear). All hookings not clearly attributable to either fishery with certainty were attributed to the bottomfish fishery, and hookings which resulted in injury of unknown severity were classified as serious. Nearshore fisheries injuries and mortalities include seals entangled/drowned in nearshore gillnets and hooked/entangled in hook-and-line gear, recognizing that it is not possible to determine whether the nets or hook-and-line gear involved were being used for commercial purposes.

Fishery Name	Year	Data Type	% Obs. coverage	Observed/Reported Mortality/Serious Injury	Estimated Mortality/ Serious Injury	Non-serious (Mitigated serious)[1]	Mean Takes (CV)
Pelagic Longline	~~2009~~ 2010 2011 2012 2013 2014	observer observer observer observer observer	~~20.6% & 100%[2]~~ 21.1% & 100%[2] 20.3% & 100%[2] 20.4% & 100%[2] 20.4% & 100% 20.8% & 100%[2]	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 (0)
MHI Bottomfish[2]	~~2009~~ 2010 2011 2012 2013 2014	Incidental observations of seals	none	0 0 0 0 0	n/a	0 0 0 0 0	n/a
Nearshore[3]	~~2009~~ 2010 2011 2012 2013 2014	Incidental observations of seals	none	~~0~~ 1 0 4 0 1	n/a	~~12(3)~~ 11(2) 9 (3) 12 (5) 15 (6) 14 (9)	≥~~1.0~~ 1.2
Minimum total annual takes							≥ ~~1.0~~ 1.2

There are no fisheries operating in or near the NWHI. In the past, interactions between the Hawaii-based domestic pelagic longline fishery and monk seals were documented (Nitta and Henderson 1993). This fishery targets swordfish and tunas and does not compete with Hawaiian monk seals for prey. In October 1991, in response to 13 unusual seal wounds thought to have resulted from interactions with this fishery, NMFS established a Protected Species Zone extending 50 nautical miles around the NWHI and the corridors between the islands. Subsequently, no additional monk seal interactions with the swordfish or tuna components of the longline fishery have been observed.

Fishery Mortality Rate

Total fishery mortality and serious injury is not ~~considered to be~~ insignificant and approaching a rate of zero. Monk seals are being hooked and entangled in the MHI at a rate that has not been reliably assessed but is certainly greater than zero. The information above represents only reported direct interactions, and without directed observation effort, the true interaction rate cannot be estimated. Monk seals also die from entanglement in fishing gear and other debris throughout their range (likely originating from various sources outside of Hawaii), and NMFS along with partner agencies is pursuing a program to mitigate entanglement (see below). Indirect interactions (i.e.,

~~[1] Total non-serious injuries documented. In parentheses, number of injuries that would have been deemed serious had they not been mitigated (*e.g.*, by de-hooking or disentangling).~~
~~[2] Data for MHI bottomfish and nearshore fisheries are based upon incidental observations (i.e., hooked seals and those entangled in active gear). All hookings not clearly attributable to either fishery with certainty were attributed to the bottomfish fishery, and hookings, which resulted in injury of unknown severity were classified as serious.~~
~~[3] Includes seals entangled/drowned in nearshore gillnets and hooked/entangled in hook-and-line gear, recognizing that it is not possible to determine whether the nets or hook-and-line gear involved were being used for commercial purposes.~~

involving competition for prey or consumption of discards) remain a topic of ongoing investigation.

Entanglement in Marine Debris

Hawaiian monk seals become entangled in fishing and other marine debris at rates higher than reported for other pinnipeds (Henderson 2001). A total of ~~339~~ 347 cases of monk seals entangled in fishing gear or other debris have been observed from 1982 to ~~2013~~ 2014 (Henderson 2001; NMFS, unpubl. data). Nine documented deaths resulted from entanglement in marine debris (Henderson 1990, 2001; NMFS, unpubl. data). The fishing gear fouling the reefs and beaches of the NWHI and entangling monk seals only rarely includes types used in Hawaii fisheries. For example, trawl net and monofilament gillnet accounted for approximately 35% and 34%, respectively, of the debris removed from reefs in the NWHI by weight, and trawl net alone accounted for 88% of the debris by frequency (Donohue *et al*. 2001), despite the fact that trawl fisheries have been prohibited in Hawaii since the 1980s.

The NMFS and partner agencies continue to mitigate impacts of marine debris on monk seals as well as turtles, coral reefs and other wildlife. Marine debris is removed from beaches and seals are disentangled during annual population assessment activities at the main reproductive sites. Since 1996, annual debris survey and removal efforts in the NWHI coral reef habitat have been ongoing (Donohue *et al*. 2000, Donohue *et al*. 2001, Dameron *et al*. 2007).

Other Mortality

In the past 10 years (2004-2013) two monk seals died during enhancement activities (in 2005 and 2006) and one died during research in 2007 (NMFS unpubl. data).

Sources of mortality that impede recovery include food limitation (see Habitat Issues), single and multiple-male intra-species aggression (mobbing), shark predation, and disease/parasitism. Male seal aggression has caused episodes of mortality and injury. Past interventions to remove aggressive males greatly mitigated, but have not eliminated, this source of mortality (Johanos *et al*. 2010). Galapagos shark predation on monk seal pups has been a chronic and significant source of mortality at French Frigate Shoals since the late 1990s, despite mitigation efforts by NMFS (Gobush 2010). Infectious disease effects on monk seal demographic trends are low relative to other stressors. However, land-to-sea transfer of pathogens has been increasingly evident; since the early 2000's through 2014, six monk seal mortalities have been directly caused by protozoal infections, most often by *Toxoplasma gondii*, a protozoal parasite ~~toxoplasmosis, a protozoal parasite~~ that is shed in the feces of cats. Furthermore, the consequences of a disease outbreak introduced from livestock, feral animals, pets or other carrier wildlife may be catastrophic to the immunologically naïve monk seal population. Key disease threats include West Nile virus, morbillivirus and influenza.

Habitat Issues

Poor juvenile survival rates and variability in the relationship between weaning size and survival suggest that prey availability is limiting recovery of NWHI monk seals (Baker and Thompson 2007, Baker *et al*. 2007, Baker 2008). Multiple strategies for improving juvenile survival, including translocation and captive care are being implemented (Baker and Littnan 2008, Baker *et al*. 2013, Norris 2013). A testament to the effectiveness of past actions to improve survival, Harting *et al*. (2014) demonstrated that approximately one-third of the monk seal population alive in 2012 was made up of seals that either had been intervened with to mitigate life-threatening situations, or were descendants of such seals. In 2014, NMFS ~~has~~ produced a ~~draft~~ final Programmatic Environmental Impact Statement (PEIS) on current and future anticipated research and enhancement activities, and issued a permit covering the activities described in the PEIS preferred alternative (http://www.nmfs.noaa.gov/pr/permits/eis/hawaiianmonksealeis.htm)[1]. A major habitat issue involves loss of terrestrial habitat at French Frigate Shoals, where some pupping and resting islets have shrunk or virtually disappeared (Antonelis *et al*. 2006). Projected increases in global average sea level may further significantly reduce terrestrial habitat for monk seals in the NWHI (Baker *et al*. 2006, Reynolds *et al*. 2012).

Goodman-Lowe (1998) provided information on prey selection using hard parts in scats and spewings. Information on at-sea movement and diving is available for seals at all six main subpopulations in the NWHI using satellite telemetry (Stewart *et al*. 2006). Cahoon (2011) and Cahoon *et al*. (2013) described diet and foraging behavior of MHI monk seals, and found no striking difference in prey selection between the NWHI and MHI.

Remains of the seawall at Tern Island, French Frigate Shoals, is an entrapment hazard for seals. Vessel groundings pose a continuing threat to monk seals and their habitat, through potential physical damage to reefs, oil

~~[1] http://www.nmfs.noaa.gov/pr/permits/eis/hawaiianmonksealeis.htm~~

spills, and release of debris into habitats.

Monk seal abundance is increasing in the main Hawaiian Islands (Baker *et al*. 2011). Further, the excellent condition of pups weaned on these islands suggests ~~that there are~~ ample prey resource~~s~~ ~~available~~availability, perhaps in part due to fishing pressure that has reduced monk seal competition with large fish predators (sharks and jacks) (Baker and Johanos 2004). If the monk seal population continues to expand in the MHI, it may bode well for the species' recovery and long-term persistence. In contrast, there are many challenges that may limit the potential for growth in this region. The human population in the MHI is approximately 1.4 million compared to fewer than 100 in the NWHI, so that the potential impact of disturbance in the MHI is great. Intentional killing of seals (noted above) is a very serious concern. Also, the same fishing pressure that may have reduced the monk seal's competitors is a source of injury and mortality. Finally, vessel traffic in the populated islands carries the potential for collision with seals and impacts from oil spills. The causes of two recent non-serious injuries (in 2010 and 2011) to seals were attributed to boat propellers. Thus, issues surrounding monk seals in the main Hawaiian Islands will likely become an increasing focus for management and recovery of this species.

STATUS OF STOCK

In 1976, the Hawaiian monk seal was designated depleted under the Marine Mammal Protection Act ~~of 1972~~ and as endangered under the Endangered Species Act~~ of 1973~~. The species is well below its optimum sustainable population ~~(OSP)~~ and has not recovered from past declines. Therefore, the Hawaiian monk seal is a strategic stock. Annual human-caused mortality for the most recent 5-year period (~~2009-2013~~ 2010-2014) was at least ~~2.6~~ 2.8 animals, including fishery-related mortality in nearshore gillnets and hook-and-line gear (≥1.2/yr, Table ~~2~~ 3), and intentional killings and other human-caused mortalities ~~shooting-related deaths (>=0.8/yr), and blunt-force trauma deaths of unknown origin~~ (≥1.6/yr ~~>=0.8/yr,~~ Table ~~1~~ 2).

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HARBOR PORPOISE (*Phocoena phocoena vomerina*): Washington Inland Waters Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the eastern North Pacific Ocean, harbor porpoise are found in coastal and inland waters from Point Barrow, along the Alaskan coast, and down the west coast of North America to Point Conception, California (Gaskin 1984). Harbor porpoise are known to occur year-round in the inland trans-boundary waters of Washington and British Columbia, Canada (Osborne et al. 1988), and along the Oregon/Washington coast (Barlow 1988, Barlow et al. 1988, Green et al. 1992). Aerial survey data from coastal Oregon and Washington, collected during all seasons, suggest that harbor porpoise distribution varies by depth (Green et al. 1992). Although distinct seasonal changes in abundance along the west coast have been noted, and attributed to possible shifts in distribution to deeper offshore waters during late winter (Dohl et al. 1983, Barlow 1988), seasonal movement patterns are not fully understood.

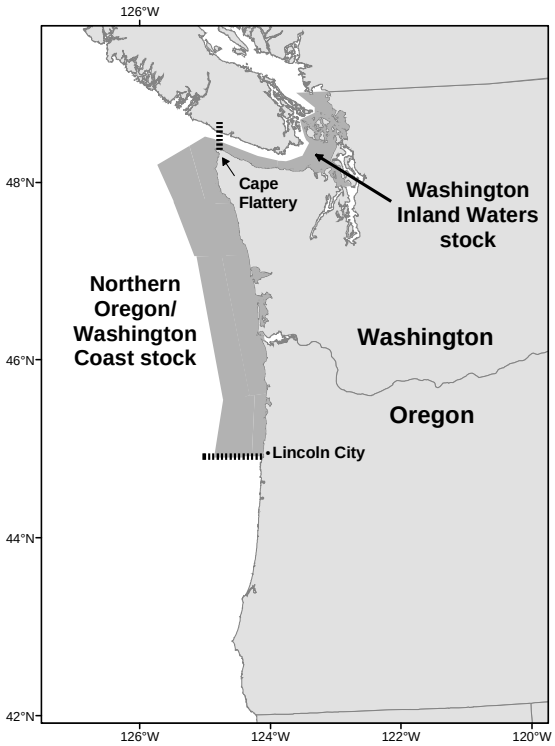

Figure 1. Stock boundaries (dashed lines) and approximate distribution (dark shaded areas) of harbor porpoise along the coasts of Washington and northern Oregon. The range of the Northern California/Southern Oregon stock of harbor porpoise (not shown), extends from Lincoln City. OR, south to Pt. Arena, CA.

Investigation of pollutant loads in harbor porpoise ranging from California to the Canadian border suggests restricted harbor porpoise movements (Calambokidis and Barlow 1991). Stock discreteness in the eastern North Pacific was analyzed using mitochondrial DNA from samples collected along the west coast (Rosel 1992) and is summarized in Osmek et al. (1994). Two distinct mtDNA groupings or clades exist. One clade is present in California, Washington, British Columbia, and Alaska (no samples were available from Oregon), while the other is found only in California and Washington. Although these two clades are not geographically distinct by latitude, the results may indicate a low mixing rate for harbor porpoise along the west coast of North America. Further genetic testing of the same data, along with additional samples, found significant genetic differences for four of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (Rosel et al. 1995). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic or migratory and that movement is sufficiently restricted that genetic differences have evolved. ~~Recent preliminary~~ Subsequent genetic analyses of samples ranging from Monterey Bay, California, to Vancouver Island, British Columbia, indicate that there is small-scale subdivision within the U.S. portion of this range (Chivers et al. 2002, 2007). This is consistent with low movement suggested by genetic analysis of harbor porpoise specimens from the North Atlantic, where numerous stocks have been delineated with clinal differences over areas as small as the waters surrounding the British Isles.

Using the 1990-1991 aerial survey data of Calambokidis et al. (1993) for water depths <50 fathoms, Osmek et al. (1996) found significant differences in harbor porpoise mean densities ($Z=6.9$, $P<0.001$) between the waters of coastal Oregon/Washington and inland Washington/southern British Columbia, Canada (i.e., Strait of Juan de Fuca/San Juan Islands). Following a risk averse management strategy, two stocks were recognized in the waters of Oregon and Washington, with a boundary at Cape Flattery, Washington. Based on more recent genetic evidence, which suggests that the population of eastern North Pacific harbor porpoise is more finely structured (Chivers et al. 2002, 2007), stock boundaries on the Oregon/Washington coast have been revised, resulting in three stocks in Oregon/Washington waters: a Northern California/Southern Oregon stock (Point Arena, CA, to Lincoln City, OR), a

Northern Oregon/Washington Coast stock (Lincoln City, OR, to Cape Flattery, WA), and the Washington Inland Waters stock (in waters east of Cape Flattery). Additional analyses are needed to determine whether to adjust the stock boundaries for harbor porpoise in Washington inland waters (Chivers et al. 2007).

In their assessment of California harbor porpoise, Barlow and Hanan (1995) recommended two stocks be recognized in California, with the stock boundary at the Russian River. Based on more recent genetic findings (Chivers et al. 2002, 2007), California coast stocks were re-evaluated and significant genetic differences were found among four identified sampling sites. Revised stock boundaries, based on these genetic data and density discontinuities identified from aerial surveys, resulted in six California/Oregon/Washington stocks where previously there had been four (e.g., Carretta et al. 2001): 1) the Washington Inland Waters stock, 2) the Northern Oregon/Washington Coast stock, 3) the Northern California/Southern Oregon stock, 4) the San Francisco-Russian River stock, 5) the Monterey Bay stock, and 6) the Morro Bay stock. The stock boundaries for animals that occur in northern Oregon/Washington waters are shown in Figure 1. This report considers only the Washington Inland Waters stock. Stock assessment reports for Northern Oregon/Washington Coast, Northern California/Southern Oregon, San Francisco-Russian River, Monterey Bay, and Morro Bay harbor porpoise also appear in this volume. Stock assessment reports for the three harbor porpoise stocks in the inland and coastal waters of Alaska, including 1) the Southeast Alaska stock, 2) the Gulf of Alaska stock, and 3) the Bering Sea stock, are reported separately in the Stock Assessment Reports for the Alaska Region. The harbor porpoise occurring in British Columbia have not been included in any of the U.S. stock assessment reports.

POPULATION SIZE

Aerial surveys of the inside waters of Washington and southern British Columbia were conducted from 2013 to 2015 (Smultea *et al*. 2015a, 2015b). ~~during August of 2002 and 2003 (J. Laake, unpublished data)~~. These aerial surveys included the Strait of Juan de Fuca, San Juan Islands, Gulf Islands, ~~and~~ Strait of Georgia, Puget Sound, and Hood Canal~~,~~. ~~which includes~~ These are the waters inhabited by the Washington Inland Waters stock of harbor porpoise as well as harbor porpoise from British Columbia. ~~An average of the 2002 and 2003 estimates of abundance in U.S. waters results in an uncorrected abundance of 3,123 (CV= 0.10) harbor porpoise in Washington inland waters (J. Laake, unpublished data). When corrected for availability and perception bias, using a correction factor of 3.42 (1/g(0); g(0)=0.292, CV=0.366) (Laake~~ et al.~~ 1997), the estimated abundance for the Washington Inland Waters stock of harbor porpoise in 2002/2003 is 10,682 (CV=0.38) animals (J. Laake, unpublished data).The harbor~~ Harbor porpoise ~~density and~~ abundance estimates were corrected for trackline animals missed by aerial observers using *g(0)* from previous studies in the same area and using similar methods (Laake *et al*. 1997). ~~However, because the most recent abundance estimate is >8 years old, there is no current estimate of abundance available for this stock.~~ For U.S. waters, the current estimate of abundance is 11,233 porpoise (CV=0.37) (Smultea *et al*. 2015a).

Minimum Population Estimate

~~No current information on abundance is available to obtain a~~ The minimum population estimate for the Washington Inland Waters stock of harbor porpoise~~.~~ is calculated as the lower 20th percentile of the log-normal distribution (Wade and Angliss 1997) of the 2015 population estimate of 11,233 harbor porpoise, or 8,308 animals.

Current Population Trend

~~There are no reliable data on long-term population trends of harbor porpoise for most waters of Oregon, Washington, or British Columbia, however, the uncorrected estimate of abundance in Washington inland waters was significantly greater in 2002/2003 than in 1996 (3,123 vs. 1,025; Z=6.16, P<0.0001) (Calambokidis~~ et al.~~ 1997; J. Laake, unpublished data~~).

Estimates of population size for Washington Inland waters from 1990-1991 aerial surveys were 3,298 (CV=0.26) animals, corrected for diving animals not seen by observers (Calambokidis *et al*. 1993). Estimates of harbor porpoise abundance for the same region from 2013-2015 surveys (11,233; CV=0.37, Smultea *et al*. 2015a), are considerably higher, however a formal trend analysis has not been performed for this stock.

In southern Puget Sound, harbor porpoise were common in the 1940s (Scheffer and Slipp 1948), but marine mammal surveys (Everitt et al. 1980), stranding records since the early 1970s (Osmek et al. 1995), and harbor porpoise surveys in 1991 (Calambokidis et al. 1992) and 1994 (Osmek et al. 1995) indicated that harbor porpoise abundance had declined in southern Puget Sound. In 1994, a total of 769 km of vessel survey effort and 492 km of aerial survey effort conducted during favorable sighting conditions produced no sightings of harbor porpoise in southern Puget Sound. Reasons for the apparent decline are unknown, but it may have been related to fishery interactions, pollutants, vessel traffic, or other factors (Osmek et al. 1995). ~~In 2009 and 2010, however, increased~~

~~numbers of harbor porpoise have been sighted during vessel surveys throughout Puget Sound and increased numbers of strandings have also been documented, suggesting a return of animals to this region (J. Calambokidis, unpublished data; B. Hanson, unpublished data)~~ Annual winter aerial surveys conducted by the Washington Department of Fish and Wildlife from 1995 to 2015 revealed an increasing trend in harbor porpoise in Washington inland waters, including the return of harbor porpoise to Puget Sound. The data suggest~~s~~ that harbor porpoise were already present in Juan de Fuca, Georgia Straits, and the San Juan Islands from the mid-1990s to mid-2000s, and then expanded into Puget Sound and Hood Canal from the mid-2000s to 2015, areas they had used historically but abandoned. Changes in fishery-related entanglement was suspected as the cause of their previous decline and more recent recovery, including a return to Puget Sound (Evenson *et al*. 2016). Seasonal surveys conducted in spring, summer, and fall 2013-2015 in Puget Sound and Hood Canal documented substantial numbers of harbor porpoise in Puget Sound. Observed porpoise numbers were twice as high in spring as in fall or summer, indicating a seasonal shift in distribution of harbor porpoise (Smultea 2015b). The reasons for the seasonal shift and for the increase in sightings is unknown.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is not available for harbor porpoise. Therefore, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% (Wade and Angliss 1997) be employed for the Washington Inland Waters harbor porpoise stock.

POTENTIAL BIOLOGICAL REMOVAL

~~Because there is no current estimate of minimum abundance, a potential biological removal (PBR) cannot be calculated for this stock.~~ The potential biological removal (PBR) for this stock is calculated as the minimum population size (8,308) times one-half the default maximum net growth rate for cetaceans (1/2 of 4%) times a recovery factor of 0.4 (for a stock of unknown status and high uncertainty in the mortality and injury estimate), resulting in a PBR of 66 harbor porpoise per year. Although no CV is available for the mortality and serious injury estimate, there is large uncertainty because the available data are limited to stranding information, which is known to have a substantial downward bias (Carretta *et al*. 2016a, 2016b). For this reason, the recovery factor was set equal to the value for a stock of unknown status with mortality and serious injury CV > 0.80 (Wade and Angliss 1997).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Fishing effort in the northern Washington marine gillnet tribal fishery is conducted within the range of both harbor porpoise stocks (Northern Oregon/Washington Coast and Washington Inland Waters) occurring in Washington State waters (Gearin et al. 1994). Some movement of harbor porpoise between Washington's coastal and inland waters is likely, but it is currently not possible to quantify the extent of such movements. For the purposes of this stock assessment report, ~~the~~ animals taken in waters east of Cape Flattery, WA, are assumed to have belonged to the Washington Inland Waters stock~~, and Table 1 includes data only from that portion of the fishery~~. Between 2010 and 2014, no harbor porpoise deaths or serious injuries were reported in this fishery (Makah Fisheries Management, unpublished data).~~There was no observer coverage in the northern Washington marine set gillnet tribal fishery in inland waters in 2005-2009; however, there were two fisherman self-reports of harbor porpoise deaths in 2008 and both deaths occurred in nets that were equipped with alarms (Makah Fisheries Management, unpublished data). The mean estimated mortality for this fishery in 2005-2009 is 0.4 harbor porpoise per year from fisherman self-reports. Fishing effort in the northern Washington marine drift gillnet tribal fishery in inland waters is also conducted within the range of the Washington Inland Waters stock of harbor porpoise. This fishery is not observed; however, there was one fisherman self-report of a harbor porpoise death in 2008 (Makah Fisheries Management, unpublished data). The mean estimated mortality for this fishery in 2005-2009 is 0.2 harbor porpoise per year from fisherman self-reports. There were also fisherman self-reports of six unidentified small odontocete deaths in this fishery in 2005 (Makah Fisheries Management, unpublished data); these animals may have been harbor porpoise, but they are not included in the mortality estimate for this fishery.~~

~~In 1993, as a pilot for future observer programs, NMFS in conjunction with the Washington Department of Fish and Wildlife (WDFW) monitored non-treaty components (areas 7, 7A, 7B/7C, 8A/8D, 10/11, and 12/12A/12B) of the Washington Puget Sound Region salmon gillnet fishery (Pierce~~ et al.~~1994). Observer coverage was 1.3% overall, ranging from 0.9% to 7.3% for the various components of the fishery. No harbor porpoise deaths were reported. Pierce et al. (1994) cautioned against extrapolating this mortality to the entire Puget Sound fishery due to the low observer coverage and potential biases inherent in the data. The area 7/7A sockeye landings represented the~~

Table 1. Summary of incidental mortality and serious injury of harbor porpoise (Washington Inland Waters stock) in commercial and tribal fisheries that might take this species and calculation of the mean annual mortality rate; n/a indicates that data are not available. Mean annual takes are based on ~~2005-2009~~ 2010-2014 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
~~Northern WA marine set gillnet (tribal fishery in inland waters)[1]~~	~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ ~~2009~~	~~observer data~~	~~0%~~ ~~0%~~ ~~0%~~ ~~0%~~ ~~0%~~	~~n/a~~ ~~n/a~~ ~~n/a~~ ~~n/a~~ ~~n/a~~	~~n/a~~ ~~n/a~~ ~~n/a~~ ~~n/a~~ ~~n/a~~	~~n/a~~
	~~2008~~	~~fisherman self-reports~~		~~2~~	~~n/a~~	~~≥0.4 (n/a)~~
~~Northern WA marine drift gillnet (tribal fishery in inland waters)[1]~~	~~2008~~	~~fisherman self-reports~~		~~1~~	~~n/a~~	~~≥0.2 (n/a)~~
WA Puget Sound Region salmon set/drift gillnet (observer programs listed below covered segments of this fishery):	-	-	-	-	-	-
Puget Sound non-treaty salmon gillnet (all areas and species)	1993	observer data	1.3%	0	0	see text~~[2]~~[1]
Puget Sound non-treaty chum salmon gillnet (areas 10/11 and 12/12B)	1994	observer data	11%	0	0	see text~~[2]~~[1]
Puget Sound treaty chum salmon gillnet (areas 12, 12B, and 12C)	1994	observer data	2.2%	0	0	see text~~[2]~~[1]
Puget Sound treaty chum and sockeye salmon gillnet (areas 4B, 5, and 6C)	1994	observer data	7.5%	0	0	see text~~[2]~~[1]
Puget Sound treaty and non-treaty sockeye salmon gillnet (areas 7 and 7A)	1994	observer data	7%	1	15	see text~~[2]~~[1]
~~Puget Sound non-treaty salmon drift gillnet (area 5)~~	~~2006~~	~~fisherman self-reports~~		~~2~~	~~n/a~~	~~≥0.4 (n/a)~~
Unknown Puget Sound Region fishery	~~2005-2009~~ 2010-2014	stranding data		~~0, 1, 1, 0, 4~~ 2, 0, 7, 1, 2	n/a	≥~~1.2~~ 2.4 (n/a)
Minimum total annual takes						≥2.~~2~~ 2.4 (n/a)

~~[1]This is a tribal fishery; therefore, it is not listed in the NMFS list of commercial fisheries.~~
~~[2]~~[1]This fishery has not been observed since 1994 (see text); these data are not included in the calculation of recent minimum total annual takes.

~~majority of the non-treaty salmon landings in 1993, approximately 67%. Results of this pilot study were used to design the 1994 observer programs discussed below.~~

~~In 1994, NMFS in conjunction with WDFW conducted an observer program during the Puget Sound non-treaty chum salmon gillnet fishery (areas 10/11 and 12/12B). A total of 230 sets were observed during 54 boat trips, representing approximately 11% observer coverage of the 500 fishing boat trips comprising the total effort in this fishery, as estimated from fish ticket landings (Erstad et al. 1996). No harbor porpoise were reported within 100 m of observed gillnets. The Puget Sound treaty chum salmon gillnet fishery in Hood Canal (areas 12, 12B, and 12C) and Puget Sound treaty sockeye/chum gillnet fishery in the Strait of Juan de Fuca (areas 4B, 5, and 6C) were also monitored in 1994 (NWIFC 1995). No harbor porpoise deaths were reported in the observer programs covering~~

~~these treaty salmon gillnet fisheries, where observer coverage was estimated at 2.2% (based on % of total catch observed) and approximately 7.5% (based on % of observed trips to total landings), respectively.~~

~~Also in 1994, NMFS in conjunction with WDFW and the Tribes conducted an observer program to examine seabird and marine mammal interactions with the Puget Sound treaty and non-treaty sockeye salmon gillnet fishery (areas 7 and 7A). During this fishery, observers monitored 2,205 sets, representing approximately 7% of the estimated 33,086 sets occurring in the fishery (Pierce~~ et al.~~ 1996). There was one observed harbor porpoise death (one other was entangled and released alive with no indication that it was injured), resulting in a mortality rate of 0.00045 harbor porpoise per set, which extrapolates to 15 deaths (CV=1.0) for the entire fishery.~~

~~It should be noted that the 1994 observer programs did not sample all segments of the entire Washington Puget Sound Region salmon set/drift gillnet fishery and, further, the extrapolations of total kill did not include effort for the unobserved segments of this fishery. Although the percentage of the overall Washington Puget Sound Region salmon set/drift gillnet fishery effort that was observed in 1994 was not quantified, the observer programs covered those segments of the fishery which had the highest salmon catches, the majority of vessel participation, and the highest likelihood of interaction with harbor porpoise (J. Scordino, pers. comm.). Harbor porpoise takes in the Washington Puget Sound Region salmon drift gillnet fishery are unlikely to have increased since the fishery was last observed in 1994, due to reductions in the number of participating vessels and available fishing time (see details in Appendix 1). Fishing effort and catch have declined throughout all salmon fisheries in the region due to management efforts to recover ESA-listed salmonids.~~

~~In 1996, Washington Sea Grant Program conducted a test fishery in the non-treaty sockeye salmon gillnet fishery (area 7) to compare entanglement rates of seabirds and marine mammals and catch rates of salmon using three experimental gears and a control (monofilament mesh net). The experimental nets incorporated highly visible mesh in the upper quarter (50-mesh gear) or upper eighth (20-mesh gear) of the net or had low-frequency sound emitters attached to the corkline (Melvin et al. 1997). In 642 sets during 17 vessel trips, 2 harbor porpoise were killed in the 50-mesh gear.~~

Commercial salmon drift gillnet fisheries in Washington inland waters were last observed in 1993 and 1994, with observer coverage levels typically less than 10% (Pierce et al. 1994, 1996; NWIFC 1995; Erstad et al. 1996). Drift gillnet fishing effort in the inland waters has declined considerably since 1994 because far fewer vessels participate today (NMFS WC Region, unpublished data), but entanglements of harbor porpoise likely continue to occur. The most recent data on harbor porpoise mortality from commercial gillnet fisheries is included in Table 1.

~~There were two fisherman self-reports of harbor porpoise deaths in the Puget Sound Region salmon drift gillnet fishery in area 5 in 2006, resulting in an estimated mean annual mortality rate of 0.4 harbor porpoise from fisherman self-reports. There was also a fisherman self-report of an unidentified neonate or juvenile porpoise death in the Puget Sound Region drift gillnet fishery in 2006; this animal may have been a harbor porpoise, but it was not included in the mortality estimate for the fishery.~~

~~Combining estimates from the northern Washington marine set gillnet tribal fishery (0.4), the northern Washington marine drift gillnet tribal fishery (0.2), and the Puget Sound Region drift gillnet fishery (0.4) results in an estimated mean annual mortality rate of 1.0 harbor porpoise from this stock from fisherman self-reports.~~

Strandings of dead or seriously injured harbor porpoise ~~wrapped~~ entangled in fishing gear ~~or with serious injuries caused by interactions with gear~~ are ~~a final~~another source of fishery-related mortality~~ information~~. ~~According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region (NMFS, Northwest Regional Office, unpublished data), t~~ There were ~~six~~ 12 fishery-related strandings of harbor porpoise from this stock in ~~2005-2009~~ 2010-2014 (~~1 in 2006, 1 in 2007, and 4 in 2009~~ 2 in 2010, 7 in 2012, 1 in 2013, and 2 in 2014), resulting in an average annual mortality and serious injury rate of ~~of 1.2~~ 2.4 harbor porpoise per year (Carretta *et al*. 2016). Evidence of fishery interactions included observed entanglements~~ in gillnet~~, net marks, and ~~rope~~ line marks. Since these deaths could not be attributed to a particular fishery, and were the only confirmed fishery-related deaths in this area in ~~2005-2009~~ 2010-2014, they are listed in Table 1 as occurring in an unknown Puget Sound Region fishery.~~ One additional harbor porpoise stranding reported in 2007 was considered a possible fishery-related death, but it was not included in the estimate of average annual mortality. This estimate is considered a minimum because not all stranded animals are found, reported, or examined for cause of death (via necropsy by trained personnel).~~ There are no observed fisheries in Washington inland waters, and the estimate of human-caused mortality of harbor porpoise (2.4/yr) is based solely on stranding data, which are uncorrected for negative biases in cetacean carcass recovery (Williams *et al.* 2014). The only published carcass recovery rate for harbor porpoise (<0.01) is from an oceanic-coast habitat in the NE United States (Moore and Read 2008), but due to the confined nature of inland waterways, recovery rates in Washington State inland waters are likely higher than that estimated by Moore and Read (2008). Wells *et al*. (2015) reported a carcass recovery rate (0.33) for bottlenose

dolphins that inhabit the densely populated Sarasota Bay area. If this recovery rate of 0.33 is applied to Washington Inland Waters harbor porpoise fishery-related strandings for the period 2010-2014, annual mortality would be estimated at 7.2 (12 documented fishery-related strandings, times a correction factor of 3, divided by 5 years), which is less than the PBR of 66. In the absence of a carcass recovery correction factor for Washington inland waters harbor porpoise, a minimum correction factor of 3 from the Wells *et al*. (2015) coastal bottlenose dolphin study is applied to fishery-related strandings here, resulting in an estimate of 7.2 porpoise annually. Additional data are required to estimate a carcass recovery rate for harbor porpoise in Washington inland waters.

Although commercial gillnet fisheries in Canadian waters are known to have taken harbor porpoise in the past (Barlow et al. 1994, Stacey et al. 1997), few data are available because the fisheries were not monitored. In 2001, the Department of Fisheries and Oceans, Canada, conducted a federal fisheries observer program and a survey of license holders to estimate the incidental mortality of harbor porpoise in selected salmon fisheries in southern British Columbia (Hall et al. 2002). Based on the observed bycatch of porpoise (2 harbor porpoise deaths) in the 2001 fishing season, the estimated mortality for southern British Columbia in 2001 was 20 porpoise per 810 boat days fished or a total of 80 harbor porpoise. However, it is not known how many harbor porpoise from the Washington Inland Waters stock are currently taken in the waters of southern British Columbia.

Other Mortality

~~According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region (NMFS, Northwest Regional Office, unpublished data), two human-caused harbor porpoise deaths were reported from non-fisheries sources in 2005-2009. One animal was struck by a ship in 2007 and one was entangled in rope in 2009, resulting in an estimated mortality of 0.4 harbor porpoise per year from this stock.~~

A significant increase in ~~the number of~~ harbor porpoise strandings reported throughout Oregon and Washington in 2006 prompted the Working Group on Marine Mammal Unusual Mortality Events to declare an Unusual Mortality Event (UME) on 3 November 2006 (Huggins 2008). A total of 114 harbor porpoise strandings were reported and confirmed ~~throughout~~ along the Oregon~~/~~ and Washington outer coasts and Washington inland waters in 2006 and 2007 (Huggins 2008). A more recent analysis of strandings before and after the suspected UME indicates that no UME occurred (Huggins *et al*. 2015). The perceived increase in mortality was the result of a combination of factors: an increase in the population of harbor porpoise, a shift of the population into Washington inland waters, and a well-established stranding network with improved response and reporting (Huggins *et al*. 2015). ~~The cause of the UME has not been determined and several factors, including contaminants, genetics, and environmental conditions, are still being investigated. Cause of death, determined for 48 of 81 porpoise that were examined in detail, was attributed mainly to trauma and infectious disease. Suspected or confirmed fishery interactions were the primary cause of adult/subadult traumatic injuries, while birth-related trauma was responsible for the neonate deaths. Although five of the Washington Inland Waters harbor porpoise deaths examined as part of the UME were suspected to have been caused by fishery interactions, only four could be confirmed as fishery-related deaths; two of these harbor porpoise deaths were self-reported by the Puget Sound Region salmon gillnet fishery in 2006 and the other two deaths (1 in 2006 and 1 in 2007) are listed in Table 1 as occurreding in an unknown Puget Sound Region fishery.~~

STATUS OF STOCK

Harbor porpoise are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the ~~total~~ minimum annual level of total human-caused mortality and serious injury ~~is 2.6 (2.2 + 0.4)~~ (7.2) harbor porpoise per year (corrected for undetected strandings) does not exceed the PBR of 66 animals. ~~A PBR cannot be calculated for this stock because there is no current abundance estimate. The previous estimate of PBR was 63 (Carretta~~ et al. ~~2009).~~The current PBR is 60 ~~Human-caused mortality relative to PBR is unknown, but it is considered to be small relative to the stock size.~~ Therefore, the Washington Inland Waters harbor porpoise stock is not classified as "strategic." The minimum ~~total~~ annual fishery mortality and serious injury for this stock ~~is~~ (~~2.2~~ 7.2 harbor porpoise per year ~~(based on self-reported fisheries information (1.0) and stranding data (1.2) where observer data were not available or failed to detect harbor porpoise mortality)~~ exceeds 10% of the calculated PBR (6.6) and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. ~~Since a PBR cannot be calculated for this stock, fishery mortality relative to PBR is unknown.~~ The status of this stock relative to its Optimum Sustainable Population (OSP) ~~level~~ and population trends is unknown. Although harbor porpoise sightings in southern Puget Sound declined from the 1940s through the 1990s, harbor porpoise have ~~been sighted in southern Puget Sound in recent vessel surveys~~ increased seasonally in this area in the last 10 years.

This stock is not recognized as "strategic," however, the current mortality rate is based on ~~fisherman self-reports and~~ stranding data, since the Washington Puget Sound Region salmon set/drift gillnet fishery has not been observed since 1994. Evaluation of the estimated take level is complicated by a lack of knowledge about the extent to which harbor porpoise from U.S. waters frequent the waters of British Columbia and are, therefore, subject to fishery-related mortality. It is appropriate to consider whether the current take level is different from the take level in 1994, when the fishery was last observed. No new information is available about mortality per set, but 1) fishing effort has decreased ~~in recent years~~ since 1994. Based on surveys conducted in between 1991/1992 and 2015 (Calambokidis *et al.* 1993, Smultea *et al.* 2015a, 2015b), the population appears to have increased, but a statistical trend analysis has been performed with existing data. An increase in harbor porpoise use of southern Puget Sound in recent years is apparent however (Evenson *et al*. 2016). ~~and 2) analysis of data from aerial surveys in 2002/2003 and 2003~~2015 ~~indicates that abundance has increased since 1996~~.

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Revised ~~01/15/2011~~ 08/22/2016

DALL'S PORPOISE (*Phocoenoides dalli dalli*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Dall's porpoises are endemic to temperate waters of the North Pacific Ocean. Off the U.S. west coast, they are commonly seen in shelf, slope and offshore waters (Figure 1; Morejohn 1979). Sighting patterns from aerial and shipboard surveys conducted in California, Oregon and Washington ~~at different times~~ (Green et al. 1992, 1993; ~~Mangels and Gerrodette 1994; Barlow 1995; Forney et al. 1995~~ Forney and Barlow 1998; Barlow 2016) suggest that north-south movement between these states occurs as oceanographic conditions change, both on seasonal and inter-annual time scales. The southern end of this population's range is not well-documented, but they are commonly seen off Southern California in winter, and during cold-water periods they probably range into Mexican waters off northern Baja California. The stock structure of eastern North Pacific Dall's porpoises is not known, but based on patterns of stock differentiation in the western North Pacific, where they have been more intensively studied, it is expected that separate stocks will emerge when data become available (Perrin and Brownell 1994). Although Dall's porpoises are not restricted to U.S. territorial waters, there are no cooperative management agreements with Mexico or Canada for fisheries which may take this species (e.g. gillnet fisheries). For the Marine Mammal Protection Act (MMPA) stock assessment reports, Dall's porpoises within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Alaskan waters.

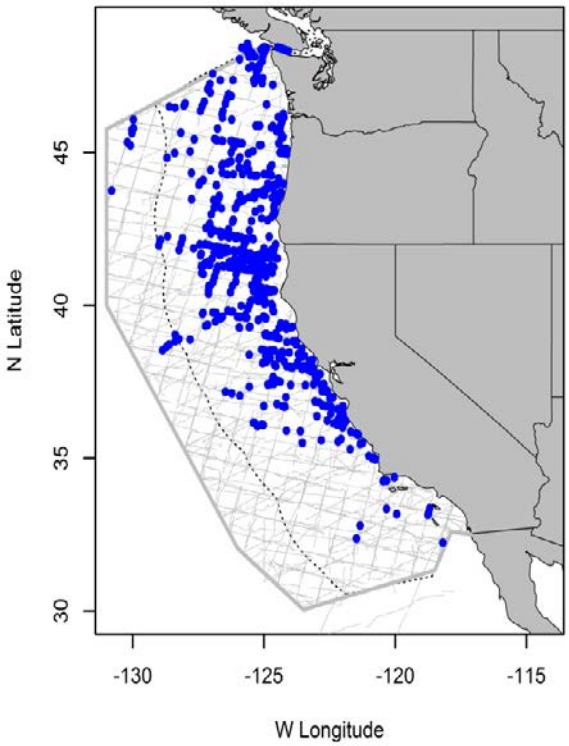

Figure 1. Dall's porpoise sightings based on ~~aerial and~~ shipboard surveys off California, Oregon, and Washington, 1991-2014 (Barlow 2016). ~~2008 (see Appendix 2 for data sources and information on timing and location of survey effort).~~ Dashed line represents the U.S. EEZ, thin gray lines represent the completed transect effort of all surveys combined~~. Key: ● = summer/autumn ship-based sightings; ■ = winter/spring aerial-based sightings.~~

POPULATION SIZE

Dall's porpoise distribution in this region is highly variable between years and appears to be affected by oceanographic conditions (Forney 1997; Forney and Barlow 1998, Barlow 2016). Because animals may spend time outside the U.S. Exclusive Economic Zone as oceanographic conditions change, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The most recent estimate of Dall's porpoise abundance is the geometric mean of estimates from ~~2005 (Forney 2007) and 2008 (Barlow 2010)~~ 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, ~~or 42,000~~ 25,750 (CV = ~~0.33~~ 0.45) animals (Barlow 2016). This estimate includes new correction factors for animals missed during the surveys.~~–~~ Additional numbers of Dall's porpoises occur in the inland waters of Washington state, but the most recent abundance estimate obtained in 1996 (900 animals, CV=0.40) is over 8 years old (Calambokidis et al. 1997) and is not included in the overall estimate of abundance for this stock.

Minimum Population Estimate

The log-normal 20th percentile of the ~~2005-2008~~ 2008-2014 average abundance estimate for the outer coast of California, Oregon and Washington waters is ~~32,106~~17,954 Dall's porpoises.

Current Population Trend

The distribution and abundance of Dall's porpoise off California, Oregon and Washington varies considerably at both seasonal and interannual time scales (Forney and Barlow 1998, Becker *et al*. 2012, Barlow 2016), but no longterm trends have been identified. ~~No information is available regarding trends in abundance of Dall's porpoises in California, Oregon and Washington. Their distribution and abundance in this region varies considerably at both seasonal and interannual time scales as oceanographic conditions vary (Forney 1997; Forney and Barlow 1998).~~

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for Dall's porpoise off the U.S. west coast.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~32,106~~17,954) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.40~~ 0.48 (for a species of unknown status and mortality rate CV between 0.3 and 0.6; Wade and Angliss 1997), resulting in a PBR of ~~257~~ 172 Dall's porpoises per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury information for this stock of Dall's porpoises is given in Table 1. More detailed information on these fisheries is provided in Appendix 1. ~~Mean annual takes for all fisheries for which mortality data are available are ≥0.4 animals per year.~~ The estimate of ~~Mortality estimates~~ mortality and serious injury for Dall's porpoise in the California drift gillnet fishery ~~are included~~ for the five most recent years of monitoring, 2010-2014, is 1.3 (CV=0.46) Dall's porpoise, or an average of 0.3 animals per year (Carretta *et al*. 2016). Although Dall's porpoises have been incidentally killed in West Coast groundfish fisheries in the past, no takes of this species were observed during the five most recent years for which data are available, 2009-2013 (Jannot et al. 2011; NWFSC unpublished data). Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki et al. 1993), where Dall's porpoise may occasionally be found, but no recent bycatch data from Mexico are available. ~~2004-2008 (Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b). After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). However, because of interannual variability in entanglement rates and the relative rarity of Dall's porpoise entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species.~~

~~Mortality of Dall's porpoises has also been documented in the California/Oregon/Washington domestic groundfish trawl fisheries (Perez and Loughlin 1991; Perez 2003). Between 2002 and 2006 with 100% of the fishing effort observed, one Dall's porpoise was reported killed in the at-sea processing portion of the Pacific hake trawl fishery. Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~

Table 1. Summary of available information on the incidental mortality and serious injury of Dall's porpoises (California/ Oregon/Washington Stock) in commercial fisheries that might take this species (Carretta *et al*. 2016; Jannot *et al*. 2011). All observed entanglements of Dall'resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. Mean annual takes are based on ~~2004-2008~~ 2010-2014 data for the CA/OR swordfish drift gillnet fishery and ~~2002-2006~~ 2005-2009 for groundfish fisheries.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated ~~Annual~~ Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	~~20.6%~~ ~~20.9%~~ ~~18.5%~~ ~~16.4%~~ ~~13.5%~~ 22%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 1[1]	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 1.3 (0.46)	~~0 (n/a)~~ 0.3 (0.46)
WA/OR/CA groundfish (bottom trawl)[a]	observer	2009-2013	23% (2009) 18% (2010) 100% (2011-2013)	0	0	0
~~**WA/OR/CA domestic groundfish trawl (At-sea processing Pacific hake fishery).**~~ WA/OR/CA groundfish (midwater trawl - at-sea hake sector)	observer	~~2002~~ ~~2003~~ ~~2004~~ ~~2005~~ ~~2006~~ 2009-2013	~~100%~~ ~~100%~~ ~~100%~~ ~~100%~~ ~~100%~~ 100%	~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	~~0.2 (n/a)~~ 0
WA/OR/CA groundfish (midwater trawl - shoreside hake sector)[b]	observer	2011-2013	100%	0	0	0
~~**Puget Sound salmon drift gillnet (tribal fishery, Area 5, Strait of Juan de Fuca)**~~	~~MMAP~~	~~2000-2004~~	~~n/a~~	~~1~~	~~1~~	~~≥0.2 (n/a)~~
Minimum total annual takes						~~≥0.4 (n/a)~~ 0.3 (0.46)

[a]The bottom trawl fishery was a limited entry fishery in 2010 and a catch shares fishery in 2011-2013.
[b]Fishery observers began monitoring the shoreside hake sector of the fishery in 2011.

STATUS OF STOCK

The status of Dall's porpoises in California, Oregon and Washington relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. No habitat issues are known to be of concern for this species. It is not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. The average annual human-caused mortality of Dall's porpoise (~~≥0.4~~ 0.3 animals) is estimated to be less than the PBR (~~257~~ 172), and ~~therefore~~ they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

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PACIFIC WHITE-SIDED DOLPHIN (*Lagenorhynchus obliquidens*): California/Oregon/Washington, Northern and Southern Stocks

STOCK DEFINITION AND GEOGRAPHIC RANGE

Pacific white-sided dolphins are endemic to temperate waters of the North Pacific Ocean, and common both on the high seas and along the continental margins (Brownell et al. 1999). Off the U.S. west coast, Pacific white-sided dolphins occur primarily in shelf and slope waters (Figure 1). Sighting patterns from aerial and shipboard surveys conducted in California, Oregon and Washington (Green et al. 1992; 1993; ~~Barlow 1995; Forney et al. 1995~~ Forney and Barlow 1998; Barlow 2016) suggest seasonal north-south movements, with animals found primarily off California during the colder water months and shifting northward into Oregon and Washington as water temperatures increase in late spring and summer ~~(Green et al. 1992; Forney 1994)~~.

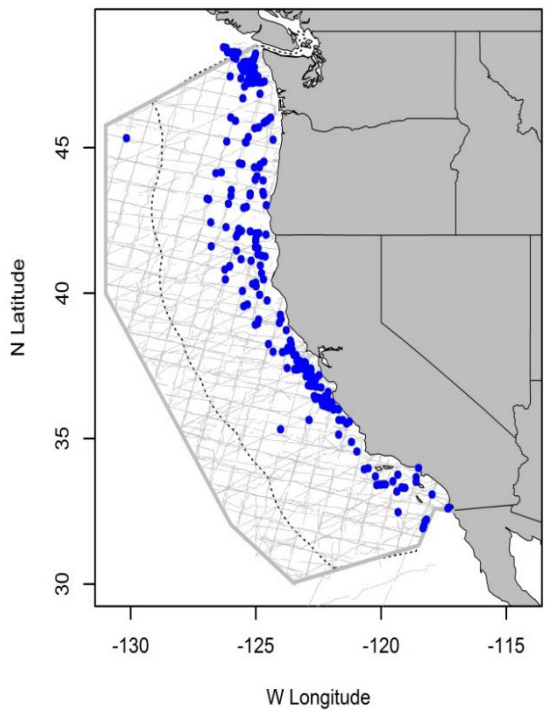

Figure 1. Pacific white-sided dolphin sightings based on ~~aerial and~~ shipboard surveys off California, Oregon, and Washington, 1991-2014 (Barlow 2016). ~~2008 (see Appendix 2 for data sources and information on timing and location of survey effort).~~ Dashed line represents the U.S. EEZ, thin gray lines indicate completed transect effort of all surveys combined. ~~Key: ● = summer/autumn ship-based sightings; ▲ = winter/spring aerial-based sightings.~~

Stock structure throughout the North Pacific is poorly understood, but based on morphological evidence, two forms are known off the California coast (Walker et al. 1986~~; Chivers et al. 1993~~). Specimens belonging to the northern form were collected from north of about 33ºN, (Southern California to Alaska), and southern specimens were obtained from about 36ºN southward along the coasts of California and Baja California. Samples of both forms have been collected in the Southern California Bight, but it is unclear whether this indicates sympatry in this region or whether they may occur there at different times (seasonally or interannually). Genetic analyses have confirmed the distinctness of animals found off Baja California from animals occurring in U.S. waters north of Point Conception, California and ~~in~~ the high seas of the North Pacific (Lux et al. 1997). Based on these genetic data, an area of mixing between the two forms appears to be located off Southern California (Lux et al. 1997). Two types of echolocation have been documented for Pacific white-sided dolphins off Southern California and these have been hypothesized to reflect acoustic differences between the two forms (Soldevilla et al. 2008, 2011; Henderson et al. 2011).

Although there is clear evidence that two forms of Pacific white-sided dolphins occur along the U.S. west coast, there are no known differences in color pattern, and it is not currently possible to distinguish ~~animals~~ the two stocks reliably during surveys. ~~without genetic or morphometric analyses~~. Geographic stock boundaries appear dynamic and are poorly understood, and therefore cannot be used to differentiate the two forms. Until means of differentiating the two forms for abundance and mortality estimation are developed, these two stocks ~~must be~~are managed as a single unit.~~; however, this is an undesirable management situation~~. ~~Furthermore, Pacific white-sided dolphins are not restricted to U.S. territorial waters, but cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Until these goals are accomplished, the management stock includes animals of both forms.~~ Pacific white-sided dolphins are not restricted to U.S. territorial waters, but there are no cooperative management agreements with Mexico or Canada for fisheries which may take this species (e.g. gillnet fisheries). For the Marine Mammal Protection

Act (MMPA) stock assessment reports, Pacific white-sided dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Alaskan waters.

POPULATION SIZE

~~The most recent estimates of abundance for Pacific white-sided dolphins are based on two summer/autumn shipboard surveys conducted within 300 nmi of the coasts of California, Oregon, and Washington in 2005 (Forney 2007) and 2008 (Barlow 2010).~~ The distribution of Pacific white-sided dolphins throughout this region is highly variable, apparently in response to oceanographic changes on both seasonal and interannual time scales (Forney and Barlow 1998, Barlow 2016). As oceanographic conditions vary, Pacific white-sided dolphins may spend time outside the U.S. Exclusive Economic Zone, and therefore a multi-year average abundance estimate including California, Oregon and Washington is the most appropriate for management within U.S. waters. The most recent estimate of Pacific white-sided dolphin abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, 26,814 (CV = 0.28) animals (Barlow 2016). This estimate includes new correction factors for animals missed during the surveys. ~~The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the two most recent ship surveys is 26,930 (CV=0.28) Pacific white-sided dolphins (Forney 2007, Barlow, 2010).~~

Minimum Population Estimate

The log-normal 20th percentile of the ~~2005-2008~~ 2008-2014 average abundance estimate is ~~21,406~~ 21,195 Pacific white-sided dolphins.

Current Population Trend

The distribution and abundance of Pacific white-sided dolphins off California, Oregon and Washington varies considerably at both seasonal and interannual time scales (Forney and Barlow 1998, Becker et al. 2012, Barlow 2016), but no longterm trends have been identified. ~~No long-term trends in the abundance of Pacific white-sided dolphins in California, Oregon and Washington are suggested based on historical and recent surveys (Dohl et al. 1980; 1983; Green et al. 1992; 1993; Barlow 1995; Forney et al. 1995, Barlow and Forney 2007, Forney 2007, Barlow 2010).~~

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for Pacific white-sided dolphins off the U.S. west coast.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~21,406~~ 21,195) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.40~~ 0.45 (for a species of unknown status with a mortality rate CV~~>0.80~~ between 0.6 and 0.8; Wade and Angliss 1997), resulting in a PBR of ~~171~~ 191 Pacific white-sided dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~**New Serious Injury Guidelines**~~

~~NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al.* 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.~~

Fishery Information

A summary of recent fishery mortality and injury information for this stock of Pacific white-sided dolphin is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. The estimate of mortality and serious injury for Pacific white-sided dolphin in the California drift gillnet fishery

for the five most recent years of monitoring, 2010-2014, is 4.4 (CV=0.76) individuals, or an average of 0.9 per year (Carretta *et al*. 2016). Although some Pacific-white sided dolphins have been incidentally killed in West Coast groundfish fisheries in the past, no takes of this species were observed during 2009-2013 (Jannot et al. 2011, NWFSC unpublished data). ~~Including mortality from drift gillnet, groundfish trawl, and unknown fisheries, the average annual fishery-related mortality of Pacific white-sided dolphins is 11.8 (CV=0.88) animals. Mortality estimates for the California swordfish drift gillnet fishery are included for the five most recent years of monitoring, 2007-2011 (2009a, 2009b, 2010, 2012a, 2012b). Acoustic pinger use in the swordfish drift gillnet fishery appears to reduce bycatch rates of Pacific white-sided dolphins, but the reduction is not statistically significant, given the rarity of bycatch of this species (Carretta and Barlow 2011). Bycatch estimates for the U.S. west coast groundfish fleet are summarized by Jannot et al. (2011).~~ Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki et al. 1993), but no recent bycatch data from Mexico are available.

Table 1. Summary of available information on the incidental mortality and injury of Pacific white-sided dolphins (California/ Oregon/Washington Stock) in commercial fisheries that might take this species (Carretta *et al*. 2016a; Jannot *et al*. 2011). All observed entanglements of Pacific white-sided dolphins resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. Mean annual takes are based on ~~2007-2011~~ 2010-2014 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated ~~Annual~~ Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer	~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ ~~2011~~ 2010-2014	~~16.4%~~ ~~13.5%~~ ~~13.0%~~ ~~11.9%~~ ~~19.5%~~ 22%	~~1~~ ~~5~~ ~~2~~ ~~0~~ ~~0~~ 0[1]	~~6 (1.00)~~ ~~37 (0.70)~~ ~~15 (1.02)~~ ~~0~~ ~~0~~ 4.4 (0.76)	~~11.6 (0.88)~~ 0.9 (0.76)
WA/OR/CA groundfish (bottom trawl)	observer	2009-2013	23% (2009) 18% (2010) 100% (2011-2013)	0	0	0
~~**WA/OR/CA domestic groundfish trawl (At-sea processing Pacific hake fishery).**~~ WA/OR/CA groundfish (midwater trawl - at-sea hake sector)	observer	~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ ~~2009~~ 2009-2013	~~100%~~ ~~100%~~ ~~99%~~ ~~99%~~ ~~100%~~ 100%	0 0 0 0 0 0	0 0 0 0 0 0	0 0
~~**West Coast limited entry bottom trawl fishery**~~	~~observer~~	~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ ~~2009~~	~~18 – 23%~~	~~0~~	~~0~~	~~0~~
WA/OR/CA groundfish (midwater trawl - shoreside hake sector)	observer	2011-2013	100%	0	0	0
~~**Unknown fishery**~~	~~stranding~~	~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ ~~2011~~		~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~	~~n/a~~	~~≥0.2 (n/a)~~
Minimum total annual takes						~~11.8 (0.88)~~ 0.9 (0.76)

[1] There were no observations of Pacific white-sided dolphin in this fishery during 2010-2014, but the model-based estimate of bycatch for this period results in a positive estimate of bycatch (Carretta *et al*. 2016a).

Other removals

Pacific white-sided dolphins have been seriously injured and killed in scientific research trawls for sardines and rockfish. From ~~2007~~ 2010 through ~~2011~~2014, there were 26 deaths and ~~4~~ 2 serious injuries of Pacific white-sided dolphins in scientific research trawls (Carretta *et al*. ~~2013~~2016b). One Pacific white-sided dolphin stranded dead in Washington Inland waters during 2014, and the cause of death was determined to be a vessel strike (Carretta *et al*. 2016b). The average annual ~~research related~~ mortality and serious injury of Pacific white-sided dolphin from other anthropogenic activities during ~~2007-2011 is 6.0~~ 2010-2014 is 5.8 animals.

STATUS OF STOCK

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. 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. ~~Including commercial fishery (11.8/yr) and research-related mortality (6.0/yr), the average annual mortality for the 5-year period 2007-2011is 17.8 animals.~~ The average annual human-caused mortality and serious injury from all known sources during 2010-2014 ~~in 2007-2011~~ (~~17.8~~ 6.7 animals) is estimated to be less than the PBR (~~171~~191), and therefore ~~they~~ this stock of Pacific white-sided dolphins is ~~are~~ not classified as a "strategic" stock under the MMPA. The total commercial fishery mortality and serious injury for this stock (~~11.8~~ 0.9 /yr) is less than 10% of the calculated PBR and, therefore, is considered to be insignificant and approaching zero ~~mortality and serious injury rate~~. ~~Including research related takes, annual mortality of this stock (17.8/yr) exceeds 10% of the calculated PBR, but under Section 118 of the MMPA, only commercial takes are evaluated against the zero mortality rate goal (ZMRG).~~

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Revised ~~01/15/2011~~ 08/22/2016

RISSO'S DOLPHIN (*Grampus griseus*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Risso's dolphins are distributed world-wide in tropical and warm-temperate waters. Off the U.S. West coast, 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. Based on sighting patterns from recent aerial and shipboard surveys conducted in these three states during different seasons (Figure 1), animals found off California during the colder water months are thought to shift northward into Oregon and Washington as water temperatures increase in late spring and summer (Green et al. 1992, 1993). The southern end of this population's range is not well-documented, but previous surveys have shown a conspicuous 500 nmi distributional gap between these animals and Risso's dolphins sighted south of Baja California and in the Gulf of California (Mangels and Gerrodette 1994). Thus this population appears distinct from animals found in the eastern tropical Pacific and the Gulf of California. Although Risso's dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). For the Marine Mammal Protection Act (MMPA) stock assessment reports, Risso's dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Hawaiian waters.

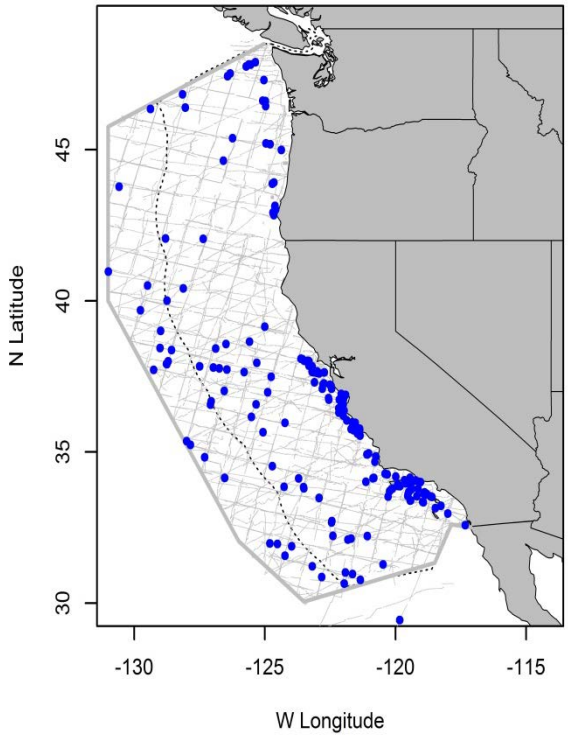

Figure 1. Risso's dolphin sightings based on ~~aerial and~~ shipboard surveys off California, Oregon, and Washington, 1991-2014 (Barlow 2016) ~~2008 (see Appendix 2 for data sources and information on timing and location of survey effort)~~. Dashed line represents the U.S. EEZ, thin gray lines indicate completed transect effort of all surveys combined. ~~Key: ● = summer/autumn ship-based sightings; ■ = winter/spring aerial-based sightings.~~

POPULATION SIZE

~~Current estimates of population size are derived from two shipboard surveys within 300 nmi of the coasts of California, Oregon, and Washington in summer/autumn of 2005 (Forney 2007) and 2008 (Barlow 2010).~~ The distribution of Risso's dolphins throughout this region is highly variable, apparently in response to oceanographic changes on both seasonal and interannual time scales (Forney and Barlow 1998). As oceanographic conditions vary, Risso's dolphins may spend time outside the U.S. Exclusive Economic Zone, and therefore a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The most recent estimate of Risso's dolphin abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, 6,336 (CV = 0.32) animals (Barlow 2016). This estimate includes new correction factors for animals missed during the surveys. ~~The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the two most recent ship surveys is 6,272 (CV=0.30) Risso's dolphins (Forney, 2007, Barlow 2010).~~

Minimum Population Estimate

The log-normal 20th percentile of the ~~2005-2008~~ 2008-2014 geometric mean abundance estimate is ~~4,913~~ 4,817 Risso's dolphins.

Current Population Trend

~~Barlow and Forney (2007) and Barlow (2010) report abundance estimates ranging from approximately 4,000 to 11,000 animals in California waters for five separate surveys conducted between 1991 and 2008, with no apparent trend in abundance. Inter-annual variability in the distribution of Risso's dolphin within the ship survey study area is likely responsible for the differences in estimated abundance between surveys.~~ The distribution and abundance of Risso's dolphins off California, Oregon and Washington varies considerably at both seasonal and interannual time scales (Forney and Barlow 1998, Becker *et al*. 2012, Barlow 2016), but no longterm trends have been identified.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this stock.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~4,913~~ 4,817) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.40~~ 0.48 (for a species of unknown status with a mortality rate CV ~~> 0.80~~ between 0.3 and 0.6; Wade and Angliss 1997), resulting in a PBR of ~~39~~ 46 Risso's dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury information for this stock of Risso's dolphin is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. The estimate of mortality and serious injury for Risso's dolphin in the California drift gillnet fishery for the five most recent years of monitoring, 2010-2014, is 9.0 (CV=0.70) individuals, or an average of 1.8 per year (Carretta *et al*. 2016a). Although some Risso's dolphins have been incidentally killed in West Coast groundfish fisheries in the past, no takes of this species were observed during 2009-2013 (Jannot *et al*. 2011, NWFSC unpublished data). Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki *et al*. 1993), but no recent bycatch data from Mexico are available. ~~Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 2004-2008 (Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b). After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). However, because of interannual variability in entanglement rates and the relative rarity of Risso's dolphin entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Mean annual takes in Table 1 are based on 2004-2008 data. This results in an average estimate 1.6 (CV = 0.99) Risso's dolphins taken annually.~~

~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~

Historically, Risso's dolphin mortality has been documented in the squid purse seine fishery off Southern California (Heyning et al. 1994). This mortality probably represented animals killed intentionally to protect catch or gear, rather than incidental mortality, and such intentional takes are now illegal under the 1994 Amendment to the MMPA. This fishery ~~has~~ expanded markedly since 1992 (California Department

of Fish and Game, unpubl. data). An observer program in the squid purse seine fishery from 2004-2008 observed ~~was initiated in 2004 and a total of~~ 377 sets (<10%) ~~have been observed through 2008~~ without a Risso's dolphin interaction. ~~Observer coverage in this fishery has been less than 10% of all fishing effort.~~

Human-caused mortality and injury documentation is often based on stranding data, where raw counts are negatively-biased because only a fraction of carcasses are detected. Carretta *et al.* (2016b) estimated the mean recovery rate of California coastal bottlenose dolphin carcasses to be 25% (95% CI 20% - 33%) and stated that given the extremely coastal habits of coastal bottlenose dolphins, carcass recovery rates for this stock represented a maximum, compared with more pelagic dolphin species in the region. Therefore, in this stock assessment report and others involving dolphins along the U.S. West Coast, human-related deaths and injuries counted from beach strandings along the outer U.S. West Coast are multiplied by a factor of 4 to account for the non-detection of most carcasses (Carretta *et al*. 2016b). Three Risso's dolphins stranded during 2010-2014 with evidence of fishery interaction (Carretta *et al*. 2016c), yielding a minimum estimate of 12 fishery-related dolphin deaths.

Table 1. Summary of available information on the incidental mortality and serious injury of Risso's dolphin (California/ Oregon/Washington Stock) in commercial fisheries that might take this species (Carretta *et al*. 2016b, 2016c; Jannot *et al*. 2011; NWFSC, unpublished data). All observed entanglements of Risso's dolphins resulted in the death of the animal. Human-caused mortality values based on strandings recovered along the outer U.S. West Coast are multiplied by a correction factor of 4 to account for undetected mortality (Carretta *et al*. 2016a).Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. ~~Mean annual takes are based on 2004-2008 data unless noted otherwise.~~

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated ~~Annual~~ Mortality (CV)	Mean Annual Takes (CV)
CA/OR thresher shark/swordfish drift gillnet fishery	observer	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	~~20.6%~~ ~~20.9%~~ ~~18.5%~~ ~~16.4%~~ ~~13.5%~~ 22%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~1~~ 1[1]	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~7 (0.99)~~ 9 (0.70)	~~1.4 (0.99)~~ 1.8 (0.70)
~~**CA shallow set longline fishery**~~	~~observer~~	~~2004 No fishery in 2005~~	~~< 10%~~		~~0~~	~~0~~
CA deep set longline fishery	observer	2005-2008	100%	0	0	0
Market squid purse seine	observer	2004-2008	<10%	0	0	0
Unknown fishery	Stranding	~~2004-2008~~ 2007-2013		~~1~~ 3	~~≥1~~ ≥ 12	~~≥0.2~~ ≥2.4 (0.46)[2]
WA/OR/CA groundfish (bottom trawl)[a]	observer	2009-2013	23% (2009) 18% (2010) 100% (2011-2013)	0	0	0
Minimum total annual takes (includes correction for unobserved beach strandings)						~~1.6 (0.99)~~ ≥ 4.2 (0.40)

STATUS OF STOCK

The status of Risso's dolphins off California, Oregon and Washington relative to OSP is not known, and there are insufficient data to evaluate potential 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. Over the last 5-year period (~~2004-2008~~ 2010-

[1] One Risso's dolphin entanglement was observed during the period 2010-2014. The entanglement occurred in 2011 (Carretta *et al.* 2016a).

[2] The coefficient of variation (CV) for corrected carcass counts was derived from the results of Carretta *et al*. (2016b), who estimated that 25% (95% CI = 20% - 33%) of all available carcasses were recovered / documented.

2014), the average annual human-caused mortality (~~1.6~~ 4.2 animals) is estimated to be less than the PBR (~~39~~ 46), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock (4.2) is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero~~ mortality and serious injury rate~~.

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COMMON BOTTLENOSE DOLPHIN (*Tursiops truncatus*): California Coastal Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bottlenose dolphins are distributed world-wide in tropical and warm-temperate waters. In many regions, including California, separate coastal and offshore populations are known (Walker 1981; Ross and Cockcroft 1990; Van Waerebeek et al. 1990). The California coastal stock of bottlenose dolphins is distinct from the offshore stock, based on significant differences in genetics and cranial morphology (Perrin et al. 2011, Lowther-Thielking *et al.* 2015). ~~From~~Of 56 haplotypes found among coastal and offshore bottlenose dolphins in the region, only one is shared by both populations (Perrin et al. 2011). ~~Based on nuclear and mtDNA analyses, Lowther (2006) identified 5 haplotypes from 29 coastal animals and 25 haplotypes from 40 offshore animals from the U.S. west coast. There were no shared haplotypes between coastal and offshore animals and significant genetic differentiation between the two ecotypes was evident.~~ California coastal bottlenose dolphins are found within about one kilometer of shore (Hansen, 1990; Carretta et al. 1998; Defran and Weller 1999) ~~primarily~~ from ~~Point Conception~~central California south into Mexican waters, at least as far south as San Quintin, Mexico (Figure 1). In southern California, animals are found within 500 m of the shoreline 99% of the time and within 250 m 90% of the time (Hanson and Defran 1993). Oceanographic events appear to influence the distribution of animals along the coasts of California and Baja California, Mexico, as indicated by a change in residency patterns along Southern California and a northward range extension into central California after the 1982-83 El Niño (Hansen and Defran 1990; Wells et al. 1990). Since the 1982-83 El Niño, which increased water temperatures off California, they have been consistently sighted in central California as far north as San Francisco. Photo-identification studies have documented north-south movements of coastal bottlenose dolphins (Hansen 1990; Defran et al. 1999), and monthly counts based on surveys between the U.S./Mexican border and Point Conception are variable (Carretta et al. 1998), indicating that animals are moving into and out of this area. There is little site fidelity of coastal bottlenose dolphins along the California coast; over 80% of the dolphins identified in Santa Barbara, Monterey, and Ensenada have also been identified off San Diego (Defran et al. 1999, Feinholz 1996, Defran *et al.* 2015~~, Defran, unpublished data~~). The area between Ensenada and San Quintin, Mexico may represent a southern boundary for the California coastal population, as very low rates of photo-ID overlap of individuals (3%) have been found between the two areas, compared to higher overlap rates to the north (Defran *et al.* 2015, Figure 1). Although coastal bottlenose dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species. Therefore, the management stock includes only animals found within U.S. waters. For the Marine Mammal Protection Act (MMPA) stock assessment reports, bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into ~~three~~ seven stocks: ~~1) California coastal stock (this report), 2) California, Oregon and Washington offshore stock, and 3) Hawaiian stock.~~1) California coastal stock (this

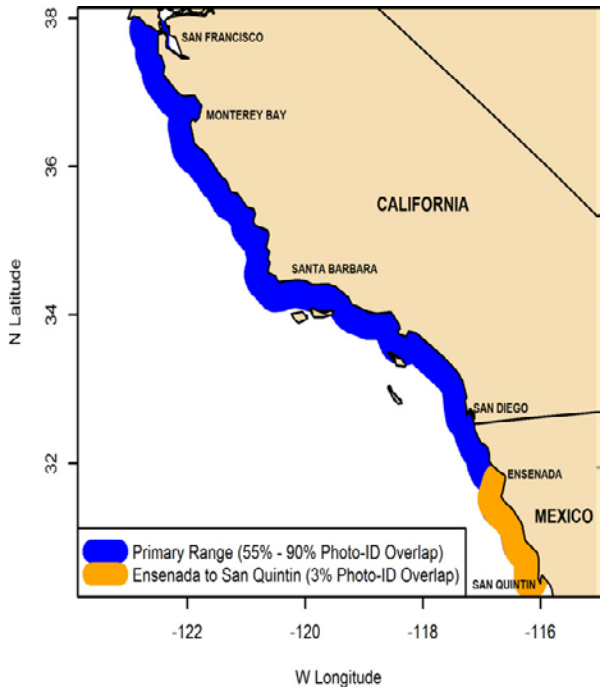

Figure 1. Approximate latitude range ~~(in bold)~~ of California coastal bottlenose dolphins, based on ~~aerial surveys along the coast of California from 1990-2000.~~ aerial and boat-based sighting surveys. This population of bottlenose dolphins is found within about 1 km of shore.

report), 2) California, Oregon and Washington offshore stock, and five stocks in Hawaiian waters: 3) Kauai/Niihau, 4) Oahu, 5) 4-Islands (Molokai, Lanai, Maui, Kahoolawe), 6) Hawaii Island and 7) the Hawaiian Pelagic Stock.

POPULATION SIZE

Based on photographic mark-recapture surveys conducted along the San Diego coast ~~in 2004 and 2005~~ from 2009 to 2011 (Weller *et al*. 2016), two separate population size estimates were generated from open and closed mark-recapture models. The best open model generated an estimate of 515 (95% CI = 470–564, CV= 0.05) animals, while the best closed model produced an estimate of 453 (95% CI = 411–524, CV=0.06) animals. These estimates are for *marked animals only* and do not include an estimated ~ 40% of animals that are not individually recognizable (Weller *et al*. 2016). The estimated fraction of unmarked animals is highly uncertain because it is unknown how often unmarked animals are resighted. The new estimates are the largest obtained for this stock, dating back to the 1980s (Defran and Weller 1999, Dudzik 1999, Dudzik *et al.* 2006). For comparison with previous estimates of this stock, the closed population estimate of 453 (CV=0.06) animals is used as the best estimate of abundance. ~~the most recent estimate of population size is 323 dolphins (CV = 0.13, 95% CI 259-430; Dudzik~~ et al. ~~2006). This estimate does not reflect that approximately 35% of dolphins encountered lack identifiable dorsal fin marks (Defran and Weller 1999). If 35% of all animals lack distinguishing marks, then the true population size would be closer to 450-500 animals. Comparing the most recent population size estimate with those obtained from 1987-89 (354 dolphins, 95% CI 330 – 390) and 1996-98 (356 dolphins, 95% CI 306 – 437; Dudzik 1999) suggests that the population size has been stable for approximately 20 years. Older estimates of population size for this stock range from 234 (95% CI 205-263) to 285 (95% CI 265-306) animals for the period 1985-89 (Defran and Weller 1999). Because coastal bottlenose dolphins spend an unknown amount of time in Mexican waters, where they may be subject to mortality in Mexican fisheries, an average abundance estimate for California only is the most appropriate for U.S. management of this stock.~~

Minimum Population Estimate

~~The minimum number of dolphins photographically identified during 2004-2005 field studies was 164, however, the discovery curve for new animals had not yet reached an asymptote during that study (Dudzik et al. 2006). The minimum population estimate for this stock is therefore taken as the lower 20th percentile of the log-normal distribution of abundance obtained from the photographic mark-recapture estimate (Dudzik et al. 2006), or approximately 290 dolphins.~~ The minimum population size is based on the minimum number of individually identifiable animals documented during surveys in 2009-2011, or 346 animals (Weller *et al*. 2016). This number of individually recognizable dolphins exceeds the number recorded in previous survey periods: 1984-1986 (160 dolphins); 1987-1989 (284); 1996-1998 (260); and 2004-2005 (164) (Weller *et al.* 2016).

Current Population Trend

Based on a comparison of mark-recapture abundance estimates for the periods 1987-89 ($\hat{N}$= 354), 1996-98 ($\hat{N}$= 356), and 2004-05 ($\hat{N}$= 323), Dudzik et al. (2006) stated that the population size had remained stable over this period. New estimates of 450 – 515 animals based on 2009-2011 surveys are the highest to date and include a high proportion (~75%) of previously uncatalogued dolphins (Weller *et al*. 2016). The number of individually-identifiable animals from 2009-2011 surveys (346) is equal to or exceeds previous mark-recapture *abundance estimates* for this stock. This suggests that the population may be growing, although the movement of dolphins north from Mexican waters may also contribute to the observed increase in unique individuals.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for California coastal bottlenose dolphins.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~290~~ 346) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.50~~ 0.48 (for a species of unknown status with mortality rate CV ≥ 0.3 and ≤ 0.6 ~~with no estimated fishery mortality~~; Wade and Angliss 1997), resulting in a PBR of ~~2.9~~ 3.3 coastal

bottlenose dolphins per year. Not all California coastal bottlenose dolphins are present in U.S. waters at any given moment and approximately 18% of the stock's range occurs in Mexican waters. Thus, the PBR is prorated by a minimum factor of 0.82 to account for time that animals spend outside of U.S. waters. Without additional data on the residence times of dolphins in Mexican waters, this factor cannot be improved upon. Because this stock spends some of its time outside the U.S. EEZ, the PBR allocation for U.S. waters is ~~2.9~~ 3.3 x 0.82 = ~~2.4~~ 2.7 dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Due to its exclusive use of coastal habitats, this bottlenose dolphin population is susceptible to fishery-related mortality in coastal ~~set net~~ gillnet fisheries, such as the halibut and yellowtail set gillnet fishery, which was responsible for one documented coastal bottlenose dolphin death in 2003. Observer coverage in this fishery from 2010-2014 has been 9% (806 observed sets from an estimated 8,654 sets fished), with no observations of coastal bottlenose dolphin entanglements. Between 2010 and 2014, there were two fishery-related deaths of coastal bottlenose dolphins (stock ID confirmed via genetics, Carretta *et al*. 2016a, Lowther-Thielking *et al*. 2015). Both animals had evidence of entanglement with rope of unknown origin. A summary of information on fishery mortality and injury for this stock of bottlenose dolphin is shown in Table 1. ~~More detailed information on the set gillnet fishery is provided in Appendix 1. From 1991-94, no bottlenose dolphins were observed taken in this fishery with 10-15% observer coverage (Julian and Beeson 1998). The observer program was discontinued at the end of 1994, when coastal set gillnet fishing was banned within 3 nmi of the southern California coast. In 2002, a ban on set gill and trammel nets inshore of 60 fathoms from Point Reyes to Point Arguello became effective. Because of these closures, the potential for mortality of coastal bottlenose dolphins in the California set gillnet fishery has been greatly reduced. Fisher self-report data and 36 stranding records for 1997-2001 do not include any evidence of fishery interactions for this stock. A renewed observer program began in the halibut set gillnet fishery in 2006. Through late 2007, a total of 260 sets were observed without a cetacean interaction. In 2003, an immature female bottlenose dolphin stranded dead in San Diego, California, with 3.5-inch mesh gillnet wrapped around its tailstock (SWFSC stranding KXD0048). Perforation of the animal's skin suggests the net was on the animal for some time. Mitochondrial DNA analysis showed that the haplotype for this animal matches that of known *coastal* animals (Lowther 2006; Lowther et al. in prep). The fishery responsible for this mortality is unknown, but the location and type of gillnet found suggests either a set or drift gillnet targeting yellowtail, white seabass, or barracuda. In 2004, a bottlenose dolphin with missing flukes washed ashore near Newport Beach, California, suggestive of an interaction with an entangling net fishery. The haplotype of this animal matched those of known *offshore* bottlenose dolphins (Lowther 2006; Lowther , in prep).~~ Coastal gillnet fisheries exist in Mexico and may take animals from this population, but no details are available.

Human-caused mortality and injury documentation is often based on stranding data, where raw counts are negatively-biased because only a fraction of carcasses are detected (Williams *et al.* 2011), even for extremely coastal species (Wells *et al.* 2015) . Carretta *et al*. (2016b) estimated the mean recovery rate of carcasses of California coastal bottlenose dolphins to be 25% (95% CI 20% - 33%). Given the extremely coastal habits of California coastal bottlenose dolphins, Carretta *et al*. (2016b) argue that carcass recovery rates for this population represent a maximum rate, compared to more pelagic dolphin species in the region. Therefore, in this stock assessment report and others involving dolphins along the U.S. west coast, human-related deaths and injuries counted from beach strandings are multiplied by a factor of 4 to account for the non-detection of most carcasses (Carretta *et al*. 2016b).

Other removals

Seven coastal bottlenose dolphins were collected during the late 1950s in the vicinity of San Diego (Norris and Prescott 1961). Twenty-seven additional bottlenose dolphins were captured off California between 1966 and 1982 (Walker 1975; Reeves and Leatherwood 1984), but based on the locations of capture activities, these animals probably were offshore bottlenose dolphins (Walker 1975). No additional captures of coastal bottlenose dolphins have been documented since 1982, and no live-capture permits are currently active for this species.

In 2012, a coastal bottlenose dolphin (stock ID confirmed via genetics) was found floating under a U.S. Navy marine mammal program dolphin pen enclosure dock and was assumed to have become entangled in the net curtain (Carretta *et al.* 2016a). Another, presumed coastal bottlenose dolphin (based on

proximity to shore) became entrapped and drowned in a sea otter research net in 2012. The average annual non-fishery related mortality and serious injury of coastal bottlenose dolphins from 2010-2014 is 0.4 animals (2 animals / 5 years).

Table 1. Summary of available information on the incidental mortality and serious injury of bottlenose dolphins (California Coastal Stock) in commercial fisheries that might take this species. ~~A renewed observer program began in the halibut set gillnet fishery in 2006 (12 sets observed total, <1% observer coverage).~~ Human-caused mortality values based on strandings recovered on the outer U.S. West Coast are multiplied by a correction factor of 4 to account for undetected mortality (Carretta *et al.* 2016b).

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA angel shark/ halibut and other species large mesh (>3.5in) set gillnet fishery	observer	~~2002~~ ~~2003~~ ~~2004~~ ~~2005~~ ~~2006~~ 2010-2014	~~0%~~ ~~0%~~ ~~0%~~ ~~0%~~ ~~<1%~~ 9%	0	0	0
Unknown fishery	stranding	~~2002-2006~~ 2010-2014	~~One bottlenose dolphin with a coastal stock haplotype stranded entangled in 3.5-inch mesh gillnet in 2003~~Two strandings with evidence of entanglement in rope or braided material.			≥~~0.2~~ 0.4 x 4 (correction factor) = 1.6 (~~n/a~~0.46)[1]
Minimum total annual takes (includes correction for unobserved beach strandings)						≥~~0.2~~ 1.6 (~~n/a~~0.46)

STATUS OF STOCK

The status of coastal bottlenose dolphins in California relative to OSP is not known, and there is no evidence of a trend in abundance. They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Coastal bottlenose dolphins are not classified as a "strategic" stock under the MMPA because total annual fishery (1.6) and other anthropogenic mortality (0.4) and serious injury for this stock (≥~~0.2~~ 2.0 per year) is less than the PBR (~~2.4~~ 2.7). The total human-caused mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero. Recent population size estimates of 450 to 515 marked individuals are the highest recorded to date (Weller *et al.* 2016), but it is unknown how much of this increase is due to population growth and immigration.

Habitat Issues

Pollutant levels, especially DDT residues, found in Southern California coastal bottlenose dolphins have been found to be among the highest of any cetacean examined (O'Shea et al. 1980; Schafer et al. 1984). Although the effects of pollutants on cetaceans are not well understood, they may affect reproduction or make the animals more prone to other mortality factors (Britt and Howard 1983; O'Shea et al. 1999). This population of bottlenose dolphins may also be vulnerable to the effects of morbillivirus outbreaks, which were implicated in the 1987-88 mass mortality of bottlenose dolphins on the U.S. Atlantic coast (Lipscomb et al. 1994).

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[1] The coefficient of variation (CV) for corrected carcass counts was derived from the results of Carretta *et al.* (2016b), who estimated that 25% (95% CI = 20% - 33%) of all available carcasses were recovered / documented.

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Revised ~~07/15/2014~~ 08/22/2016

COMMON BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): California/Oregon/Washington Offshore Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Bottlenose dolphins are distributed world-wide in tropical and warm-temperate waters. In many regions, including California, separate coastal and offshore populations are known (Walker 1981; Ross and Cockcroft 1990; Van Waerebeek et al. 1990; Lowther 2006). On surveys conducted off California, offshore bottlenose dolphins have been found at distances greater than a few kilometers from the mainland and throughout the Southern California Bight. They have also been documented in offshore waters as far north as about 41ºN (Figure 1), and they may range into Oregon and Washington waters during warm-water periods. Sighting records off California and Baja California (Lee 1993; Mangels and Gerrodette 1994) suggest that offshore bottlenose dolphins have a continuous distribution in these two regions. ~~Based on aerial surveys conducted during winter/spring 1991-92 (Forney et al. 1995) and shipboard surveys conducted in summer/fall 1991 (Barlow 1995),~~ There is no apparent ~~no~~ seasonality in distribution ~~is apparent~~ (Forney and Barlow 1998). Offshore bottlenose dolphins are not restricted to U.S. waters, but cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Therefore, the management stock includes only animals found within U.S. waters. For the Marine Mammal Protection Act (MMPA) stock assessment reports, bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into seven stocks: 1) California coastal stock, 2) California, Oregon and Washington offshore stock (this report), and five stocks in Hawaiian waters: 3) Kauai/Niihau, 4) Oahu, 5) 4-Islands (Molokai, Lanai, Maui, Kahoolawe), 6) Hawaii Island and 7) the Hawaiian Pelagic Stock.

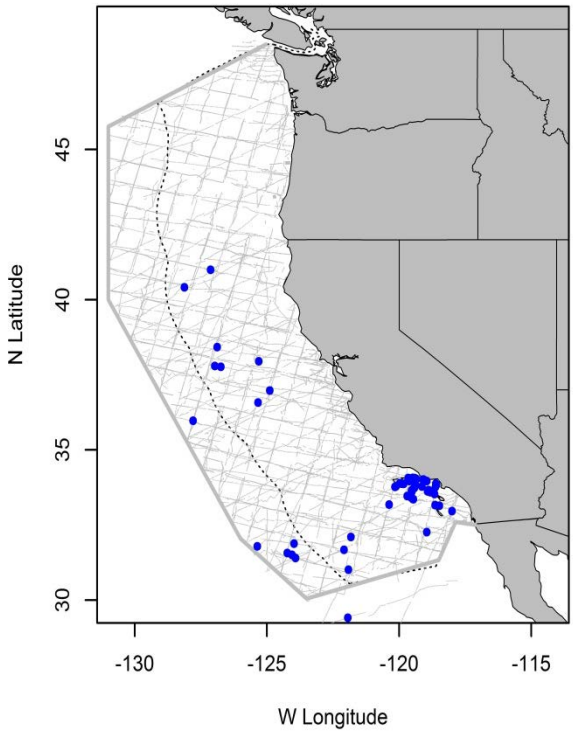

Figure 1. Offshore bottlenose dolphin sightings based on shipboard surveys off California, Oregon, and Washington, 1991-2014 (Barlow 2016). ~~2008 (see Appendix 2 for data sources and information on timing and location of survey effort).~~ Dashed line represents the U.S. EEZ, thin gray lines indicate completed transect effort of all surveys combined.

POPULATION SIZE

~~The most recent shipboard surveys conducted within 300 nmi of the coasts of California, Oregon, and Washington were in 2005 (Forney 2007) and 2008 (Barlow 2010). Because the distribution of bottlenose dolphins appears to vary interannually and they may spend time outside the U.S. Exclusive Economic Zone, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. The most comprehensive multi-year average abundance is the geometric mean abundance estimate for California, Oregon and Washington waters based on the 2005 and 2008 ship surveys, or 1,006 (CV=0.48) offshore bottlenose dolphins (Forney 2007, Barlow 2010).~~ The most recent estimate of bottlenose dolphin abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, 1,924 (CV = 0.54) animals (Barlow 2016). This estimate includes new correction factors for animals missed during the surveys.

Minimum Population Estimate

The log-normal 20th percentile of the ~~2005-2008~~ 2008-2014 ~~average~~ geometric mean abundance estimate is ~~684~~ 1,255 offshore bottlenose dolphins.

Current Population Trend

Trend analyses for this stock have not been performed to date, while other stocks with more urgent conservation concerns are analyzed (e.g., Moore and Barlow 2011, 2013).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this population of offshore bottlenose dolphins.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~684~~1,255) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.40~~ 0.45 (for a species of unknown status with fishery mortality CV between 0.6 and 0.8~~>0.80~~; Wade and Angliss 1997), resulting in a PBR of ~~5.5~~ 11 offshore bottlenose dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~**New Serious Injury Guidelines**~~

~~NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al*. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.~~

Fishery Information

A summary of known fishery mortality and serious injury for this stock of bottlenose dolphin is shown in Table 1. The estimate of mortality and serious injury for bottlenose dolphin in the California drift gillnet fishery for the five most recent years of monitoring, 2010-2014, is 1.3 (CV=0.75) individuals, or an average of 0.3 per year (Carretta *et al*. 2016a). One bottlenose dolphin was seriously injured in the limited entry fixed gear sablefish fishery during 2009, but no other deaths or injuries were reported in West Coast groundfish fisheries for the period 2009-2013 (Jannot *et al*. 2011). Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki *et al*. 1993), but no recent bycatch data from Mexico are available. ~~During 2007-2011, two offshore stock bottlenose dolphins were seriously injured in commercial fishing gear (Jannot et al. 2011, Carretta et al. 2013) and one was killed in commercial fishing gear (Carretta and Enriquez 2012). The fisheries involved included sablefish fixed longline gear (Jannot et al. 2011), the California swordfish drift gillnet fishery (Carretta and Enriquez 2012), and a stranding record from an unknown fishery interaction (Carretta et al. 2013). Bottlenose dolphins are rarely observed entangled in the California swordfish drift gillnet fishery and potential reductions in bycatch resulting from acoustic pinger use in this fishery are unknown, due to small sample sizes (Barlow and Cameron 2003, Carretta and Barlow 2011). The average annual fishery-related serious injury and mortality of offshore stock bottlenose dolphins for the period 2007-2011 is ≥ 2.0 animals/yr (Table 1).~~ Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki et al. 1993), but no recent bycatch data from Mexico are available.

~~Offshore bottlenose dolphins are often associated with Risso's dolphins and pilot whales, for which mortality has been documented in the squid purse seine fishery off Southern California (Heyning et al. 1994). Based on this association, offshore bottlenose dolphins may also have experienced some mortality in this fishery. However these would probably represent animals killed intentionally to protect catch or gear, rather than incidental kills, and such intentional takes are now illegal under the 1994 Amendment to the MMPA.~~

Table 1. Summary of available information on the incidental mortality and serious injury of bottlenose dolphins (California/ Oregon/Washington Offshore Stock) in commercial fisheries that might take this species (Carretta *et al*. 2016a, 2016b; Jannot *et al*. 2011). ~~Mean annual takes are based on 2007-2011 data unless noted otherwise (Carretta and Enriquez 2009a, 2009b, 2010, 2012a, 2012b, Jannot et al. 2011).~~ Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality (and Serious Injury)	Estimated ~~Annual~~ Mortality and Serious Injury (CV)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer	~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ ~~2011~~ 2010-2014	~~16.4%~~ ~~13.5%~~ ~~13.3%~~ ~~11.9%~~ ~~18.8%~~ 22%	~~0~~ ~~0~~ ~~0~~ ~~1~~ ~~0~~ 1[1]	~~0~~ ~~0~~ ~~0~~ ~~8 (0.96)~~ ~~0~~ 1.3	~~1.6 (0.96)~~ 0.3 (0.75)
~~**California halibut and white seabass set gillnet**~~ **CA halibut / white seabass and other species set gillnet fishery**	observer	~~2007~~ ~~2010~~ ~~2011~~ 2010-2014	~~17.8%~~ ~~12.5%~~ ~~8%~~ 9%	0 0 0 0	0	0
California yellowtail, barracuda, and white seabass drift gillnet fishery	observer	2010-2012 ~~2011~~	~~5.0%~~ ~~3.3%~~ ~4%	0 ~~0~~	0	0
CA lobster trap/pot	At-sea disentanglement	2008	n/a	0 (1)	1 (n/a)	0.2 (n/a)
~~**Sablefish offshore fixed gear**~~ **Limited entry fixed gear (longline) sablefish fishery**	At-sea disentanglement	2005 2006 2007 2008 2009	0.5% 1.5% 3.4% 1.5% 2.4%	~~0~~ ~~0~~ ~~0~~ ~~0~~ 0 (1)	1 (n/a)*	0.2 (n/a)
Minimum total annual takes						~~≥2.0 (0.96)~~ ≥0.7 (0.75)

*No estimate of bycatch was derived from the one observation of a bottlenose dolphin released injured from sablefish gear (Jannot *et al*. ~~2009~~ 2011).

STATUS OF STOCK

The status of offshore bottlenose dolphins in California relative to OSP is not known, 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. Because average annual fishery takes (~~2.0~~ 0.7/yr) are less than the calculated PBR (~~5.5~~ 11), offshore bottlenose dolphins are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for this stock is ~~greater~~ less than 10% of the PBR and, therefore, can ~~cannot~~ be considered to be insignificant and approaching zero.

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Revised ~~01/15/2011~~ 08/22/2016

STRIPED DOLPHIN (*Stenella coeruleoalba*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Striped dolphins are distributed world-wide in tropical and warm-temperate pelagic waters. ~~On recent shipboard surveys extending about 300 nmi offshore of California, they were sighted within about 100-300 nmi from the coast (Figure 1). No sightings have been reported for Oregon and Washington waters, but striped dolphins have stranded in both states (Oregon Department of Fish and Wildlife, unpublished data; Washington Department of Fish and Wildlife, unpublished data).~~ Striped dolphins are commonly encountered in warm offshore waters of California, and a few sightings have been made off Oregon (Figure 1, Barlow 2016). Striped dolphins are also commonly found in the central North Pacific, but sampling between this region and California has been insufficient to determine whether the distribution is continuous. Based on sighting records off California and Mexico, striped dolphins appear to have a continuous distribution in offshore waters of these two regions (Perrin et al. 1985; Mangels and Gerrodette 1994). No information on possible seasonality in distribution is available, because the California surveys which extended 300 nmi offshore were conducted only during the summer/fall period. Although striped dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Therefore, the management stock includes only animals found within U.S. waters. For the Marine Mammal Protection Act (MMPA) stock assessment reports, striped dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) waters around Hawaii.

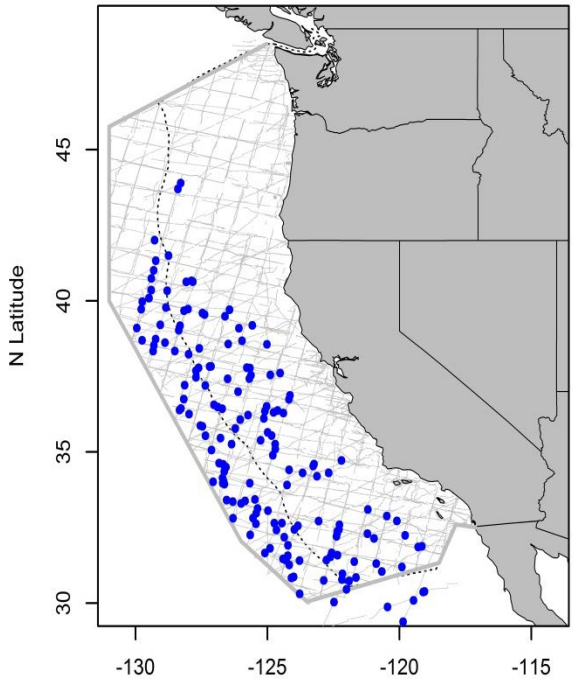

Figure 1. Striped dolphin sightings based on ~~aerial and~~ shipboard surveys off California, Oregon, and Washington, 1991-~~2008~~ 2014 (Barlow 2016).~~(see Appendix 2 for data sources and information on timing and location of survey effort).~~ Dashed line represents the U.S. EEZ, thin gray lines indicate the completed transect effort of all surveys combined.

POPULATION SIZE

~~Abundance is estimated from two summer/fall shipboard surveys conducted within 300 nmi of the coasts of California, Oregon and Washington in 2005 (Forney 2007) and 2008 (Barlow 2010).~~ The abundance of striped dolphins in this region appears to be variable between years and may be affected by oceanographic conditions, as with other odontocete species (Forney 1997, ~~Forney and Barlow 1998~~ Becker et al. 2012, Barlow 2016). Because animals may spend time outside the U.S. Exclusive Economic Zone as oceanographic conditions change, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. ~~The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the 2005 and 2008 ship surveys is 10,908 (CV=0.34) striped dolphins (Barlow and Forney 2007 , Forney 2007, Barlow 2010).~~ The most recent estimate of striped dolphin abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, 29,211 (CV = 0.20) animals (Barlow 2016). This estimate includes new correction factors for animals missed during the surveys.

Minimum Population Estimate

The log-normal 20th percentile of the ~~2005-2008~~ 2008-2014 ~~mean~~ average abundance estimate is ~~8,231~~ 24,782 striped dolphins.

Current Population Trend

~~Prior to a 1991 shipboard survey (Barlow 1995), striped dolphins were not thought to be common off California (Leatherwood et al. 1982), and two surveys extending approximately 200 nmi offshore of California and Baja California in 1979 and 1980 resulted in only one sighting of three striped dolphins (Smith et al. 1986). Thus it is possible that striped dolphin abundance off California has increased over the last decade (consistent with the observed warming trend for these waters; Roemmich 1992); however, no definitive statement can be made, because statistical estimates of abundance were not obtained for the earlier surveys. Barlow and Forney (2007) reported striped dolphin abundance estimates of 32,370, 14,622, 4,796, 12,570, and 25,561 for the years 1991, 1993, 1996, 2001, and 2005, respectively. The estimate from the most recent 2008 ship survey is 4,655 (CV=0.30) (Barlow 2010). Currently, there is no evidence of a trend in abundance for this stock.~~ The distribution and abundance of Pacific white-sided dolphins off California, Oregon and Washington varies interannually (Becker et al. 2012, Barlow 2016), but no longterm trends have been identified.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for striped dolphins off California.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~8,231~~ 24,782) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.50~~ 0.40 (for a species of unknown status with ~~no known~~ fishery mortality CV > 0.80; Wade and Angliss 1997), resulting in a PBR of ~~82~~ 198 striped dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for this stock of striped dolphin is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. The estimate of mortality and serious injury for striped dolphin in the California drift gillnet fishery for the five most recent years of monitoring, 2010-2014, is 0.2 (CV=4.3) individuals, or an average of 0.04 per year (Carretta et al. 2016b). Human-caused mortality and injury documentation is often based on stranding data, where raw counts are negatively-biased because only a fraction of carcasses are detected. Carretta *et al*. (2016a) estimated the mean recovery rate of California coastal bottlenose dolphin carcasses to be 25% (95% CI 20% - 33%) and stated that given the extremely coastal habits of coastal bottlenose dolphins, carcass recovery rates for this stock represented a maximum, compared with more pelagic dolphin species in the region. Therefore, in this stock assessment report and others involving dolphins along the U.S. West Coast, human-related deaths and injuries counted from beach strandings along the outer U.S. West Coast are multiplied by a factor of 4 to account for the non-detection of most carcasses (Carretta *et al*. 2016a). One striped dolphin stranded during 2010-2014 with evidence of fishery interaction (Carretta *et al*. 2016c), yielding a minimum estimate of four fishery-related dolphin deaths. Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki et al. 1993), but no recent bycatch data from Mexico are available.

~~Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 2004-2008 (Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b). No striped dolphins were observed killed in the most recent five year period. One striped dolphin was observed killed in the drift gillnet fishery in 1994. After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). However, because of interannual variability in entanglement rates and the rarity of striped dolphin entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Mean annual takes in Table 1 are based on 2004-2008 data. This results in an average estimate of zero striped dolphins taken annually.~~

~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed-fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~

Table 1. Summary of available information on the incidental mortality and serious injury of striped dolphins (California/ Oregon/Washington Stock) in commercial fisheries that might take this species (Carretta *et al*. 2016b, 2016c.). Human-caused mortality values based on strandings recovered along the outer U.S. West Coast are multiplied by a correction factor of 4 to account for undetected mortality (Carretta *et al*. 2016a). Coefficients of variation for mortality estimates are provided in parentheses.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated ~~Annual~~ Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer	~~2004-2008~~ 2010-2014	~~13-21%~~ 22%	0[1]	~~0~~ 0.2 (4.30)	~~0~~ 0.04 (4.3)
Unidentified fishery	Stranding	2010-2014	-	1	≥ 4	≥ 0.8 (0.46)[2]
Minimum total annual takes (includes correction for unobserved beach strandings)						~~0~~ ≥ 0.84 (0.87)

~~**Other mortality**~~

~~One striped dolphin stranded in Oregon in 2006 with "bruising and trauma, possible impact or fisheries interaction" evidence. This results in a human caused average annual mortality of 0.2 striped dolphins per year for the period 2004-2008~~.

STATUS OF STOCK

The status of striped dolphins in California relative to OSP is not known, and there are insufficient data to evaluate potential 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. ~~The average annual human-caused mortality in 2004-2008 is 0.2.~~ Because recent fishery and human-caused mortality (0.84) is less than 10% of the PBR (~~82~~ 198), striped dolphins are not classified as a "strategic" stock under the MMPA, and the total fishery mortality and serious injury for this stock can be considered to be insignificant and approaching zero.

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[1] There were no observations of striped dolphin in this fishery during 2010-2014, but the model-based estimate of bycatch for this period results in a positive estimate of bycatch (Carretta *et al*. 2016b).

[2] The coefficient of variation (CV) for corrected carcass counts was derived from the results of Carretta *et al*. (2016a), who estimated that 25% (95% CI = 20% - 33%) of all available carcasses were recovered / documented.

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Revised ~~01/15/2011~~ 08/22/2016

SHORT-BEAKED COMMON DOLPHIN (*Delphinus delphis*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Short-beaked common dolphins are the most abundant cetacean off California, and are widely distributed between the coast and at least 300 nmi distance from shore (Figure 1). The abundance of this species off California has been shown to change on both seasonal and inter-annual time scales (Dohl *et al.* 1986; ~~Barlow 1995; Forney et al. 1995~~ Forney and Barlow 1998; Barlow 2016). ~~Historically, they were reported primarily south of Pt. Conception (Dohl et al. 1986), but have been commonly sighted as far north as 42ºN during 1991-2008 NMFS line-transect vessel surveys (Figure 1). Four strandings of common dolphins have been reported in Oregon and Washington since 1942 (B. Norberg, pers. comm.), but three of these could not be identified to species. One animal, which stranded in 1983, was identified as a short-beaked common dolphin (J. Hodder, pers. comm.).~~ Significant seasonal shifts in the abundance and distribution of common dolphins have been identified based on winter/spring 1991-92 and summer/fall 1991 surveys (Forney and Barlow 1998). ~~Their~~ The distribution of short-beaked common dolphins is continuous southward into Mexican waters to about 13ºN (Perrin *et al.* 1985; Wade and Gerrodette 1993; Mangels and Gerrodette 1994), and short-beaked common dolphins off California may be an extension of the "northern common dolphin" stock defined for management of eastern tropical Pacific tuna fisheries (Perrin *et al.* 1985). However, preliminary data on variation in dorsal fin color patterns suggest there may be multiple stocks in this region, including at least two possible stocks in California (Farley 1995). ~~The less abundant long-beaked common dolphin has only recently been recognized as a different species (Heyning and Perrin 1994; Rosel et al. 1994), and much of the available information has not differentiated between the two types of common dolphin.~~ Although short-beaked common dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Under the Marine Mammal Protection Act (MMPA), short-beaked common dolphins involved in tuna purse seine fisheries in international waters of the eastern tropical Pacific are managed separately, and they are not included in the assessment reports. For the MMPA stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of California, Oregon and Washington.

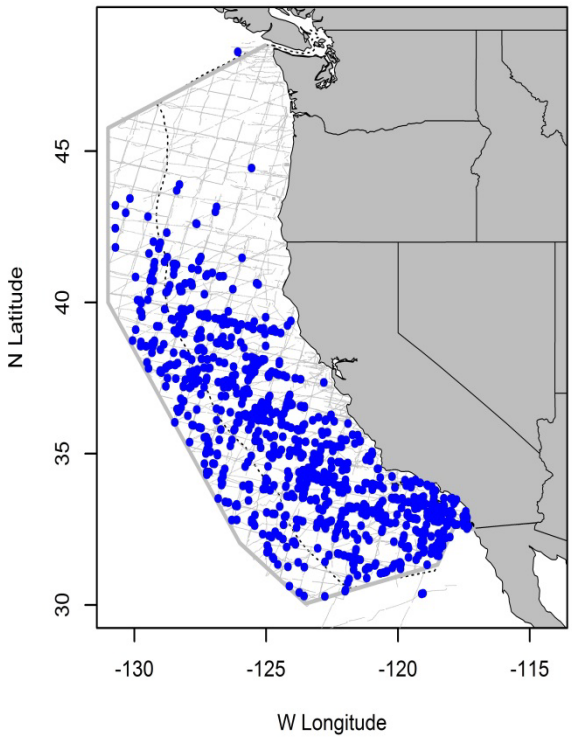


Figure 1. Short-beaked common dolphin sightings based on shipboard surveys off California, Oregon, and Washington, 1991-2014 (Barlow 2016). ~~2008 (see Appendix 2, for data sources and information on timing and location of survey effort).~~ Dashed line represents the U.S. EEZ, thin gray lines indicate completed transect effort of all surveys

POPULATION SIZE

~~The most recent estimates of abundance estimates are based on two summer/fall shipboard surveys that were conducted within 300 nmi of the coasts of California, Oregon and Washington in 2005 (Forney 2007) and 2008 (Barlow 2010.).~~ The distribution of short-beaked common dolphins throughout this region is highly variable, apparently in response to oceanographic changes on both seasonal and interannual time scales (Heyning and Perrin 1994; Forney 1997; Forney and Barlow 1998). As

oceanographic conditions vary, short-beaked common dolphins may spend time outside the U.S. Exclusive Economic Zone, and therefore a multi-year average abundance estimate is the most appropriate for management within U.S. waters. ~~The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the two ship surveys is 411,211 (CV= 0.21) short-beaked common dolphins .~~ The most recent estimate of short-beaked common dolphin abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, 969,861 (CV = 0.17) animals (Barlow 2016). This estimate includes new correction factors for animals missed during the surveys.

Minimum Population Estimate

The log-normal 20th percentile of the ~~2005-2008~~ 2008-2014 average abundance estimate is ~~343,990~~ 839,325 short-beaked common dolphins.

Current Population Trend

~~In the past,~~ Short-beaked common dolphin abundance off the U.S. West Coast is known ~~has been shown~~ to increase ~~off California~~ during ~~the~~ warm-water ~~months~~ periods (Dohl *et al.* 1986, Forney and Barlow 1998, Barlow 2016). The most recent 2014 survey was conducted during extremely warm ocean conditions (Bond *et al*. 2015) and resulted in the largest abundance estimate since large-scale surveys began in 1991. The increase in short-beaked common dolphin abundance is likely a result of northward movement of this transboundary stock from waters off Mexico (Barlow 2016). ~~Surveys conducted during both cold-water and warm-water conditions in 1991 and 1992 (Barlow 1995, Forney et al. 1995) resulted in overall abundance estimates (for both types of common dolphins combined) which were considerably greater than historical estimates (Dohl et al. 1986). Environmental models (Forney 1997) and seasonal comparisons (Forney and Barlow 1998) have shown that the abundance of short-beaked common dolphins off California varies with seasonal and interannual changes in oceanographic conditions. An ongoing decline in the abundance of 'northern common dolphins' (including both long-beaked and short-beaked common dolphins) in the eastern tropical Pacific and along the Pacific coast of Mexico suggests a possible northward shift in the distribution of common dolphins (IATTC 1997) during this period of gradual warming of the waters off California (Roemmich 1992). The majority of this shift would likely be reflected in an increase in short-beaked common dolphin abundance. Heyning and Perrin (1994) have detected changes in the proportion of short-beaked to long-beaked common dolphins stranding along the California coast, with short-beaked common dolphin stranding more frequently prior to the 1982-83 El Niño (which increased water temperatures off California), and the long-beaked common dolphin more commonly observed for several years afterwards. Thus, it appears that both relative and absolute abundances of these species off California may change with varying oceanographic conditions.~~

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of current or maximum net productivity rates for short-beaked common dolphins.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~343,990~~ 839,325) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with a mortality rate CV< 0.30; Wade and Angliss 1997), resulting in a PBR of ~~3,440~~ 8,393 short-beaked common dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for short-beaked common dolphins is shown in Table 1. The estimate of mortality and serious injury for short-beaked common dolphin in the California drift gillnet fishery for the five most recent years of monitoring, 2010-2014, is 105 (CV=0.14) individuals, or an average of 21 per year (Carretta *et al*. 2016c). No takes were documented by observers during the most recent five years of monitoring for other gillnet and purse seine fisheries that have interacted with short-beaked common dolphins in the past. However, two short-beaked common dolphins stranded with evidence of fishery interaction with an unidentified gillnet fishery. Human-caused mortality and injury documentation is often based on stranding data, where raw counts are negatively-biased because only a

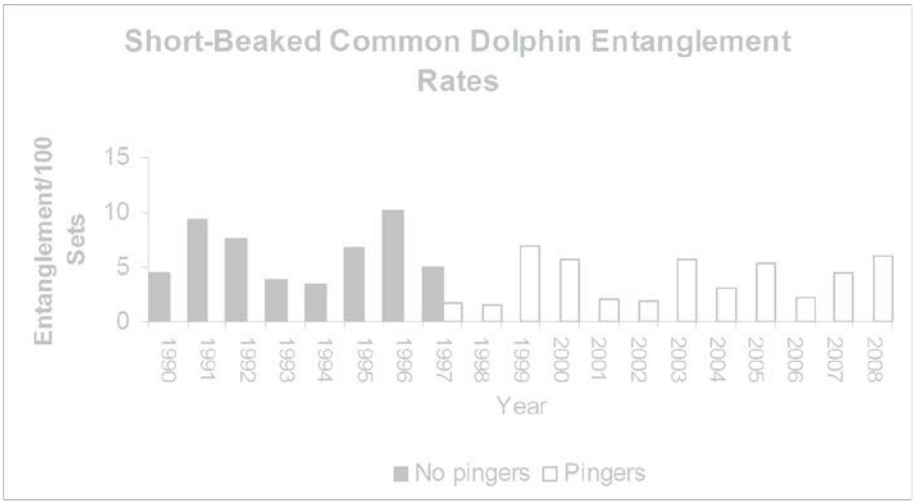
fraction of carcasses are detected. Carretta *et al*. (2016a) estimated the mean recovery rate of California coastal bottlenose dolphin carcasses to be 25% (95% CI 20% - 33%) and stated that given the extremely coastal habits of coastal bottlenose dolphins, carcass recovery rates for this stock represented a maximum, compared with more pelagic dolphin species in the region. Therefore, in this stock assessment report and others involving dolphins along the U.S. West Coast, human-related deaths and injuries counted from beach strandings along the outer U.S. West Coast are multiplied by a factor of 4 to account for the non-detection of most carcasses (Carretta *et al*. 2016a). Applying this correction factor to the two stranded short-beaked common dolphins yields a minimum estimate of 8 fishery-related dolphin deaths.~~Mean annual takes in Table 1 are based on 2004-2008 data. This results in an average estimate of 64 (CV=0.29) short-beaked common dolphins taken annually. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 2004-2008 (Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b). After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6 fathom extenders, common dolphin entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). Since the initial pinger experiments in 1996, short-beaked common dolphin entanglement rates have remained below pre-pinger levels, even though a time/area closure in 2001 shifted fishing effort south of Point Conception, California, where common dolphin densities are highest (Figure 2). Prior to the use of acoustic pingers in the fishery, short-beaked common dolphin were observed entangled at a rate of 6.7 animals per 100 sets (125 entanglements in 1,848 sets) in sets south of Point Conception. In the same region, sets with twenty or more pingers have an entanglement rate of 4.4 animals per 100 sets (137 entanglements in 3,104 sets). The difference between the two entanglement rates is statistically significant (Poisson probability < 0.002).~~

Table 1. Summary of available information on the incidental mortality and injury of short-beaked common dolphins (California/Oregon/Washington Stock)~~,~~ in commercial fisheries that might take this species (Carretta *et al*. 2016b, 2016c). All entanglements resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. ~~Mean annual takes are based on 2004-2008 data unless noted otherwise.~~ Human-caused mortality values based on strandings recovered along the outer U.S. West Coast are multiplied by a correction factor of 4 to account for undetected mortality (Carretta *et al*. 2016a).

Fishery Name	Data Type	Year	Percent Observer Coverage	Observed Mortality	Estimated ~~Annual~~ Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	~~20.6%~~ ~~20.9%~~ ~~18.5%~~ ~~16.4%~~ ~~13.5%~~ 22%	~~7~~ ~~12~~ ~~6~~ ~~9~~ ~~8~~ 22	~~34 (0.49)~~ ~~57 (0.30)~~ ~~32 (0.52)~~ ~~54 (0.41)~~ ~~59 (0.43)~~ 105 (0.14)	~~47 (0.19)~~ 21 (0.14)
CA squid purse seine	observer	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2004-2008	~~unknown~~ ~~1.1%~~ ~~unknown~~ ~~<5%~~ ~~<5%~~ <10%	~~0~~ ~~1~~ ~~0~~ ~~0~~ ~~0~~ 0	~~0~~ ~~87 (0.98)~~ ~~0~~ ~~0~~ ~~0~~ 0	~~17 (0.98)~~ 0 (n/a)
CA halibut / white seabass and other species set gillnet fishery[2]	~~Self-report~~ ~~Self-report~~ ~~Observer~~ ~~Observer~~ ~~Observer~~ observer	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	~~n/a~~ ~~n/a~~ ~~~1%~~ ~~17%~~ ~~not observed~~ 9%	~~1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	~~≥1~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	~~≥1 (n/a)~~ 0 (n/a)

Fishery Name	Data Type	Year	Percent Observer Coverage	Observed Mortality	Estimated ~~Annual~~ Mortality	Mean Annual Takes (CV in parentheses)
Unidentified gillnet fishery	Stranding	2010-2014	-	2	≥8	≥1.6 (0.46)[1]
~~**Unknown fishery**~~	~~strandings~~	~~2004-2008~~	~~Two unidentified common and three short-beaked common dolphin stranded with evidence of fishery interactions. Evidence of fishery interactions included net marks and/or positive metal detector scans. None of the strandings could be linked to a specific commercial fishery. These strandings may have come from observed fisheries that already have bycatch estimates and thus are not included in the annual average to prevent double-counting of fishery mortality. Mean annual takes are therefore based on stranded animals only if the stranding can be attributed to a fishery lacking an observer program or cases where stranded animals represent the only documented fishery-related deaths in a given year.~~			~~≥ 0 (n/a)~~
Minimum total annual takes (includes correction for unobserved beach strandings)						~~64 (0.29)~~ ≥22.6 (0.13)

~~[1]The set gillnet fishery was observed from 1991-94 and then only in Monterey Bay during 1999-2000, where 20-25% of the local fishery was observed. There are no estimates of common dolphin mortality in this fishery because of a lack of recent observer effort. Observer coverage in this fishery resumed in 2006 (12 sets observed) and continued into 2007 (248 sets observed).~~



~~Figure 2. Entanglement rates of short-beaked common dolphin per set fished in the California drift gillnet fishery for swordfish and thresher shark, 1990-2008. Entanglement rates include observations from pingered and unpingered sets. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. In 1996, no short-beaked common dolphin were observed killed in 146 pingered sets. For the period 1998–2008, more than 99% of all observed sets utilized pingers.~~

~~Common dolphin mortality has also been reported in halibut set gillnets in California (Julian and Beeson 1998). The fishery has been observed only four times since 1994 (in 1999, 2000, 2006, and 2007), at low levels of observer coverage (< 20% of fishing effort). No common dolphins were observed entangled in 2007, when the fishery had approximately 18% observer coverage (248 sets observed).~~

[1] The coefficient of variation (CV) for corrected carcass counts was derived from the results of Carretta *et al*. (2016a), who estimated that 25% (95% CI = 20% - 33%) of all available carcasses were recovered / documented.

~~There were 377 sets observed in the squid purse seine fishery from 2004-2008. One short-beaked common dolphin mortality was observed in 2005, with a resulting mortality estimate of 87 (CV=0.98) animals (Carretta and Enriquez 2006). In addition, there was one squid purse seine set in 2006 where 8 unidentified dolphins were encircled. Seven were released alive and the eighth was seriously injured.~~

~~One unidentified and three short-beaked common dolphin stranded with evidence of fishery interaction (NMFS, Southwest Region, unpublished data) between 2004-2008. It is not known which fisheries were responsible for these deaths.~~

~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~

Other Mortality

In the eastern tropical Pacific, 'northern common dolphins' have been incidentally killed in international tuna purse-seine fisheries since the late 1950's and are managed separately under a section of the MMPA written specifically for the management of dolphins involved in eastern tropical Pacific tuna fisheries. Cooperative international management programs have dramatically reduced overall dolphin mortality in these fisheries ~~during the last~~in recent decades (~~Joseph 1994~~ IATTC 2015). Between ~~2000-2004~~, 2007 and 2014, annual fishing mortality of northern common dolphins (potentially including both short-beaked and long-beaked common dolphins) ranged between ~~54~~ 35 and ~~159~~ 124 animals, with an average of ~~102~~ 75 (IATTC, ~~2006~~ 2015). Although it is unclear whether these animals are part of the same population as short-beaked common dolphins found off California, the distributions of both of the species that comprise the 'northern common dolphins' appear to shift into U.S. waters during certain oceanographic conditions (IATTC 2006). ~~they are managed separately under a section of the MMPA written specifically for the management of dolphins involved in eastern tropical Pacific tuna fisheries.~~

STATUS OF STOCK

The status of short-beaked common dolphins in Californian waters relative to OSP is not known. The observed increase in abundance of this species off California probably reflects a distributional shift (Anganuzzi *et al.* 1993; ~~Barlow 1995; Forney et al. 1995;~~ Forney and Barlow 1998, Barlow 2016), rather than an overall population increase due to growth. 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. The average annual human-caused mortality in ~~2004-2008 (64 animals)~~ 2010-2014 (22.6 animals) is estimated to be less than the PBR (~~3,440~~ 8,393), and therefore they are not classified as a "strategic" stock under the MMPA. The total estimated fishery mortality and injury for short-beaked common dolphins is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

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Revised ~~12/15/2012~~ 8/22/2016

LONG-BEAKED COMMON DOLPHIN (*Delphinus capensis*): California Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Long-beaked common dolphins were recognized as a distinct species in the 1990s (Heyning and Perrin 1994; Rosel *et al*. 1994). Along the U.S. west coast, their distribution overlaps with that of the short-beaked common dolphin~~, and much historical information has not distinguished between these two species~~. Long-beaked common dolphins are commonly found within about 50 nmi of the coast, from Baja California (including the Gulf of California) northward to about central California (Figure 1). Along the west coast of Baja California, long-beaked common dolphins primarily occur inshore of the 250 m isobath, with very few sightings (<15%) in waters deeper than 500 meters (Gerrodette and Eguchi 2011). Stranding and sighting records indicate that the abundance of this species off California changes both seasonally and inter-annually (Heyning and Perrin 1994, Forney and Barlow 1998, Barlow 2016). Although long-beaked common dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). For the MMPA stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone off California.

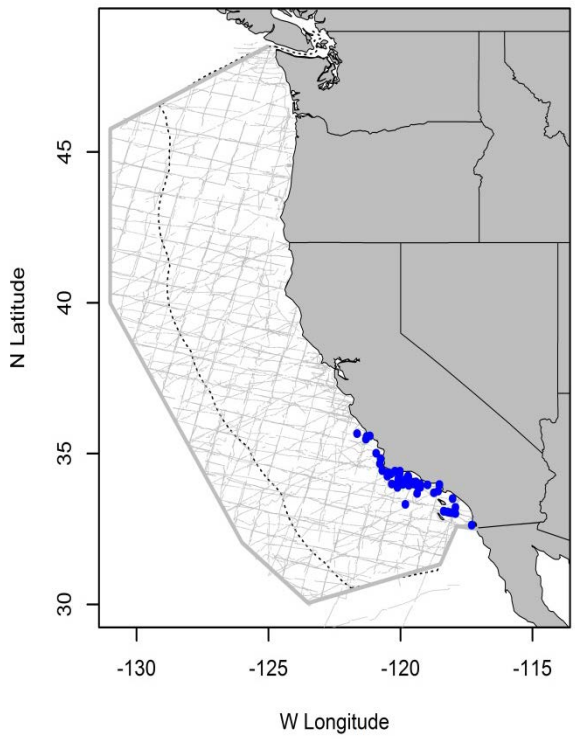

Figure 1. Long-beaked common dolphin sightings based on shipboard surveys off California, Oregon, and Washington, 1991- ~~2010~~ 2014 (Barlow 2016). ~~(see Appendix 2 for information on timing and location of survey effort). No Delphinus sightings have been made off Washington.~~ Dashed line represents the U.S. EEZ, thin gray lines indicate completed transect effort of all surveys combined.

POPULATION SIZE

~~The most recent abundance estimates for this stock are 62,447 (CV=0.80) and 183,396 (CV=0.41) dolphins, based on 2008 and 2009 ship line transect surveys, respectively (Barlow 2010; Carretta *et al*. 2011).~~ The distribution and abundance of long-beaked common dolphins off California varies inter-annually and seasonally (Heyning and Perrin 1994). As oceanographic conditions change, long-beaked common dolphins may move between Mexican and U.S. waters, and therefore a multi-year average abundance estimate is the most appropriate for management within the U.S. waters. The geometric mean abundance estimate for California, Oregon and Washington waters based on two ship surveys conducted in 2008 and ~~2009~~ 2014 (~~Barlow 2010; Carretta *et al*. 2011~~Barlow 2016) is ~~107,016~~101,305 (~~0.42~~ 0.49) long-beaked common dolphins. This estimate includes new correction factors for animals missed during the surveys. Although Carretta *et al*. (2011) also estimated abundance of this stock from a 2009 survey, that estimate did not include the correction factors and had high imprecision for one of the geographic strata, so it is not included in the multi-year average.

Minimum Population Estimate

The log-normal 20th percentile of the weighted 2008-2014 ~~average~~ abundance estimate is ~~76,224~~ 68,432 long-beaked common dolphins.

Current Population Trend

California waters represent the northern limit for this stock and animals likely move between U.S. and Mexican waters. While no formal statistical trend analysis exists for this stock of long-beaked common dolphin, abundance estimates for California waters from~~a 2009~~ vessel-based line-transect surveys have been greater in recent years as water conditions have been warmer (Barlow 2016).~~were the highest of any survey dating back to 1991 (Carretta et al. 2011).~~ The ratio of strandings of long-beaked to short-beaked common dolphin in southern California has varied, suggesting that the proportions of each species present change as ocean conditions vary (Heyning and Perrin 1994, Danil *et al*. 2010). ~~increased following a strong 1982-1983 El Niño (Heyning and Perrin 1994). Within San Diego County, dramatic increases in the ratio of long-beaked to short-beaked common dolphin strandings were observed between 2006 and 2008 (Danil *et al*. 2010), with higher numbers of long-beaked strandings persisting through 2010 (NMFS unpublished stranding data).~~ During a 2009 ship-based survey of California and Baja California waters, the ratio of long-beaked to short-beaked common dolphin sightings was nearly 1:1, whereas during previous surveys conducted from 1986 to 2008 in the same geographic strata, the ratio was approximately 1:3.5 (Carretta *et al*. 2011). There appears to be an increasing trend of long-beaked common dolphins in California waters over the last 30 years, but a trend analysis for this stock has not been performed to date, while other stocks with more urgent conservation concerns are analyzed (e.g., Moore and Barlow 2011, 2013)..

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of current or maximum net productivity rates for long-beaked common dolphins.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~76,224~~ 68,432) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.40~~ 0.48 (for a species of unknown status with a mortality rate CV of 0.3 to 0.6 ~~> 0.80~~; Wade and Angliss 1997), resulting in a PBR of ~~610~~ 657 long-beaked common dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for long-beaked common dolphins is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. The estimate of mortality and serious injury for long-beaked common dolphin in the California drift gillnet fishery for the five most recent years of monitoring, 2010-2014, is 8 (CV=0.86) individuals, or an average of 1.6 per year (Carretta *et al*. 2016b). One interaction with the halibut set gillnet fishery was observed during 2010-2014, resulting in an estimate of 7 (CV=1.17) dolphins (Carretta and Enriquez 2012). No mortality or serious injury has been documented by observers during the most recent five years of monitoring for the small mesh gillnet fishery, which has interacted with long-beaked common dolphins in the past. However, 36 long-beaked common dolphins stranded with evidence of interaction with unidentified fisheries. Human-caused mortality and injury documentation is often based on stranding data, where raw counts are negatively-biased because only a fraction of carcasses are detected. Carretta *et al*. (2016a) estimated the mean recovery rate of California coastal bottlenose dolphin carcasses to be 25% (95% CI 20% - 33%) and stated that given the extremely coastal habits of coastal bottlenose dolphins, carcass recovery rates for this stock represented a maximum, compared with more pelagic dolphin species in the region. Therefore, in this stock assessment report and others involving dolphins along the U.S. West Coast, human-related deaths and injuries counted from beach strandings along the outer U.S. West Coast are multiplied by a factor of 4 to account for the non-detection of most carcasses (Carretta *et al*. 2016a). Applying this correction factor to the 36 stranded long-beaked common dolphins yields a minimum estimate of 144 fishery-related dolphin deaths, or an average of 29 per year. Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki *et al*. 1993), but no recent bycatch data from Mexico are available. ~~Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 2006-2010 (Carretta and Enriquez 2007, 2009a, 2009b, 2012). Acoustic pingers have been shown to significantly reduce the bycatch rates of short-beaked common dolphins (*Delphinus delphis*) (Barlow and Cameron 2003, Carretta and Barlow 2011). The effectiveness of pingers on reducing bycatch of long-~~

~~beaked common dolphins is expected to be similar to that shown for short-beaked common dolphins but is unknown, because long-beaked common dolphins are rarely observed entangled in this fishery.~~

~~Long-beaked common dolphin mortality has also been reported in halibut set gillnets in California (Julian and Beeson 1998, Carretta and Enriquez 2012, Table 1).~~

Table 1. Summary of available information on the incidental mortality and serious injury of long-beaked common dolphins (California Stock) ~~and prorated unidentified common dolphins~~ in commercial fisheries that might take this species (Carretta *et al*. 2016b, 2016c). All observed entanglements resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses, when available. ~~Mean annual takes are based on 2006-2010 data unless noted otherwise.~~ n/a = information not available. Human-caused mortality values based on strandings recovered along the outer U.S. West Coast are multiplied by a correction factor of 4 to account for undetected mortality (Carretta *et al*. 2016a).

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed (or self-reported)	Estimated ~~Annual~~ Mortality	Mean Annual Takes (CV in parentheses)
CA thresher shark/swordfish drift gillnet fishery	observer	~~2006~~ ~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ 2010-2014	~~18.5%~~ ~~16.4%~~ ~~13.5%~~ ~~13.3%~~ ~~11.9%~~ 22%	~~1~~ ~~0~~ ~~1~~ ~~0~~ ~~1~~ 2[1]	~~5 (1.04)~~ ~~0~~ ~~7 (1.08)~~ ~~0~~ ~~8 (1.00)~~ 8.0 (0.86)	~~4.0 (1.01)~~ 1.6 (0.86)
CA small mesh drift gillnet fishery for white seabass, yellowtail, barracuda, and tuna	observer	~~2006~~ ~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ 2010-2012	~~17.6%~~ ~~not observed~~ ~~not observed~~ ~~not observed~~ ~~not observed~~ ~~4%~~	~~1~~ ~~n/a~~ ~~n/a~~ ~~n/a~~ ~~n/a~~ 0	~~5 (1.18)~~ ~~n/a~~ ~~n/a~~ ~~n/a~~ ~~n/a~~ 0	~~5 (1.18)~~ 0 (n/a)
CA halibut/white seabass and other species set gillnet fishery	~~Self report & observer~~	~~2006~~ ~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ 2010-2014	~~1%~~ ~~17%~~ ~~not observed~~ ~~not observed~~ ~~12.5%~~ 9%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~1~~ 1	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~7 (1.07)~~ 7 (1.17)	~~1.4 (1.07)~~ 1.4 (1.17)
Unidentified fishery interaction	Strandings	2010-2014	-	36	≥144	≥29 (0.46)[2]
~~**Undetermined**~~	~~strandings~~	~~2006-2010~~	~~36 common dolphins (two unidentified and 34 longbeaked common dolphins) stranded with evidence of fishery interactions. Evidence of fishery interactions included severed flukes, net fragments, net marks, positive metal detector scans, and knife marks or cuts. Some strandings may have come from observed fisheries that already have bycatch estimates and these are not included in the annual average to prevent double-counting of fishery mortality. Mean annual takes are therefore based on stranded animals only if the stranding can be attributed to a fishery lacking an observer program or cases where stranded animals represent the only documented fishery-related deaths in a given year. This results in a minimum of 13 long-beaked common dolphin strandings over the 5 year period, or 2.6 animals annually.~~			~~≥ 2.6 (n/a)~~

[1] There were 2 observed entanglements of long-beaked common dolphin in this fishery during the period 2010-2014; one occurred in 2010 and 2011, respectively (Carretta *et al*. 2016b).

[2] The coefficient of variation (CV) for corrected carcass counts was derived from the results of Carretta *et al*. (2016a), who estimated that 25% (95% CI = 20% - 33%) of all available carcasses were recovered / documented.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed (or self-reported)	Estimated ~~Annual~~ Mortality	Mean Annual Takes (CV in parentheses)
Minimum total annual takes (includes correction for unobserved beach strandings)						~~13.0 (0.55)~~ ≥32 (0.42)

~~Thirty-six common dolphins (two unidentified common dolphins and 34 long-beaked common dolphins) stranded with evidence of fishery interactions (NMFS, Southwest Region, unpublished data) between 2006-2010. Most strandings showed evidence of an interaction with an unknown entangling net fishery (severed flukes, knife cuts, net marks, or net fragments wrapped around the animal). Mean annual takes in Table 1 are based on 2006-2010 data. Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki et al. 1993), but no recent bycatch data from Mexico are available.~~

Other Mortality

Three long-beaked common dolphins died near San Diego in 2011 as the result of blast trauma associated with underwater detonations conducted by the U.S. Navy. Three days later, a fourth animal stranded approximately 70 km north of that location with similar injuries (Danil and St. Leger 2011). One long-beaked common dolphin was incidentally killed during fishery research during 2013 (Carretta *et al*. 2016b). Stranding records from 2010-2014 include three additional human-related long-beaked common dolphin deaths, including one animal that was struck by a vessel, one animal that had ingested marine debris, and one animal that had been cut in half (Carretta *et al*. 2016b). Applying the minimum correction factor to account for undetected mortality (Carretta *et al*. 2016a), this yields an estimated 12 human-caused long-beaked common dolphin deaths. From all sources combined, this results in a total of 17 non-fishery human-caused deaths between 2010 and 2014, or an average of 3.4 dolphins per year.

'Unusual mortality events' of long-beaked common dolphins off California due to domoic acid toxicity have been documented by NMFS as recently as 2007. One study suggests that increasing anthropogenic CO_2 levels and ocean acidification may increase the toxicity of the diatom responsible for these mortality events (Tatters *et al*. 2012).

In the eastern tropical Pacific, 'northern common dolphins' have been incidentally killed in international tuna purse-seine fisheries since the late 1950's and are managed separately under a section of the MMPA written specifically for the management of dolphins involved in eastern tropical Pacific tuna fisheries. Cooperative international management programs have dramatically reduced overall dolphin mortality in these fisheries (Joseph 1994). Between ~~2004-2008,~~ 2007 and 2014, annual fishing mortality of northern common dolphins (potentially including both short-beaked and long-beaked common dolphins) ranged between ~~55~~ 35 and ~~156~~ 124 animals, with an average of ~~112~~ 75 (IATTC ~~2010~~2015). the distributions of both of the species that comprise the 'northern common dolphins' appear to shift into U.S. waters during certain oceanographic conditions (IATTC 2006). ~~Although it is unclear whether any long-beaked dolphins are taken in international purse-seine fisheries in the eastern tropical Pacific, common dolphins in this region are managed separately under a section of the MMPA written specifically for the management of dolphins involved in eastern tropical Pacific tuna fisheries.~~

STATUS OF STOCK

The status of long-beaked common dolphins in California waters relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. Exposure to blast trauma resulting from underwater detonations is a local concern for this stock, but population level impacts from such activities are unclear. In response to the 2011 event, the U.S. Navy has implemented new training protocols to reduce the probability of blast trauma events occurring (Danil and St. Leger 2011). Long-beaked common dolphins are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. ~~Including past mortality both from commercial fisheries between 2006 and 2010 (13.0 animals per year) and the average annual mortality resulting from the single blast trauma event of 2011 (0.8 animals per year for the 5-yr period 2007 to 2011), the~~ The average annual human-caused mortality from commercial fisheries (≥32 dolphins /year) and other sources (3.4 dolphins/year) is ~~13.8~~ 35.4 long-beaked common dolphins. This does not exceed the PBR (~~610~~ 657), and therefore they are not classified as a "strategic" stock under the MMPA. The average total fishery mortality

and injury for long-beaked common dolphins ~~(13.0)~~ is less than 10% of the PBR and therefore, is considered to be insignificant and approaching zero mortality and serious injury rate.

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Revised ~~01/15/2011~~ 8/22/2016

NORTHERN RIGHT-WHALE DOLPHIN (*Lissodelphis borealis*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern right-whale dolphins are endemic to temperate waters of the North Pacific Ocean. Off the U.S. west coast, they have been seen primarily in shelf and slope waters (Figure 1), with seasonal movements into the Southern California Bight (Leatherwood and Walker 1979; Dohl et al. 1980; 1983;~~ NMFS, unpublished data~~). Sighting patterns from recent aerial and shipboard surveys conducted in California, Oregon and Washington during different seasons (Green et al. 1992; 1993;~~ Forney et al. 1995; Barlow 1995~~ Forney and Barlow 1998; Barlow 2016) suggest seasonal north-south movements, with animals found primarily off California during the colder water months and shifting northward into Oregon and Washington as water temperatures increase in late spring and summer~~ (Green et al. 1992; Forney 1994; Forney and Barlow 1998)~~. The southern end of this population's range is not well-documented, but during cold-water periods, they probably range into Mexican waters off northern Baja California. Genetic analyses have not found statistically significant differences between northern right-whale dolphins from the U.S. West coast and other areas of the North Pacific (Dizon et al. 1994); however, power analyses indicate that the ability to detect stock differences for this species is poor, given traditional statistical error levels (Dizon et al. 1995). Although northern right-whale dolphins are not restricted to U.S. territorial waters, there are currently no international agreements for cooperative management. For the Marine Mammal Protection Act (MMPA) stock assessment reports, there is a single management stock including only animals found within the U.S. Exclusive Economic Zone of California, Oregon and Washington.

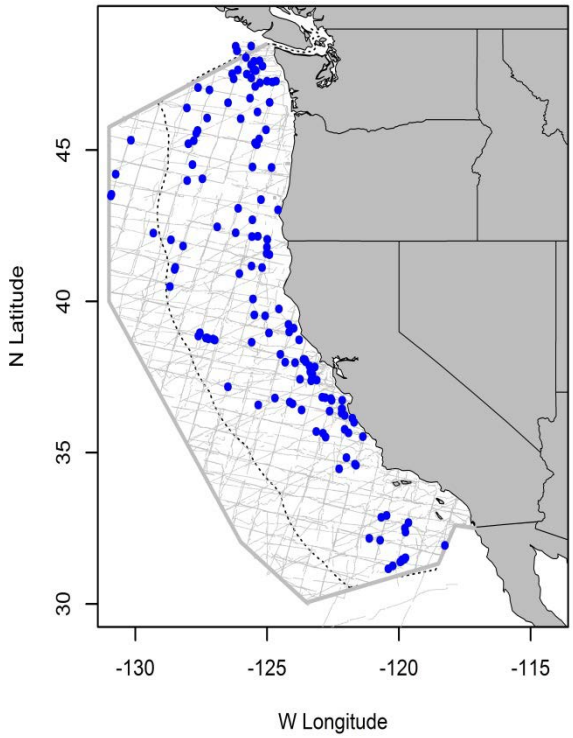


Figure 1. Northern right whale dolphin sightings based on ~~aerial and~~ shipboard surveys off California, Oregon, and Washington, 1991-2014 (Barlow 2016). ~~2008 (see Appendix 2 for data sources and information on timing and location of survey effort).~~ Dashed line represents the U.S. EEZ, thin gray lines indicate~~s~~ completed transect effort of all surveys combined. ~~Key: ● = summer/autumn ship-based sightings; ■ = winter/spring aerial-based sightings.~~

POPULATION SIZE

~~The previous best estimates of abundance for northern right whale dolphins (Barlow et al. 1997) were based on winter/spring 1991-92 aerial surveys (Forney et al. 1995) off California, which were presumed to include northern right whale dolphins that are found off Oregon and Washington during summer and fall. Two summer/fall shipboard surveys were conducted within 300 nmi of the coasts of California, Oregon and Washington in 2005 (Forney 2007) and 2008 (Barlow 2010).~~ The distribution of northern right-whale dolphins throughout this region is highly variable, apparently in response to oceanographic changes on both seasonal and interannual time scales (Forney and Barlow 1998, Barlow 2016). As oceanographic conditions vary, northern right-whale dolphins may spend time outside the U.S. Exclusive Economic Zone, and therefore a multi-year average abundance estimate is the most appropriate for management within U.S. waters. ~~The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the two ship surveys is 8,334 (CV=0.40) northern right whale dolphins (Forney 2007, Barlow 2010).~~ The most recent estimate of northern right whale dolphin abundance

is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, 26,556 (CV = 0.44) animals (Barlow 2016). This estimate includes new correction factors for animals missed during the surveys.

Minimum Population Estimate

The log-normal 20th percentile of the ~~2005-2008~~ 2008-2014 average abundance estimate is ~~6,019~~18,608 northern right-whale dolphins.

Current Population Trend

~~Abundance estimates for all California, Oregon, and Washington waters from 1996, 2001, 2005, and 2008 surveys were 11,347 (CV = 0.27), 14,937 (0.21), 11,100 (0.60), and 6,258 (CV=0.58), respectively (Barlow and Forney 2007, Forney 2007, Barlow 2010). Currently, there is no evidence of a trend in abundance for this stock.~~ The distribution and abundance of northern right whale dolphins off California, Oregon and Washington varies considerably at both seasonal and interannual time scales (Forney and Barlow 1998, Becker *et al*. 2012, Barlow 2016), but no long term trends have been identified.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for northern right-whale dolphins off the U.S. west coast.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~6,019~~18,608) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.40~~ 0.48 (for a species of unknown status with a mortality rate CV between 0.3 and 0.6 ~~>0.80~~; Wade and Angliss 1997), resulting in a PBR of ~~48~~ 179 northern right-whale dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury information for this stock of northern right-whale dolphin is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. The estimate of mortality and serious injury for northern right whale dolphin in the California drift gillnet fishery for the five most recent years of monitoring, 2010-2014, is 17.6 (CV=0.36) individuals, or an average of 3.5 per year (Carretta *et al*. 2016). Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki *et al*. 1993), but no recent bycatch data from Mexico are available.~~Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 2004-2008 (Carretta et al. 2005 Carretta and Enriquez 2006, 2007, 2009a, 2009b). After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). However, because of interannual variability in entanglement rates and the relative rarity of northern right-whale dolphin entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. Entanglement rates for this species may be related to oceanographic conditions, as lower entanglement rates have been observed during warm water periods, such as El Niño (Figure 2). Mean annual takes in Table 1 are based on 2004-2008 data. This results in an average estimate of 3.6 (CV= 0.96) northern right-whale dolphins taken annually.~~

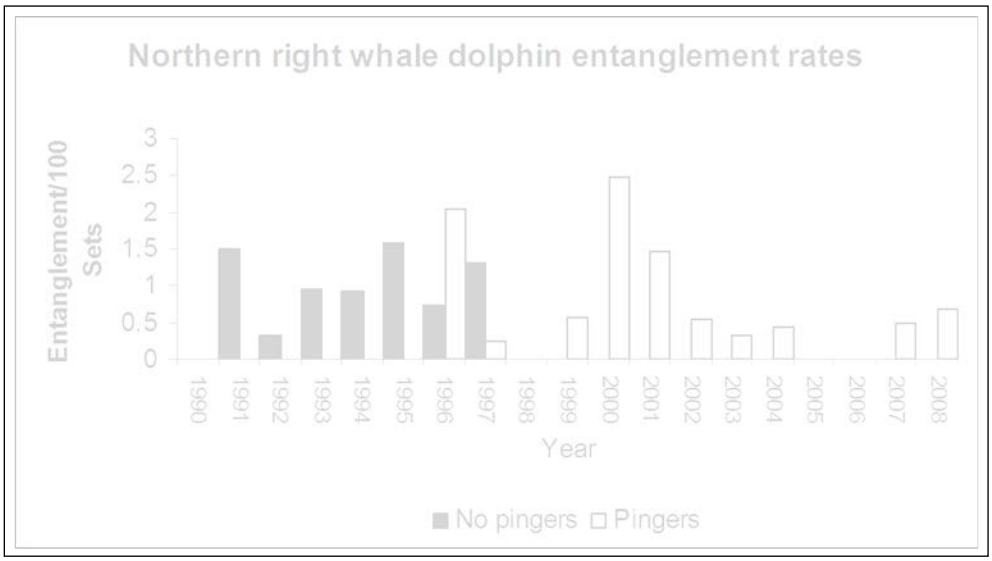
~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to~~

~~convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~

Table 1. Summary of available information on the incidental mortality and serious injury of northern right-whale dolphins (California/Oregon/Washington Stock) in commercial fisheries that might take this species (Carretta *et al*. 2016). All observed entanglements of northern right-whale dolphins resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses. ~~Mean annual takes are based on 2004-2008 data unless noted otherwise.~~

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	~~20.6%~~ ~~20.9%~~ ~~18.5%~~ ~~16.4%~~ ~~13.5%~~ 22%	~~1~~ ~~0~~ ~~0~~ ~~1~~ ~~1~~ 6	~~5 (0.99)~~ ~~0~~ ~~0~~ ~~6 (1.00)~~ ~~7 (0.99)~~ 17.6 (0.36)	~~3.6 (0.96)~~ 3.5 (0.36)
Minimum total annual takes						~~3.6 (0.96)~~ 3.5 (0.36)

~~**Figure 2.** Entanglement rates of northern right whale dolphin per set fished in the California drift gillnet fishery for swordfish and thresher shark, 1990-2008. Kill rates include observations from pingered and unpingered sets. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. For the period 1998-2008, over 99% of all observed sets utilized pingers.~~



~~**Other removals**~~

~~In 2008, six northern right whale dolphins were incidentally killed in California waters during scientific sardine trawling operations conducted by NMFS (Southwest Regional Office Stranding Program, unpublished data). All six animals were killed in a single trawl where 11 Pacific white-sided dolphin were also killed (see Pacific white-sided dolphin stock assessment). The average annual research-related mortality of northern right whale dolphin from 2004 to 2008 is 1.2 animals.~~

STATUS OF STOCK

The status of northern right-whale dolphins in California, Oregon and Washington relative to OSP is not known, 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. The average annual human-caused mortality in ~~2004-2008~~ 2010-2014 (~~4.8~~ 3.5animals) is estimated to be less than the PBR (~~48~~179), and therefore they are not classified as a "strategic" stock under the MMPA. The total fishery mortality and serious injury for northern right-whale dolphins does not exceed 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

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Revised ~~12/31/2015~~ 08/22/2016

KILLER WHALE (*Orcinus orca*): Eastern North Pacific Southern Resident Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have a cosmopolitan distribution, ranging from equatorial to polar waters, with highest densities found in coastal temperate waters (Forney and Wade 2006). Along the west coast of North America, killer whales occur along the entire Alaskan coast as far north as Barrow (George *et al.* 1994, Lowry *et al.* 1987, Clarke *et al.* 2013), in British Columbia and Washington inland waterways (Bigg *et al.* 1990), and along the outer coasts of Washington, Oregon, and California (Barlow and Forney 2007). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intra-coastal waterways of British Columbia and Washington State, where pods have been labeled as 'resident,' 'transient,' and 'offshore' (Bigg *et al.* 1990, Ford *et al.* 1994) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982, Baird and Stacey 1988, Baird *et al.* 1992, Hoelzel *et al.* 1998). Through examination of photographs of recognizable individuals and pods, movements of whales between Prince William Sound and Kodiak Island have been observed (Matkin *et al.* 1999) 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).

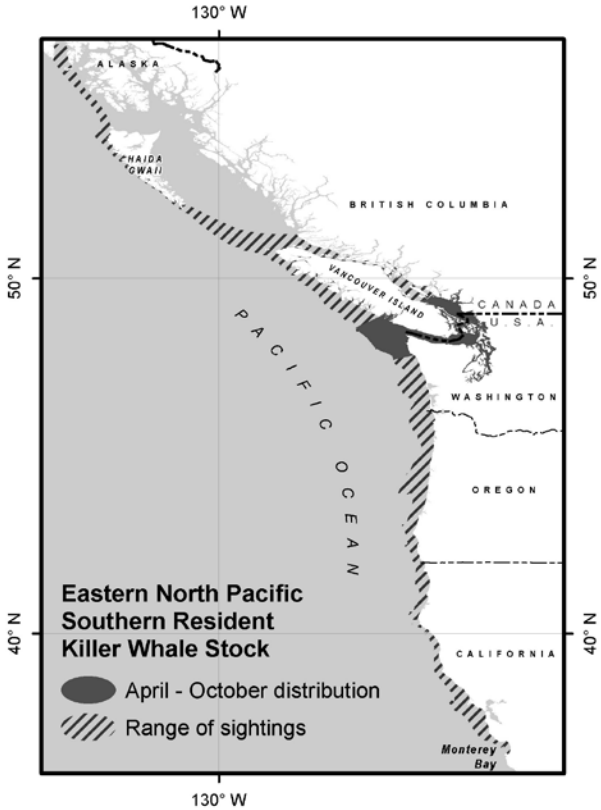

Figure 1. Approximate April - October distribution of the Eastern North Pacific Southern Resident killer whale stock (shaded area) and range of sightings (diagonal lines).

Genetic studies provide evidence that the 'resident' and 'transient' types are distinct (Stevens *et al.* 1989, Hoelzel 1991, Hoelzel and Dover 1991, Hoelzel *et al.* 1998, Morin *et al.* 2010). Analyses of complete mitochondrial genomes indicates that transient killer whales should be recognized as a separate species, and that, pending additional data, resident killer whales should be recognized as a separate subspecies (Morin *et al.* 2010). The genetic data results support previous lines of evidence for separation of the transient and resident ecotypes, including differences in 1) acoustic dialects; 2) skull features; 3) morphology; 4) feeding specializations; and 5) a lack of interbreeding between the two sympatric ecotypes (Krahn *et al.* 2004).

Most sightings of the Eastern North Pacific Southern Resident stock of killer whales have occurred in the summer in inland waters of Washington and southern British Columbia. However, pods belonging to this stock have also been sighted in coastal waters off southern Vancouver Island and Washington (Bigg *et al.* 1990, Ford *et al.* 2000, NWFSC unpubl. data). The complete winter range of this stock is uncertain. Of the three pods comprising this stock, one (J1) is commonly sighted in inshore waters in winter, while the other two (K1 and L1) apparently spend more time offshore (Ford *et al.* 2000). These latter two pods have been sighted as far south as Monterey Bay and central California in recent years ~~(N. Black, pers. comm., K. Balcomb, pers. comm.)~~. They sometimes have also been seen entering the inland waters of Vancouver Island through Johnstone Strait in the spring (Ford *et al.* 2000), suggesting that they may spend time along the outer coast of Vancouver Island during the winter. In June 2007, whales from L-pod were sighted off Chatham Strait, Alaska, the farthest north they have ever been documented (J. Ford, pers. comm.). Passive autonomous acoustic recorders have recently provided more information on the seasonal occurrence of these pods along the west coast of the U.S. (Hanson *et al.* 2013). In addition, satellite-linked tags were recently deployed in winter months on members of J, K, and L pods. Results were consistent with previous data, but provided much greater detail, showing wide-ranging use of inland waters by J Pod whales and extensive movements in U.S. coastal waters by K and L Pods ~~(NWFSC, unpubl. data)~~.

Based on data regarding association patterns, acoustics, movements, genetic differences and potential fishery interactions, eight killer whale stocks are recognized within the Pacific U.S. EEZ: 1) the Eastern North Pacific Alaska Resident stock - occurring from Southeast Alaska to the Bering Sea, 2) the Eastern North Pacific Northern Resident stock - occurring from British Columbia through Alaska, 3) the Eastern North Pacific Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia but extending from central California into southern Southeast Alaska (see Fig. 1), 4) the ~~Eastern North Pacific~~West Coast Transient stock - occurring from Alaska through California, 5) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring from southeast Alaska to the Bering Sea, 6) the AT1 Stock – found only in Prince William Sound, 7) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California, 8) the Hawaiian stock. The Stock Assessment Reports for the Alaska Region contain information concerning the Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident and the Gulf of Alaska, Aleutian Islands, and Bering Sea, AT1, and Eastern North Pacific Transient stocks.

POPULATION SIZE

The Eastern North Pacific Southern Resident stock is a trans-boundary stock including killer whales in inland Washington and southern British Columbia waters. Photo-identification of individual whales through the years has advanced knowledge of this stock's structure, behaviors, and movements. In 1993, the three pods comprising this stock totaled 96 killer whales (Ford *et al.* 1994). The population increased to 99 whales in 1995, then declined to 79 whales in 2001, and most recently numbered ~~78~~ 81 whales in ~~2014~~ 2015 (Fig. 2; Ford *et al.* 2000; Center for Whale Research ~~2015~~2016). The 2001-2005 counts included a whale born in 1999 (L-98) that was listed as missing during the annual census in May and June 2001 but was subsequently discovered alone in an inlet off the west coast of Vancouver Island. L-98 remained separate from L pod until 10 March 2006 when he died due to injuries associated with a vessel interaction in Nootka Sound. L-98 has been subtracted from the official 2006 and subsequent population censuses. The most recent census spanning 1 July ~~2013~~ 2014 through 1 July ~~2014~~ 2015 includes ~~no~~ 5 new calves (3 presumed male, one female) and the deaths of one ~~post~~ reproductive age adult female (that was pregnant with a female neonate), ~~an adult female, an adult male,~~ and a ~~young adult male~~calf of unknown sex. This does not include 5 additional calves born between September 2015 and January 2016. In addition, a young adult female was observed pushing a dead neonate (not one of the recently born calves) in January 2016. ~~a reproductive age female (that was pregnant) that stranded in December 2014 and a calf that was initially observed in September 2014 that subsequently disappeared in October 2014. It also does not include calves born in December 2014 and February 2015 (Center for Whale Research, 2015).~~

Minimum Population Estimate

The abundance estimate for this stock of killer whales is a direct count of individually identifiable animals. It is thought that the entire population is censused every year. This estimate therefore serves as both a best estimate of abundance and a minimum estimate of abundance. Thus, the minimum population estimate (N_{min}) for the Eastern North Pacific Southern Resident stock of killer whales is 81~~78~~ animals.

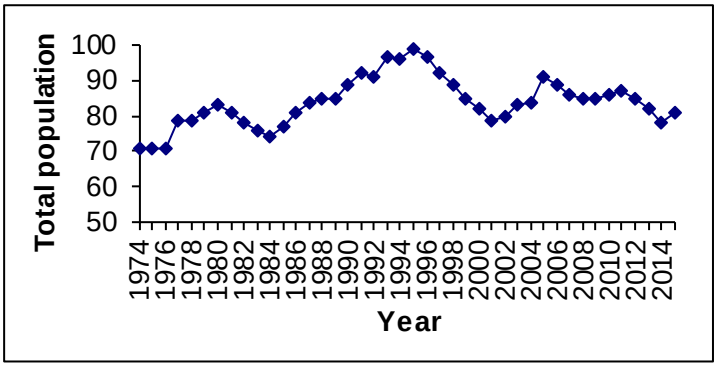

Figure 2. Population of Eastern North Pacific Southern Resident stock of killer whales, 1974-~~2014~~2015. Each year's count includes animals first seen and first missed; a whale is considered first missed the year after it was last seen alive (Ford *et al.* 2000; Center for Whale Research~~, unpubl. Data~~ 2015).

Current Population Trend

During the live-capture fishery that existed from 1967 to 1973, it is estimated that 47 killer whales, mostly immature, were taken out of this stock (Ford *et al.* 1994). Since the first complete census of this stock in 1974 when 71 animals were identified, the number of southern resident killer whales has fluctuated annually. Between 1974 and the mid-1990s, the Southern Resident stock increased approximately 35% (Ford *et al.* 1994), representing a net annual growth rate of 1.8% during those years. Following the peak census count of 99 animals in 1995, the population size

has declined and currently stands at 81 ~~78~~ animals as of the ~~2014~~ 2015 census (Ford *et al.* 2000; Center for Whale Research~~, unpubl. Data~~ 2015).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this stock of killer whales. Matkin *et al.* (2014) estimated a maximum population annual growth rate of 1.035 for southern Alaska resident killer whales. The authors noted that the 3.5% annual rate estimated for southern Alaska residents is higher than previously measured rates for British Columbia northern residents (2.9%, Olesiuk *et al.* 1990) and "probably represents a population at r-max (maximum rate of growth)." In the absence of published estimates of R_{max} for southern resident killer whales, the maximum annual rate of 3.5% found for southern Alaska residents is used for this stock of southern resident killer whales. This reflects more information about the known life history of resident killer whales than the default R_{max} of 4% and results in a more conservative estimate of potential biological removal (PBR).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (81 ~~78~~) times one-half the maximum net growth rate for *Alaska* resident killer whales (½ of 3.5%) times a recovery factor of 0.1 (for an endangered stock, Wade and Angliss 1997), resulting in a PBR of 0.14 whales per year, or approximately 1 animal every 7 years.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Salmon drift gillnet fisheries in Washington inland waters were last observed in 1993 and 1994 and no killer whale entanglements were documented, though observer coverage levels were ~~typically~~ less than 10% (Erstad *et al.* 1996, Pierce *et al.* 1994, Pierce *et al.* 1996, NWIFC 1995). Fishing effort in the inland waters drift gillnet fishery has declined considerably since 1994 because far fewer vessels participate today (~~NMFS NW~~ NOAA West Coast Region~~, unpublished data~~). Past marine mammal entanglements in this fishery included harbor porpoise, Dall's porpoise, and harbor seals. Coastal marine tribal set gillnets also occur along the outer Washington coast and no killer whale interactions have been reported in this fishery since the inception of the observer program in 1988, though the fishery is not active every year (Gearin *et al.* 1994, Gearin *et al.* 2000, Makah Fisheries Management, ~~unpublished data~~). ~~A fishery experiment with 100% observer coverage and acoustic alarms on all set gillnets was conducted in 2008 and 2011. No killer whale bycatch was documented (Makah Fisheries Management, unpublished data).~~

An additional source of information on killer whale mortality and injury incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. No self-report records of killer whale mortality have been reported.

Due to a lack of observer programs, there are few data concerning the mortality of marine mammals incidental to Canadian commercial fisheries. Since 1990, there have been no reported fishery-related strandings of killer whales in Canadian waters. However, in 1994 one killer whale was reported to have contacted a salmon gillnet but did not entangle (Guenther *et al.* 1995). Data regarding the level of killer whale mortality related to commercial fisheries in Canadian waters are not available.

The known total fishery mortality and serious injury for this stock is zero.

Other Mortality

No human-caused killer whale mortality or serious injuries were reported from non-fisheries sources in ~~2009-2013~~ 2010-2014 (Carretta *et al.* ~~2015~~ 2016). In 2012, a moderately decomposed juvenile female southern resident killer whale (L-112) was found dead near Long Beach, WA. A full necropsy was performed and the cause of death was determined to be blunt force trauma to the head, however the source of the trauma (vessel strike, intraspecific aggression, or other unknown source) could not be established (NOAA 2014). There was documentation of a whale-boat collision in Haro Strait in 2005 which resulted in a minor injury to a whale. In 2006, whale L98 was killed during a vessel interaction. It is important to note that L98 had become habituated to regularly interacting with vessels during its isolation in Nootka Sound. The annual known level of non-fishery human-caused mortality for this stock over the past five years (~~2008-2012~~ 2010-2014) is zero animals per year.

STATUS OF STOCK

~~Southern Resident killer whales were listed as endangered under the ESA in 2005.~~ Total annual fishery mortality and serious injury for this stock (0) is not known to exceed 10% of the calculated PBR (0.14) and, therefore, appears to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury of zero animals per year does not exceed the PBR (0.14). Southern Resident killer whales ~~a~~ were formally listed as "endangered" under the ESA in 2005 and consequently the stock is automatically considered as a "strategic" stock under the MMPA. This stock was considered "depleted" prior to its 2005 listing under the ESA.

Habitat Issues

Several ~~of the~~ potential risk factors identified for this population have habitat implications. The summer range of this population, the inland waters of Washington and British Columbia, ~~is the~~ are home to a large commercial whale watch industry, ~~as well as~~ and high levels of recreational boating and commercial shipping. ~~There continues to be concern about potential for masking effects by noise generated from these activities on the whales'~~ Potential for acoustic masking effects on the whales' communication and foraging due to vessel traffic remains a concern (Erbe 2002, Clark *et al.* 2009). In 2011 vessel approach regulations were implemented to restrict vessels from approaching closer than 200m. This population appears to be Chinook salmon specialists (Ford and Ellis 2006, Hanson *et al.* 2010), although other species, ~~particularly chum,~~ such as chum, pink, and coho salmon also appear to be important elements of the diet ~~in the fall (NWFSC unpubl. Data~~ Ford *et al.* 1998). There is evidence that changes in Chinook abundance have affected this population (Ford *et al.* 2009, Ward *et al.* 2009). In addition, the high trophic level and longevity of the animals has predisposed them to accumulate levels of contaminants that are high enough to cause potential health impacts. In particular, there is recent evidence of extremely high levels of flame retardants in young animals (Krahn *et al.* 2007, 2009).

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Revised ~~01/15/2011~~ 08/22/2016

SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Two genetically and morphologically distinct pilot whale types are described in the Pacific ('Shiho' and 'Naisa') by Van Cise *et al.* (2016), which correspond to the northern and southern types (respectively) described off Japan (Kasuya *et al.* 1988; Wada 1988; Miyazaki and Amano 1994). Shiho type animals are largely confined to the California Current and eastern tropical Pacific, while Naisa type pilot whales occur in the central Pacific and Japan. Differences in body size, head shape, coloration, and number of teeth characterize Shiho and Naisa morphotypes, with the larger eastern Pacific Shiho type characterized by a rounder melon and distinct light saddle patch. Short-finned pilot whales were once common off Southern California, with an apparently resident population around Santa Catalina Island, as well as seasonal migrants (Dohl et al. 1980). After a strong El Niño event in 1982-83, short-finned pilot whales virtually disappeared from this region, and despite increased survey effort along the entire U.S. west coast, sightings and fishery takes are rare and have primarily occurred during warm-water years (Julian and Beeson 1998, Carretta *et al.* 2004, Barlow 2016). ~~few sightings were made from 1984-1992 (Jones and Szczepaniak 1992; Barlow 1997; Carretta and Forney 1993; Shane 1994; Green et al. 1992, 1993). In 1993, six groups of short-finned pilot whales were again seen off California (Carretta et al. 1995; Barlow and Gerrodette 1996), and mortality in drift gillnets increased (Julian and Beeson 1998) but sightings remain rare (Barlow 1997).~~ Figure 1 summarizes the sightings of short-finned pilot whales off the U.S. west coast from 1991-~~2008~~2014. ~~Although the full geographic range of the California, Oregon, and Washington population is not known, it may be continuous with animals found off Baja California, and its individuals are morphologically distinct from short-finned pilot whales found farther south in the eastern tropical Pacific (Polisini 1981).~~ Pilot whales in the California Current and eastern tropical Pacific likely represent a single population, based on a lack of differentiation in mtDNA (Van Cise *et al.* 2016), while animals in Hawaiian waters are characterized by unique haplotypes that are absent from eastern and southern Pacific samples, despite relatively large sample sizes from Hawaiian waters.~~Separate southern and northern forms of short-finned pilot whales have also been documented for the western North Pacific (Kasuya et al. 1988; Wada 1988; Miyazaki and Amano 1994).~~ For the Marine Mammal Protection Act (MMPA) stock assessment reports, short-finned pilot whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Hawaiian waters. Shiho-type short-finned pilot whales comprise the California, Oregon and Washington stock, and are covered in this report. Naisa-type short-finned pilot whales comprise the Hawaiian stock.

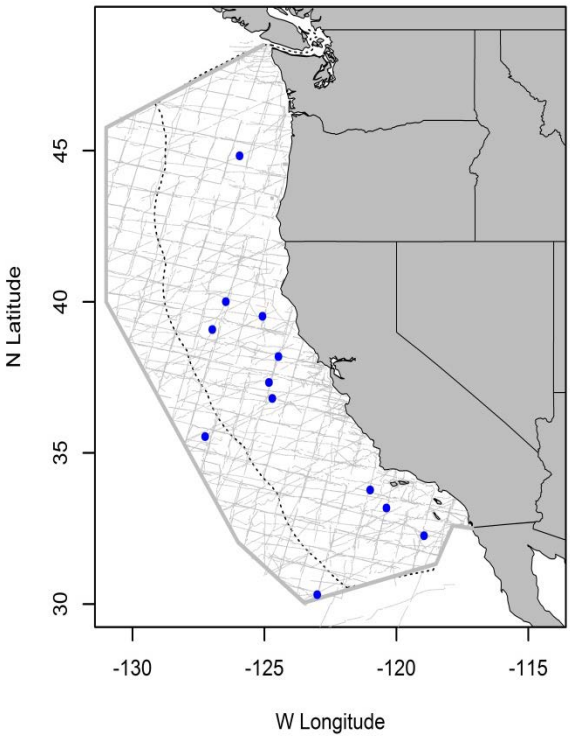

Figure 1. Short-finned pilot whale sightings made during shipboard surveys conducted off California, Oregon, and Washington, 1991-2014 (Barlow 2016). ~~2008. See Appendix 2 for data sources and information on timing and location of survey effort.~~ Dashed line represents the U.S. EEZ, thin gray lines indicate completed transect effort of all surveys

POPULATION SIZE

~~Only two groups of pilot whales numbering approximately 26 and 43 animals, respectively were seen during the two most recent ship surveys conducted off California, Oregon, and Washington in 2005 and 2008 (Barlow and Forney 2007; Forney 2007, Barlow 2010). Abundance is estimated at 489 (CV=0.97) and 1,180 (CV=1.00) for the 2005 and 2008 surveys, respectively (Forney 2007, Barlow 2010).~~ The abundance of short-finned pilot whales in this region is variable and may be influenced by prevailing oceanographic conditions (Forney 1997, Forney and Barlow 1998, Barlow 2016). Because animals may spend time outside the U.S. Exclusive Economic Zone as oceanographic conditions change, a multi-year average abundance estimate is the most appropriate for management within U.S. waters. ~~The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters based on the two ship surveys is 760 (CV=0.64) short-finned pilot whales (Barlow and Forney 2007 ; Forney 2007; Barlow 2010).~~ The most recent estimate of short-finned pilot whale abundance is the geometric mean of estimates from 2008 and 2014 summer/autumn vessel-based line-transect surveys of California, Oregon, and Washington waters, or 836 (CV = 0.79) animals (Barlow 2016). This estimate includes new correction factors for animals missed during the surveys.

Minimum Population Estimate

The log-normal 20th percentile of the ~~2005-2008~~ 2008-2014 geometric mean abundance estimate is ~~465~~ 466 short-finned pilot whales.

Current Population Trend

~~Approximately nine years after the virtual disappearance of short-finned pilot whales following~~ Following the virtual disappearance of short-finned pilot whales from California after the 1982-83 El Niño, they have been encountered infrequently and primarily during warm-water years, such as 1991, 1993, 1997, 2014, and 2015 (e.g., Carretta et al. 1995, Julian and Beeson 1998, Carretta et al. 2004, Barlow 2016). ~~appear to have returned to California waters, as indicated by an increase in sighting records as well as incidental fishery mortality (Barlow and Gerrodette 1996; Carretta et al. 1995; Julian and Beeson 1998; Forney 2007; Barlow 2010). However, this cannot be considered a true growth in the population, because it merely reflects~~ These patterns likely reflect large-scale, long-term movements of this species in response to changing oceanographic conditions. It is not known ~~where the animals went after the 82-83 El Niño, or where the recently observed animals came from~~whether the animals sighted more recently are part of the same population that was documented off Southern California before the mid-1980s or a different wide-ranging pelagic population. ~~Until the range of this population and the movements of animals in relation to environmental conditions are better documented, no~~Therefore, no~~-~~ inferences can be drawn regarding trends in abundance of short-finned pilot whales off California, Oregon and Washington.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for short-finned pilot whales off California, Oregon and Washington.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~465~~ 466) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.50~~ 0.48 (for a species of unknown status with mortality rate CV between 0.3 and 0.6 ~~no known fishery mortality in the last 5 years~~; Wade and Angliss 1997), resulting in a PBR of ~~4.6~~ 4.5 short-finned pilot whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of known fishery mortality and injury for this stock of short-finned pilot whale is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. The estimate of mortality and serious injury for short-finned pilot whale in the California drift gillnet fishery for the five most recent years of monitoring, 2010-2014, is 5.8 (CV=0.42) individuals, or an average of 1.2 per year (Carretta *et al*. 2016). ~~Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 2004-2008 (Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b). After the 1997 implementation of a Take Reduction Plan, which included skipper education~~

~~workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). However, because of interannual variability in entanglement rates and the relative rarity of short-finned pilot whale entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of this particular species. There have been 11 pilot whale deaths observed in this fishery since 1990. In 1993, there were 8 deaths observed, and one each in 1990, 1992, 1997 (in an unpingered net) and 2003. Mean annual takes in Table 1 are based on 2004-2008 data. This results in an average estimate of zero short-finned pilot whales taken annually.~~

~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~

Historically, short-finned pilot whales were also killed in squid purse seine operations off Southern California (Miller et al. 1983; Heyning et al. 1994), but these deaths occurred when pilot whales were still common in the region. An observer program in the squid purse seine fishery was initiated in 2004 and a total of 377 ~~sets~~ sets (<10% of effort) ~~have been~~were observed through 2008 without a pilot whale interaction. ~~Observer coverage in this fishery has been less than 10% of all fishing effort.~~ Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki et al. 1993), but no recent bycatch data from Mexico are available.

Table 1. Summary of available information on the incidental mortality and serious injury of short-finned pilot whales (California/Oregon/Washington Stock) in commercial fisheries that might take this species (Carretta *et al*. 2016). Coefficients of variation for mortality estimates are provided in parentheses; n/a = not available. ~~Mean annual takes are based on 2004-2008 data unless noted otherwise.~~

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated ~~Annual~~ Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	~~20.6%~~ ~~20.9%~~ ~~18.5%~~ ~~16.4%~~ ~~13.5%~~ 22%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 2[1]	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 5.8 (0.42)	~~0~~ 1.2 (0.42)
Market squid purse seine	observer	2004-2008	<10%	0	0	0
Minimum total annual takes						~~0~~ 1.2 (0.42)

STATUS OF STOCK

The status of short-finned pilot whales off California, Oregon and Washington in relation to OSP is unknown. They have declined in abundance in the Southern California Bight, ~~likely a result of a change in their distribution~~ since the 1982-83 El Niño, but the nature of these changes and potential habitat issues are not adequately understood. Short-finned pilot whales are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. The average annual human-caused mortality ~~from 2004-2008 is zero~~ . 1.2 animals, is less than the PBR of ~~4.6~~ 4.5, and therefore they are not classified as a "strategic" stock under the MMPA. Total annual human-caused mortality and serious injury

[1] There were two observed entanglements of short-finned pilot whales in this fishery during 2010-2014; both occurred in 2014 (Carretta *et al*. 2016).

for this stock is~~ estimated at zero animals~~ greater than 10 % of PBR;~~,~~ therefore, mortality and serious injury cannot be ~~ is~~ considered to be approaching a zero mortality and serious injury rate.

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Revised ~~01/15/2011~~ 9/23/2016

PYGMY SPERM WHALE (*Kogia breviceps*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Pygmy sperm whales are distributed throughout deep waters and along the continental slopes of the North Pacific and other ocean basins (Ross 1984; Caldwell and Caldwell 1989). Along the U.S. west coast, sightings of this species and of animals identified only as *Kogia* sp. have been ~~very~~ rare (Figure 1). However, this probably reflects their pelagic distribution, small body size and cryptic behavior, rather than a measure of rarity. Strandings of pygmy sperm whales in this region are known from California, Oregon and Washington (Roest 1970; Caldwell and Caldwell 1989; NMFS, Northwest Region, unpublished data; NMFS, Southwest Region, unpublished data), while strandings of dwarf sperm whales (*Kogia sima*) are rare in this region. At-sea sightings in this region have all been either of pygmy sperm whales or unidentified *Kogia* sp. Available data are insufficient to identify any seasonality in the distribution of pygmy sperm whales, or to delineate possible stock boundaries. For the Marine Mammal Protection Act (MMPA) stock assessment reports, pygmy sperm whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Hawaiian waters.

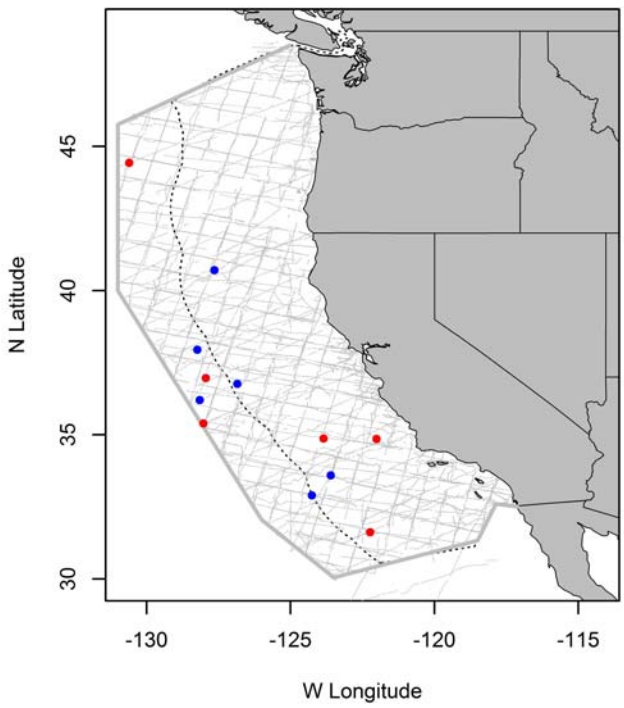

Figure 1. *Kogia* sightings based on shipboard surveys off California, Oregon and Washington, 1991- ~~2008~~ 2014~~(see Appendix 2 for data sources and information on timing and location of survey effort)~~. Key: ● = *Kogia breviceps*, ● = *Kogia* spp. Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined.

POPULATION SIZE

~~Although pygmy sperm whales have been sighted along the U.S. west coast on several line transect surveys, sightings have been too rare to produce reliable population estimates. The most recent abundance estimate of 1,157 (CV=1.02) animals is based on one sighting of an unidentified *Kogia* during a 2008 ship survey of California, Oregon, and Washington waters (Barlow 2010).~~ Most sightings of *Kogia* in the California Current are only identified to genus due to their cryptic nature, but ~~Based~~ based on positively-identified sightings from previous ~~sighting~~ surveys and historical stranding data, ~~it is likely that~~ most of these sightings were ~~of~~ probably pygmy sperm whales; *K. breviceps*. ~~The 2008 estimate incorporate a correction factor for animals missed, based on a model of their diving behavior, detection distances, and the searching behavior of observers (Barlow 1999). About 35% of all trackline groups are estimated to be seen.~~ The rarity of sightings likely reflects the cryptic nature of this species (they are detected almost exclusively in extremely calm sea conditions), rather than an absence of animals in the region. The best estimate of abundance for this stock is the geometric mean of ~~2005 and~~ 2008 and 2014 shipboard line-transect surveys, or ~~579 (CV=1.02)~~ 4,111 (CV=1.12) animals. This estimate is considerably higher than previous abundance estimates for the genus *Kogia* and results from a new and lower estimate of *g(0)*, the trackline detection probability (Barlow 2015). Only 3% of *Kogia* groups were estimated to have been detected on the trackline during 1991-2014 surveys (Barlow 2016).

Minimum Population Estimate

The minimum population estimate is taken as the log-normal 20th percentile of the ~~2005 and~~ 2008 and 2014 average abundance estimate for California, Oregon, and Washington waters, or ~~271~~ 1,924 animals.

Current Population Trend

Due to the rarity of sightings of this species on surveys along the U.S. West coast, no information exists regarding trends in abundance of this population.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this species.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~271~~ 1,924) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality during the last five years; Wade and Angliss 1997), resulting in a PBR of ~~2.7~~ 19 pygmy sperm whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for pygmy sperm whales and unidentified *Kogia*, which may have been pygmy sperm whales, is shown in Table 1. ~~More detailed information on the drift gillnet fishery is provided in Appendix 1.~~ In the California swordfish drift gillnet fishery (the only U.S. west coast fishery likely to interact with *Kogia*), no mortality of pygmy sperm whales or unidentified *Kogia* was observed during the most recent five years of monitoring (Carretta *et al*. 2016a ~~2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b~~). Over 8,600 fishing sets have been monitored in the California swordfish drift gillnet fishery between 1990 and 2014 and only 2 pygmy sperm whales were observed entangled (Carretta et al. 2016). Both animals were entangled in years that predated the use of acoustic pingers in the fishery to reduce bycatch (Barlow and Cameron 2003), but the small sample size of *Kogia breviceps* bycatch in the fishery precludes any conclusions regarding the effectiveness of acoustic pingers in reducing bycatch of this species (Carretta and Barlow 2011). ~~One pygmy sperm whale was observed killed in the drift gillnet fishery in 1992 and another in 1993. After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). However, because of interannual variability in entanglement rates and the rarity of *Kogia* entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of pygmy sperm whales.~~ Mean annual takes in Table 1 are based on ~~2004-2008~~ 2010-2014 data. This results in an average estimated annual mortality of zero pygmy sperm whales.

~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~

One pygmy sperm whale stranded in California in 2002 with evidence that it died as a result of a shooting (positive metal detector scan). Due to the cryptic and pelagic nature of this species, it is likely that the shooting resulted from an interaction with an unknown entangling net fishery. Although there are no records of fishery-related strandings of pygmy sperm whales along the U.S. west coast in recent years (Carretta *et al*. 2013, 2014, 2015, 2016b), compared with other more coastal cetaceans, the probability of a pygmy sperm whale carcass coming ashore and being detected would be quite low (Carretta *et al*. 2016c).

Other mortality

~~No human-caused mortality of pygmy sperm whales has been documented during the most recent five-year period (2004-2008)~~. Unknown levels of injuries and mortality of pygmy sperm whales may occur as a result of anthropogenic sound, such as military sonars ~~(U.S. Dept. of Commerce and Secretary of the Navy 2001) or other commercial and scientific activities involving the use of air guns~~. Such injuries or mortality would rarely be documented, due to the remote nature of many of these activities and the low probability that an injured or dead pygmy sperm whale would strand. Unknown levels of injuries and mortality of pygmy sperm whales may occur as a result of anthropogenic sound, such as military sonars. Atypical multispecies mass strandings, sometimes involving pygmy and/or dwarf sperm whales have been associated with military sonar use. One 1988 event from the Canary Islands included 2 pygmy sperm whales and the species *Ziphius cavirostris* and *Hyperoodon ampullatus* (reviewed in D'Amico *et al*. 2009). Another mass stranding and unusual mortality event (UME) in North Carolina, USA in 2005 included 2 dwarf sperm whales, in addition to 33 short-finned pilot whales and a minke whale (Hohn *et al*. 2006). This UME coincided in time and space with military activity using mid-frequency active sonar, although the authors note that a definitive association between the UME and sonar use is lacking (Hohn *et al*. 2006). Such injuries or mortality would rarely be documented, due to the remote nature of many of these activities and the low probability that an injured or dead pygmy sperm whale would strand.

STATUS OF STOCK

The status of pygmy sperm whales in California, Oregon and Washington waters relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. Although the impacts of anthropogenic sounds such as sonar are often focused on beaked whales (Barlow and Gisiner 2006), the impacts of such sounds on deep-diving pygmy beaked whales also warrants concern. ~~No habitat issues are known to be of concern for this species, but in recent years questions have been raised regarding potential effects of human-made sounds on deep-diving cetacean species, such as pygmy sperm whales (Richardson et al. 1995). In particular, active sonar has been implicated in the mass stranding of beaked whales in the Mediterranean Sea (Frantzis 1998) and more recently in the Caribbean (U.S. Dept. of Commerce and Secretary of the Navy 2001).~~ They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Given the rarity of sightings and lack of recent documented fishery interactions in U.S. west coast waters, pygmy sperm whales are not classified as a "strategic" stock under the MMPA.

Table 1. Summary of available information on the incidental mortality and injury of pygmy sperm whales and unidentified *Kogia* sp. (California/Oregon/Washington Stock) in commercial fisheries that might take this species. Coefficients of variation for mortality estimates are provided in parentheses. Mean annual takes are based on ~~2004-2008~~ 2010-2014 data unless noted otherwise (Carretta *et al*. 2016a).

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality *K. breviceps /Kogia* sp.	*Estimated Annual Mortality of K. breviceps/Kogia* sp.	*Mean Annual Takes (CV in parentheses)*
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	~~20.6%~~ ~~20.9%~~ ~~18.5%~~ ~~16.4%~~ ~~13.5%~~ 22%	~~0 / 0~~ ~~0 / 0~~ ~~0 / 0~~ ~~0 / 0~~ ~~0 / 0~~ 0	~~0 / 0~~ ~~0 / 0~~ ~~0 / 0~~ ~~0 / 0~~ ~~0 / 0~~ 0	0
Minimum total annual takes						0

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Revised ~~01/15/2011~~ 10/23/2016

DWARF SPERM WHALE (*Kogia sima*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Dwarf sperm whales are distributed throughout deep waters and along the continental slopes of the North Pacific and other ocean basins (Caldwell and Caldwell 1989; Ross 1984). This species was only recognized as being distinct from the pygmy sperm whale in 1966 (Handley, 1966), and early records for the two species are confounded. Along the U.S. west coast, no at-sea sightings of this species have been reported; however, this may be partially a reflection of their pelagic distribution, small body size and cryptic behavior. A few sightings of animals identified only as *Kogia* sp. have been reported (Figure 1), and some of these may have been dwarf sperm whales. At least five dwarf sperm whales stranded in California between 1967 and 2000 (Roest 1970; Jones 1981; J. Heyning, pers. comm.; NMFS, Southwest Region, unpublished data), and one stranding is reported for western Canada (Nagorsen and Stewart 1983). It is unclear whether records of dwarf sperm whales are so rare because they are not regular inhabitants of this region, or merely because of their cryptic habits and offshore distribution. Available data are insufficient to identify any seasonality in the distribution of dwarf sperm whales, or to delineate possible stock boundaries. For the Marine Mammal Protection Act (MMPA) stock assessment reports, dwarf sperm whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Hawaiian waters.

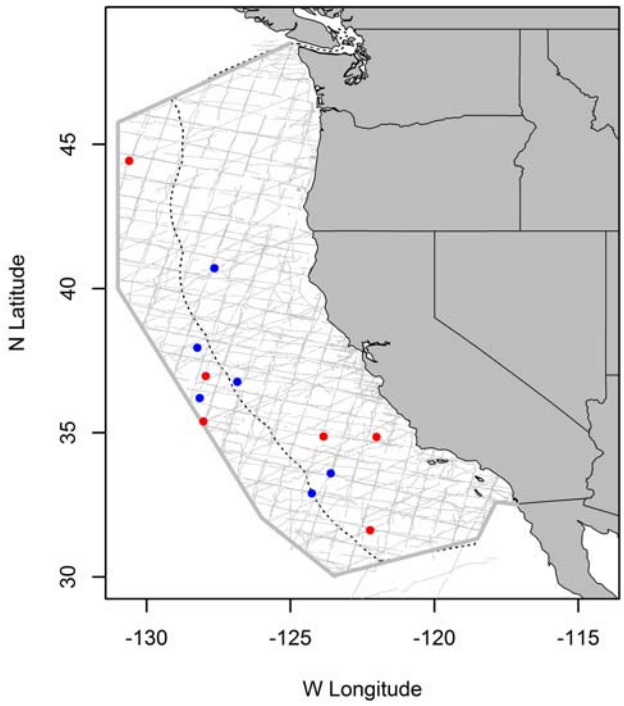

Figure 1. *Kogia* sightings based on shipboard surveys off California, Oregon and Washington, 1991-~~2008~~2014 ~~(see Appendix 2 for data sources and information on timing and location of survey effort)~~. Key: ● = *Kogia breviceps*; ● = *Kogia* spp. Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined.

POPULATION SIZE

No information is available to estimate the population size of dwarf sperm whales off the U.S. west coast, as no sightings of this species have been documented despite numerous vessel surveys of this region (Barlow 1995; Barlow and Gerrodette 1996; Barlow and Forney 2007; Forney 2007; Barlow 2010, Barlow 2016). Based on previous sighting surveys and historical stranding data, it is likely that recent ship survey sightings were of pygmy sperm whales; *K. breviceps*.

Minimum Population Estimate

No information is available to obtain a minimum population estimate for dwarf sperm whales.

Current Population Trend

Due to the rarity of records for this species along the U.S. West coast, no information exists regarding trends in abundance of this population.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this species.

POTENTIAL BIOLOGICAL REMOVAL

Based on this stock's unknown status and growth rate, the recovery factor (F_r) is 0.5, and ½R_{max} is the default value of 0.02. However, due to the lack of abundance estimates for this species, no potential biological removal (PBR) can be calculated.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The fishery most likely to interact with dwarf sperm whales in the California Current is the swordfish drift gillnet fishery. There have been no observed dwarf sperm whale entanglements in over 8,600 monitored fishing sets from 1990 to 2014 (Carretta *et al.* 2016a). Although there are no records of fishery-related strandings of dwarf sperm whales along the U.S. west coast in recent years (Carretta *et al.* 2013, 2014, 2015, 2016b), compared with other more coastal cetaceans, the probability of a dwarf sperm whale carcass coming ashore and being detected would be quite low (Carretta *et al*. 2016c).

Table 1. Summary of available information on the incidental mortality and injury of dwarf sperm whales and unidentified *Kogia* sp. (California/Oregon/Washington Stock) in commercial fisheries that might take this species. Coefficients of variation for mortality estimates are provided in parentheses. Mean annual takes are based on ~~2004-2008~~ 2010-2014 data ~~unless noted otherwise~~.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality *K. breviceps /Kogia* sp.	*Estimated Annual Mortality of K. breviceps/Kogia* sp.	*Mean Annual Takes (CV in parentheses)*
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	2010-2014	22%	0	0	0
Minimum total annual takes						0

~~In the California drift gillnet fishery, no mortality of dwarf sperm whales or unidentified *Kogia* was observed during the most recent five years of monitoring, 2004-2008 (Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b). After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6 fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). However, because of interannual variability in entanglement rates and the rarity of *Kogia* entanglements, additional years of data will be required to fully evaluate the effectiveness of pingers for reducing mortality of dwarf sperm whales. Mean annual takes in Table 1 are based on 2004-2008 data. This results in an average estimated annual mortality of zero dwarf sperm whales.~~

~~Similar drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which has increased from two vessels in 1986 to 29 vessels in 1992 (Sosa-Nishizaki et al. 1993). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~

Other Mortality

Unknown levels of injuries and mortality of dwarf sperm whales may occur as a result of anthropogenic sound, such as military sonars. Atypical multispecies mass strandings, sometimes involving dwarf and/or pygmy sperm whales have been associated with military sonar use. One 1988 event from the Canary Islands included 2 pygmy sperm whales and the species *Ziphius cavirostris* and *Hyperoodon ampullatus* (reviewed in D'Amico *et al.* 2009). Another mass stranding and unusual mortality event (UME) in North Carolina, USA in 2005 included 2 dwarf sperm whales, in addition to 33 short-finned pilot whales and a minke whale (Hohn *et al.* 2006). This UME coincided in time and space with military activity using mid-frequency active sonar, although the authors note that a definitive association between the UME and sonar use is lacking (Hohn *et al.* 2006). Such injuries or mortality would rarely be documented, due to the remote nature of many of these activities and the low probability that an injured or dead dwarf sperm whale would strand.

STATUS OF STOCK

The status of dwarf sperm whales in California, Oregon and Washington waters relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance. Although the impacts of anthropogenic sounds such as sonar are often focused on beaked whales (Barlow and Gisiner 2006), the impacts of such sounds on deep-diving dwarf beaked whales also warrants concern. ~~No habitat issues are known to be of concern for this species, but in recent years questions have been raised regarding potential effects of human-made sounds on deep-diving cetacean species, such as dwarf sperm whales (Richardson et al. 1995). In particular, active sonar has been implicated in the mass stranding of beaked whales in the Mediterranean Sea (Frantzis 1998) and more recently in the Caribbean (U.S. Dept. of Commerce and Secretary of the Navy 2001).~~ They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Given that this species rarely occurs off the U.S. west coast and ~~current fishery mortality is zero~~ a lack of recent documented fishery mortality, dwarf sperm whales off California, Oregon and Washington are not classified as a "strategic" stock under the MMPA.

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Revised ~~6/4/2014~~ 9/21/2016

HUMPBACK WHALE (*Megaptera novaeangliae*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

NMFS has conducted a global Status Review of humpback whales (Bettridge *et al*. 2015), and recently revised the ESA listing of the species (81 FR 62259, September 8, 2016). NMFS is evaluating the stock structure of humpback whales under the MMPA, but no changes to current stock structure are presented at this time. However, effects of the ESA listing final rule on the status of the stock are discussed below. Northern Hemisphere humpback whales (*M. novaeangliae kuzira*) comprise a distinct subspecies based on mtDNA and DNA relationships and distribution compared to North Atlantic humpback whales (*M n. novaeangliae*) and those in the Southern Hemisphere (*M. n. australis*) (Jackson *et al*. 2014). Humpback whales occur throughout the North Pacific, with multiple populations currently recognized based on low-latitude winter breeding areas (Baker *et al*. 1998, Calambokidis *et al*. 2001, Calambokidis *et al*. 2008, Barlow *et al*. 2011, Fleming and Jackson 2011). North Pacific breeding areas fall broadly into three regions, including the 1) western Pacific (Japan and Philippines); 2) central Pacific (Hawaiian Islands); and 3) eastern Pacific (Central America and Mexico) (Calambokidis *et al*. 2008). Exchange of animals between breeding areas rarely occurs, based on photo-identification data of individual whales (Calambokidis *et al*. 2001, Calambokidis *et al*. 2008). Photo-identification evidence also suggests strong site fidelity to feeding areas, but animals from multiple feeding areas converge on common winter breeding areas (Calambokidis *et al*. 2008). Baker *et al*. (2008) reported significant differences in mtDNA haplotype frequencies among different breeding and feeding areas in the North Pacific, reflecting strong matrilineal site fidelity to the respective migratory destinations. The most significant differences in haplotype frequencies were found between the California/Oregon feeding area and Russian and Southeastern Alaska feeding areas (Baker *et al*. 2008). Among breeding areas, the greatest level of differentiation was found between Okinawa and Central America and most other breeding grounds (Baker *et al*. 2008). Genetic differences between feeding and breeding grounds were also found, even for areas where regular exchange of animals between feeding and breeding grounds is confirmed by photo-identification (Baker *et al*. 2008).

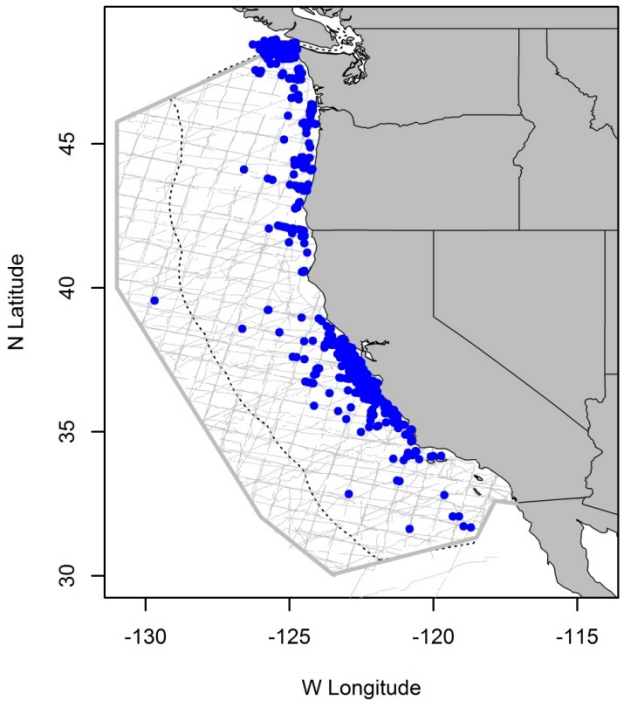

Figure 1. Humpback whale sightings based on shipboard surveys off California, Oregon, and Washington, 1991-~~2008~~ 2014. Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined. See Appendix 2 for data sources and information on timing and location of survey effort.

Along the U.S. west coast, one stock is currently recognized, which includes animals that appear to be part of two separate feeding groups, a California and Oregon feeding group and a northern Washington and southern British Columbia feeding group (Calambokidis *et al*. 2008, Barlow *et al*. 2011). Very few photographic matches between these feeding groups have been documented (Calambokidis *et al*. 2008). Humpbacks from both groups have been photographically matched to breeding areas off Central America, mainland Mexico, and Baja California, but whales from the northern Washington and southern British Columbia feeding group also winter near the Hawaiian Islands and the Revillagigedo Islands off Mexico (Barlow *et al*. 2011). Seven 'biologically important

areas' for humpback whale feeding are identified off the U.S. west coast by Calambokidis *et al*. (2015), including 5 in California, 1 in Oregon, and 1 in Washington.

For the Marine Mammal Protection Act (MMPA) stock assessment reports, the California/Oregon/Washington Stock is defined to include humpback whales that feed off the west coast of the United States, including animals from both the California-Oregon and Washington-southern British Columbia feeding groups (Calambokidis *et al*. 1996, Calambokidis *et al*. 2008, Barlow *et al*. 2011). Three other stocks are recognized in the U.S. MMPA Pacific stock assessment reports: the Central North Pacific Stock (with feeding areas from Southeast Alaska to the Alaska Peninsula), the Western North Pacific Stock (with feeding areas from the Aleutian Islands, the Bering Sea, and Russia), and the American Samoa Stock in the South Pacific (with largely undocumented feeding areas as far south as the Antarctic Peninsula).

POPULATION SIZE

Based on whaling statistics, the pre-1905 population of humpback whales in the North Pacific was estimated to be 15,000 (Rice 1978), but this population was reduced by whaling to approximately 1,200 by 1966 (Johnson and Wolman 1984). A photo-identification study in 2004-2006 estimated the abundance of humpback whales in the entire Pacific Basin to be 21,808 (CV=0.04) (Barlow *et al*. 2011). Barlow (~~2010~~ 2016) recently estimated ~~1,090~~ 3,064 (CV=~~0.41~~ 0.82) humpback whales from a ~~2008~~ 2014 summer/fall ship line-transect survey of California, Oregon, and Washington waters. Abundance estimates from photographic mark-recapture surveys conducted in California and Oregon waters every year from 1991 through 2011 represent the most ~~current~~ precise estimates (Calambokidis 2013). These estimates include only animals photographed in California and Oregon waters and not animals that are part of the separate feeding group found off Washington state and southern British Columbia (Calambokidis *et al*. 2009). California and Oregon estimates range from approximately 1,100 to 2,600 animals, depending on the choice of recapture model and sampling period (Figure 2). The best estimate of abundance for California and Oregon waters is taken as the 2008-2011 Darroch estimate of 1,729 (CV = 0.03) whales, which is also the most precise estimate (Calambokidis and Barlow 2013).

Calambokidis *et al*. (2008) reported a range of photographic mark-recapture abundance estimates (145 – 469) for the northern Washington and southern British Columbia feeding group most recently in 2005. The best model estimate from that paper (lowest AIC_c score) was reported as 189 (CV not reported) animals. This estimate is ~~approximately~~ more than 8 years old and ~~will soon be~~ is outdated for use in stock assessments; however, because west-coast humpback whale populations are growing (Calambokidis and Barlow 2013), this is still a valid minimum population estimate.

Combining abundance estimates from both the California/Oregon and Washington/southern British Columbia feeding groups (1,729 + 189) yields an estimate of 1,918 (CV≈0.03) animals for the California/Oregon/Washington stock. The approximate CV of 0.03 for the combined estimate reflects that a vast majority of the variance is derived from the California and Oregon estimate (CV=0.03) and that no CV was provided for the Washington state and southern British Columbia estimate.

Minimum Population Estimate

The minimum population estimate for humpback whales in the California/Oregon/Washington stock is taken as the lower 20th percentile of the log-normal distribution of the combined mark-recapture estimate for both feeding groups given above, or 1,876 animals.

Current Population Trend

Ship surveys provide some indication that humpback whales increased in abundance in California coastal waters between 1979/80 and 1991 (Barlow 1994) and between 1991 and ~~2005~~ 2014 (~~Barlow and Forney 2007; Forney 2007~~ Barlow 2016), but this increase was not steady, and estimates showed ~~a~~ slight dips in 2001 and 2008. Mark-recapture population estimates had shown a long-term increase of approximately 7.5% per year (Calambokidis *et al*. 2009, Figure 2), but more recent estimates show variable trends (Figure 2), depending on the choice of model and time frame used (Calambokidis and Barlow 2013). Population estimates for the entire North Pacific have also increased substantially from 1,200 in 1966 to approximately 18,000 - 20,000 whales in 2004 to 2006 (Calambokidis *et al*. 2008). Although these estimates are based on different methods and the earlier estimate is extremely uncertain, the growth rate implied by these estimates (6-7%) is consistent with growth rate of the California/Oregon/Washington stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The proportion of calves in the California/Oregon/Washington stock from 1986 to 1994 appeared much lower than previously measured for humpback whales in other areas (Calambokidis and Steiger 1994), but in 1995-97 a greater proportion of calves were identified, and the 1997 reproductive rates for this population are closer to those reported for humpback whale populations in other regions (Calambokidis et al. 1998). Despite the apparently low proportion of calves, two independent lines of evidence indicate that this stock was growing in the 1980s and early 1990s (Barlow 1994; Calambokidis *et al*. 2003) with a best estimate of 8% growth per year (Calambokidis *et al*. 1999). The current net productivity rate is unknown.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,876) times one half the estimated population growth rate for this stock of humpback whales (½ of 8%) times a recovery factor of 0.3 (for an endangered species~~,~~; see Status of Stock section below regarding ESA listing status) with N_{min} > 1,500 and CV(N_{min}) < 0.50), resulting in a PBR of 22. Because this stock spends approximately half its time outside the U.S. EEZ, the PBR allocation for U.S. waters is 11 whales per year.

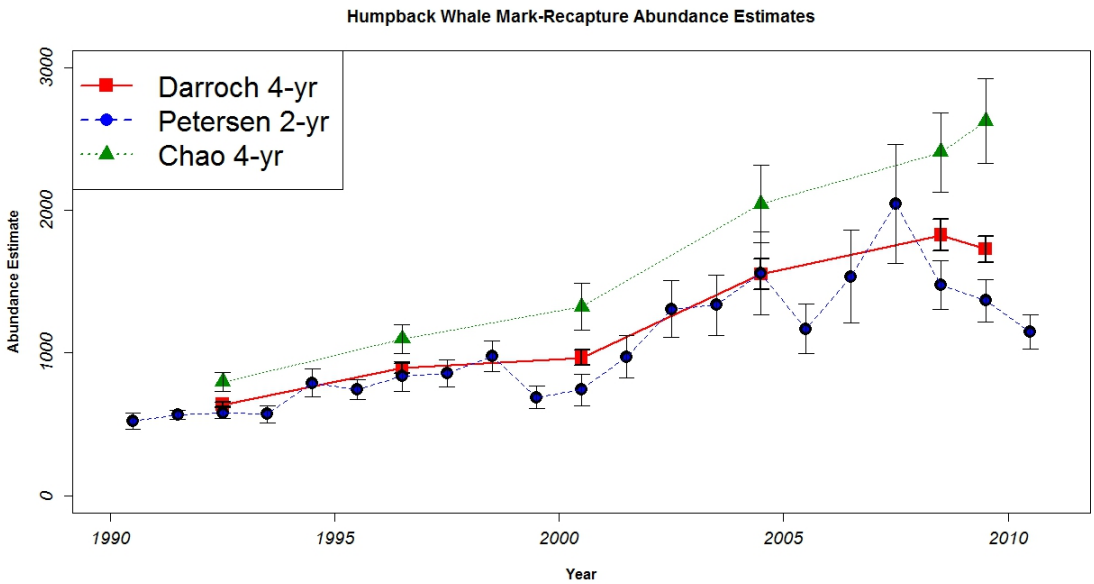

Figure 2. Mark-recapture estimates of humpback whale abundance in California and Oregon, 1991-2011, based on 3 different mark-recapture models and sampling periods (Calambokidis and Barlow 2013). Vertical bars indicate ±2 standard errors of each abundance estimate. Darroch and Chao models use 4 consecutive non-overlapping sample years, except for the last estimates, which use the four most recent years, but overlap with the next-to-last estimate (Calambokidis and Barlow 2013).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~**New Serious Injury Guidelines**~~

~~NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al*. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.~~

Fishery Information

Pot and trap fisheries are the most commonly documented source of serious injury and mortality of humpback whales in U.S. west coast waters (Carretta *et al*. 2013, 2015, 2016a). From 2010 to 2014, there were 27 documented interactions associated with pot and trap fisheries (Carretta *et al*. 2016a, Jannot *et al*. 2016). Five records (3 CA spot prawn pot + 2 unidentified pot/trap fisheries) involved non-serious injuries resulting from human

intervention to remove gear, or cases where animals were able to free themselves. Four records involved dead whales, including one case where a pair of severed humpback flukes were found in southern California waters with 2 sets of California Dungeness crab gear attached (Carretta *et al.* 2016a). The remaining 18 cases involved serious injuries (prorated and non-prorated) attributed to unidentified pot/trap fisheries (12 total serious injuries), WA coastal Dungeness crab pot (1), CA Dungeness crab pot (1), and CA spot prawn pot (0.75), for a total of 14.75 serious injuries / 5 years, or 2.95 humpback whales annually (Table 1). Including the 4 deaths attributed to pot/traps, the minimum level of annual mortality and serious injury across all pot/trap fisheries is 14.75 + 4 = 18.75 / 5 years = 3.75 whales annually (Table 1). ~~Between 2007 and 2011, there were 16 documented humpback whale interactions with pot/trap fisheries (Carretta et al. 2013). Of the 16 documented interactions, 10 were identified as generic 'crab pot/trap' and 4 as 'unidentified pot/trap' fishery. Two interactions identified as generic 'crab pot fishery entanglements' in Oregon resulted in the death of whales. An additional 4 serious injuries and 10 prorated serious injuries of humpbacks occurred during this same period (Carretta et al. 2013). Two interactions with serious injuries had gear positively identified: the CA lobster trap fishery and the CA dungeness crab fishery.~~

Table 1. Summary of available information on the incidental mortality and serious injury of humpback whales (California/Oregon/Washington stock) for commercial fisheries that are likely to take this species (Carretta *et al.* ~~2013~~ 2015, Carretta *et al.* 2016a, Carretta *et al.* 2016b). Mean annual takes are based on ~~2007-2011~~ 2010-2014 data unless noted otherwise. Serious injuries may include prorated serious injuries with values less than one (NOAA 2012), thus the sum of serious injury and mortality may not be a whole number.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality (and serious injury)	Estimated mortality and serious injury (CV)	Mean Annual Takes (CV)
CA swordfish and thresher shark drift gillnet fishery	~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ ~~2011~~ 2010-2014	observer	~~16.4%~~ ~~13.5%~~ ~~13.3%~~ ~~11.9%~~ ~~19.5%~~ 22%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0[1]	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0.5 (2.2)	~~0 (n/a)~~ 0.1 (2.2)
CA halibut/white seabass and other species large mesh (≥3.5") set gillnet fishery	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	observer	~~0%~~ ~~0%~~ ~~~1%~~ ~~17.8%~~ ~~0%~~ 9%	~~n/a~~ ~~n/a~~ ~~n/a~~ ~~0 (0)~~ ~~n/a~~ 0	~~n/a~~ 0	0 (n/a)
CA spot prawn pot	2010-2014	Strandings / sightings	n/a	0 (0.75)	n/a	≥ 0.15
Unspecified pot or trap fisheries (includes generic 'Dungeness' crab gear not attributed to a specific state fishery)	2010-2014	Strandings / sightings	n/a	1 (12)	n/a	≥ 2.6
CA Dungeness crab pot	2010-2014	Strandings / sightings	n/a	1 (1)	n/a	≥ 0.4
OR Dungeness crab pot	2010-2014	Strandings / sightings	n/a	1 (0)	n/a	≥ 0.2
WA coastal Dungeness crab pot	2010-2014	Strandings / sightings	n/a	0 (1)	n/a	≥ 0.2
WA/OR/CA limited entry sablefish pot	2014	observer	31%	1 (0)	n/a[2]	≥ 0.2
unidentified fisheries	~~2007-2011~~ 2010-2014	Strandings / sightings	n/a	~~1 (7.5)~~ 2 (5.5)	n/a	~~≥ 1.7~~ ≥ 1.5
Total Annual Takes						~~≥ 4.4~~ ≥ 5.3

[1] There were no observations of humpback whales in this fishery during 2010-2014, but the model-based estimate of bycatch for this period results in a positive estimate of bycatch (Carretta *et al.* 2016b).
[2] No estimate of total bycatch has been generated for this fishery.

Gillnet and unidentified fisheries accounted for ~~10~~ 8 interactions with humpback whales between 2010 and 2014 (Carretta *et al.* 2016a). Two interactions involved dead whales, both with evidence of recent entanglements around the tailstock. Three interactions involved at-sea sightings of seriously injured humpback whales with constricting gear (rope and/or netting) that was cutting into the animal. Three interactions involved at-sea sightings of whales trailing gear of unknown type and configuration. The latter 3 cases were prorated as 0.75 serious injuries each according to NMFS serious injury policy guidelines (NOAA 2012). The total annual mortality and serious injury due to unidentified fisheries from 2010 to 2014 is based on 2 deaths + 3 serious injuries + 3 prorated serious injuries (0.75 x 3 = 2.25), or 7.25 whales. The 5-year annual mean serious injury and mortality due to unidentified fisheries during this period is 7.25 / 5 = 1.5 whales. ~~2007 and 2011 (1 death, 7 serious injuries, and 2 prorated serious injuries). Only one record had a positive identification of the fishery: a self report of a humpback released with trailing gear from the CA swordfish drift gillnet fishery in 2009. This was designated as a prorated serious injury (prorate value = 0.75), based on a lack of detail regarding the amount of trailing gear or if the gear was constricting in any way. No humpback whales were reported entangled by fishery observers in the California swordfish drift gillnet fishery during 2007-2011 (Carretta and Enriquez 2009a, 2009b, 2010, 2012a, 2012b). The remaining 9 fishery interactions involved humpback whales entangled in ropes and unidentified nets.~~ Three humpback whale entanglements (all released alive) were observed in the CA swordfish drift gillnet fishery from over 8,600 fishing monitored between 1990 and 2014 (Carretta *et al.* 2016b). Some opportunistic sightings of free-swimming humpback whales entangled in gillnets may also originate from this fishery. The most recent model-based estimate of humpback whale bycatch in this fishery for 2010-2014 is 0.5 whales (CV=2.2). The corresponding ratio estimate of bycatch for the same time period is zero (Carretta *et al.* 2016b). The model-based estimate is considered superior because it utilizes all 25 years of data for estimation, in contrast to the ratio estimate that uses only 2010-2014 data. The model-based estimate does not distinguish between non-serious injuries and mortality and no proration is applied because of small observed sample sizes and the likelihood that whales may swim away with sections of gillnet and not be recorded by the observer program. The average annual estimated bycatch in the CA swordfish drift gillnet fishery is 0.1 whales (0.5 total whales / 5 years).

Total commercial fishery serious injury and mortality of humpback whales for the period 2010-2014 is the sum of pot/trap fishery records (18.75), plus unidentified fishery records (7.5), plus estimates from the CA swordfish drift gillnet fishery (0.5), or 26.75 total whales. The mean annual serious injury and mortality from commercial fisheries during 2010-2014 is 26.75 whales / 5 years = 5.3 whales (Table 1). Most serious injury and mortality records from commercial fisheries reflect opportunistic stranding and at-sea sighting data and thus, represent minimum counts of impacts, for which no correction factor is currently available. ~~A summary of human-caused mortality and serious injury of humpback whales from commercial fisheries during 2007 to 2011 is provided in Table 1. Serious injury designations follow the new NMFS serious injury policy implemented in 2012 (Carretta et al. 2013, NOAA 2012).~~

~~Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki *et al.* 1993), but no recent bycatch data from Mexico are available.~~

Ship Strikes

~~Eight~~ Seven humpback whales (4 deaths, 1 serious injury, and 2 non-serious injuries) were reported struck by vessels between 2010 and 2014 (Carretta *et al.* 2015, Carretta *et al.* 2016a) ~~2007 and 2011 (Carretta et al. 2013). Four deaths, two non-serious injuries, one serious injury, and one prorated serious injury (prorate value = 0.36) resulted from vessel strikes during this period (Carretta et al. 2013).~~ In addition, there ~~were four~~ was one serious ~~injuries~~ injury to an unidentified large whale~~s~~ from a ship strike~~s~~ during this time. The average annual serious injury and mortality of humpback whales attributable to ship strikes during ~~2007-2011 is 1.1~~ 2010-2014 is 1.0 whale~~s~~ per year (4 deaths, plus one serious injury = 5 deaths/injuries / 5 years = 1 whale). ~~plus one prorated serious injury = 5.36 deaths or injuries / 5 yr period~~).

Other human-caused mortality and serious injury

A humpback whale was entangled in a research wave rider buoy in 2014. The whale is estimated to have been entangled for 3 weeks and had substantial necrotic tissue around the caudal peduncle. Although the whale was fully disentangled by a whale entanglement team, this animal was categorized as a serious injury[3] because of the necrotic condition of the caudal peduncle and the possibility that the whale would lose its flukes due to the severity of the entanglement (NOAA 2012, Carretta *et al.* 2016a).

[3] This whale was initially listed as a non-serious injury in Carretta *et al.* (2016a) due to insufficient detail in the preliminary reporting. It is considered a serious injury for purposes of this stock assessment report.

~~The average number of observed humpback deaths from unknown anthropogenic sources is zero during 2007-2011~~.

STATUS OF STOCK

Approximately 15,000 humpback whales were taken from the North Pacific from 1919 to 1987 (Tonnessen and Johnsen 1982~~; C. Allison, IWC unpubl. Data~~), and, of these, approximately 8,000 were taken from the west coast of Baja California, California, Oregon and Washington (Rice 1978), presumably from this stock. Shore-based whaling apparently depleted the humpback whale stock off California twice: once prior to 1925 (Clapham *et al*. 1997) and again between 1956 and 1965 (Rice 1974). There has been a prohibition on taking humpback whales since 1966. As a result of commercial whaling, humpback whales were listed as "endangered" under the Endangered Species Conservation Act of 1969. This protection was transferred to the Endangered Species Act (ESA) in 1973. The humpback whale ESA listing final rule (81 FR 62259, September 8, 2016) established 14 distinct population segments (DPSs) with different listing statuses. The DPSs that occur in waters under the jurisdiction of the United States do not necessarily equate to the existing MMPA stocks. Some of the listed DPSs partially coincide with the currently defined CA/OR/WA stock. Until such time as the MMPA stock delineations are reviewed in light of the DPS designations, NMFS considers this stock to be endangered and depleted for MMPA management purposes (e.g., selection of a recovery factor, stock status).~~The species is still listed as "endangered", and consequently~~ Consequently, the California/Oregon/Washington stock is automatically considered as a ~~"depleted" and~~ "strategic" stock under the MMPA. The estimated annual mortality and serious injury due to commercial fishery entanglements (~~4.4/yr~~ 5.3/yr), and non-fishery entanglements (0.2/yr), ~~other anthropogenic sources (zero)~~, plus ship strikes (~~1.1/yr~~ 1.0/yr), equals 6.5 animals, and ~~in California~~ is less than the PBR allocation of 11 for U.S. waters. Most data on human-caused serious injury and mortality for this population is based on opportunistic stranding and at-sea sighting data and represents a minimum count of total impacts. There is currently no estimate of the fraction of anthropogenic injuries and deaths to humpback whales that are undocumented on the U.S. west coast. Based on strandings and at sea observations, annual humpback whale mortality and serious injury in commercial fisheries (5.3/yr) is greater than 10% of the PBR; therefore, total fishery mortality and serious injury is not approaching zero mortality and serious injury rate. The California/Oregon/Washington stock ~~underwent~~ showed a long-term increase in abundance from 1990 through approximately 2008 (Figure 2), but more recent estimates have shown variable trends.

Habitat Concerns

Increasing levels of anthropogenic sound in the world's oceans (Andrew *et al*. 2002), such as those produced by shipping traffic, or LFA (Low Frequency Active) sonar, have been ~~suggested to~~ identified as ~~be~~ a habitat concern for whales, as it can reduce acoustic space used for communication (masking) (Clark *et al*. 2009, NOAA 2016). This can be particularly problematic for baleen whales that may communicate using low-frequency sound (Erbe 2016). Based on vocalizations (Richardson *et al*. 1995; Au *et al*. 2006), reactions to sound sources (Lien *et al*. 1990, 1992; Maybaum 1993), and anatomical studies (Hauser *et al*. 2001), humpback whales also appear to be sensitive to mid-frequency sounds, including those used in active sonar military exercises (U.S. Navy 2007). ~~Behavioral changes associated with exposure to simulated mid-frequency sonar, including no change in behavior, cessation of feeding, increased swimming speeds, and movement away from simulated sound sources has been documented in tagged blue whales (Goldbogen *et al*. 2013), but it is unknown if humpback whales respond in the same manner to such sounds.~~

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FIN WHALE (*Balaenoptera physalus physalus*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern Hemisphere fin whales (*B. physalus physalus*) likely comprise distinct Pacific and Atlantic subspecies (Archer *et al*. 2013). ~~The International Whaling Commission (IWC) recognized two stocks of fin whales in the North Pacific: the East China Sea and the rest of the North Pacific (Donovan 1991).~~ Mizroch *et al*. (2009) described eastern and western North Pacific populations, based on a review of sightings data, catch statistics, recaptures of marked whales, blood chemistry data, and acoustics. The two populations are thought to have separate wintering and mating grounds off ~~the coasts~~ of Asia and North America and during summer, whales from each population may co-occur near the Aleutian Islands and Bering Sea (Mizroch *et al*. 2009). Non-migratory populations exist in the Gulf of California (Tershy et al. 1993; Bérubé et al. 2002) and the East China Sea (Fujino 1960). Evidence of additional subpopulations near Sanriku-Hokkaido and the Sea of Japan exists, based on seasonal catch data and recaptures of marked animals (Mizroch *et al*. 2009). Fin whales occur throughout the North Pacific, from the southern Chukchi Sea to the Tropic of Cancer (Mizroch *et al*. 2009), but their wintering areas are poorly known. Fin whales are scarce in the eastern tropical Pacific in summer (Wade and Gerrodette 1993) and winter (Lee 1993). Fin whales occur year-round in the Gulf of Alaska (Stafford et al. 2007); the Gulf of California (Tershy et al. 1993; Bérubé et al. 2002); California (Dohl et al. 1983); and Oregon and Washington (Moore et al. 1998). Fin whales satellite-tagged in the Southern California Bight (SCB) appear to use the region year-round, although they seasonally range to central California and Baja California before returning to the SCB (Falcone and Schorr 2013). The longest satellite track reported by Falcone and Schorr (2013) was a fin whale tagged in the SCB in January 2014, with the whale moving south to central Baja California by February and north to the Monterey area by late June. Archer *et al*. (2013) present evidence for geographic separation of fin whale mtDNA clades near Point Conception, California: a significantly higher proportion of 'clade A' is composed of samples from the SCB and Baja California, while 'clade C' is largely represented by samples from central California, Oregon, Washington, and the Gulf of Alaska.

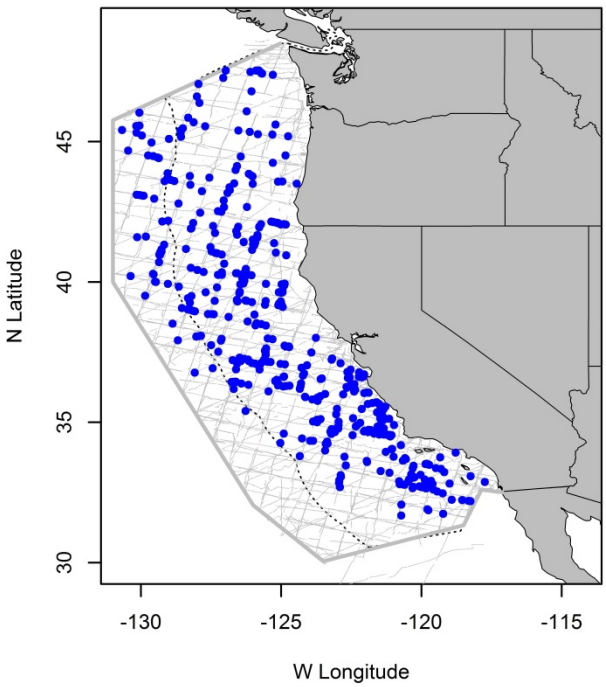

Figure 1. Fin whale sighting locations based on shipboard surveys off California, Oregon, and Washington, 1991-~~2008~~ 2014~~(see Appendix 2 for data sources and information on timing and location of surveys)~~. Dashed line represents the U.S. EEZ; thin lines indicate completed transect effort of all surveys combined.

~~There is still i~~ Insufficient information exists to determine population structure, but from a conservation perspective it may be risky to assume panmixia in the entire North Pacific. This assessment ~~will~~ covers the stock of fin whales ~~which is~~ found along the coasts of California, Oregon, and Washington. Because fin whale abundance appears lower in winter/spring in California (Dohl *et al*. 1983; Forney *et al*. 1995) and in Oregon (Green *et al*. 1992), it is likely that the distribution of this stock extends seasonally outside these coastal waters. Fin whales are present year-round in southern California waters, as evidenced

by individually-identified whales being photographed in all four seasons (Falcone and Schorr 2013). The Marine Mammal Protection Act (MMPA) stock assessment reports recognize three stocks of fin whales in the North Pacific: 1) the California/Oregon/Washington stock (this report), 2) the Hawaii stock, and 3) the Northeast Pacific stock.

POPULATION SIZE

The pre-whaling population of fin whales in the North Pacific was estimated to be 42,000-45,000 (Ohsumi and Wada 1974). In 1973, the North Pacific population was estimated to have been reduced to 13,620-18,680 (Ohsumi and Wada 1974), of which 8,520-10,970 were estimated to belong to the eastern Pacific stock. ~~The Gulf of California resident population was estimated at approximately 400 whales (Urbán 1996), but that estimate is now outdated.~~ The best estimate of fin whale abundance in California, Oregon, and Washington waters out to 300 nmi is from a trend-model analysis of line-transect data from 1991 through ~~2008~~ 2014 (~~Moore and Barlow 2011~~ Nadeem *et al*. 2016; Fig. 2), which generated an estimate for ~~2008 of 3,051 (CV=0.18)~~ 2014 of 9,029 (CV=0.12) whales. The new ~~trend~~ estimates are based on similar ~~to~~ methods to those first applied to this population ~~in~~by Moore and Barlow (2011). However, the new abundance estimates are substantially higher than earlier estimates because the new analysis incorporates lower estimates of *g(0)*, the trackline detection probability~~,~~ (Barlow 2015). The trend-model analysis incorporates information from the entire 1991-~~2008~~ 2014 time series for each annual estimate of abundance, and given the strong evidence of an increasing abundance trend over that time (Moore and Barlow 2011, Nadeem *et al*. 2016), the best estimate of abundance is represented by the ~~model-averaged~~ estimate for the most recent year, or ~~2008~~ 2014. This is probably an underestimate because it excludes some fin whales ~~which~~ that could not be identified in the field and ~~which~~ were recorded as "unidentified rorqual" or "unidentified large whale".

Minimum Population Estimate

The minimum population estimate for fin whales is taken as the lower 20th percentile of the posterior distribution of abundance estimated for ~~2008 (Moore and Barlow (2011)~~ 2014, or approximately ~~2,598~~ 8,127 whales.

Current Population Trend

Indications of recovery in CA coastal waters date back to 1979/80 (Barlow 1994), but there is now strong evidence that fin whale abundance increased in the California Current between 1991 and 2008 based on analysis of abundance data from line transect surveys conducted in the California Current between 1991 and ~~2008~~ 2014 ~~(Moore and Barlow 2011~~Nadeem *et al*. 2016) (Figure 2). Abundance in waters out to 300 nmi off the coast of California approximately doubled between 1991 and ~~1996~~1993, from approximately ~~800~~ 1,744 (CV = ~~0.29~~ 0.25) to ~~1400~~ 3,369 (CV=~~0.20~~ 0.21), suggesting probable dispersal of animals into this area. Across the entire study area (waters off California, Oregon, and Washington), the mean annual abundance increase was 7.5%, although abundance appeared stable between 2008 and 2014. In all, there has been a roughly 5-fold increase between 1991 and 2014. Since 2005, the abundance increase has been driven by increases off northern California, Oregon and Washington, while numbers off Central and Southern California have been stable (Nadeem *et al*. 2016). ~~abundance from 1996 to 2008 increased by an estimated 51%. Mean population growth rate decreased from an estimated~~

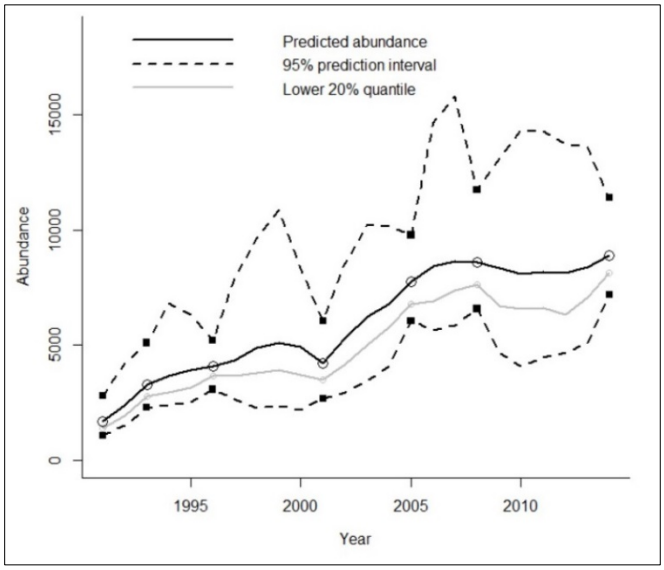

Figure 2. Trend-based estimates of fin whale abundance, 1991-~~2008~~ 2014, with ~~90~~ 95% Bayesian credible intervals (~~Moore and Barlow 2011~~Nadeem *et al*. 2016).

~~7% per year in 1996/1997 to 3.5% per year by 2008.~~ Zerbini *et al*. (2006) found similar evidence of increasing abundance trend for fin whales in Alaskan waters at a rate of 4.8% per year between 2001 and 2003.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

~~There are no estimates of the growth rate of fin whale populations in the North Pacific (Best 1993).~~ Estimated annual rates of increase in the California Current (California, Oregon, and Washington waters) averaged ≈ 7.5% from 1991 to 2014 (Nadeem *et al*. 2016) ~~during the mid-late 1990s, declining to ≈ 3.5% by 2008 (Moore and Barlow 2011~~). However, it is unknown how much of this growth is due to immigration rather than birth and death processes. A ~~near~~ doubling of the abundance estimate in California waters between 1991 and 1993 cannot be explained by birth and death processes alone, and movement of individuals between U.S. west coast waters and other areas (e.g., Alaska, Mexico) have been documented (e.g., Mizroch et al. 1984).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~2,598~~ 8,127) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.3~~ 0.5 (for an endangered species, with N_{min} > ~~1,500~~ 5,000 and CV_{Nmin} < 0.50, Taylor *et al*. 2003), resulting in a PBR of ~~16~~ 81 whales.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~**New Serious Injury Guidelines**~~

~~NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al*. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.~~

Fisheries Information

One fin whale death (in 1999) ~~has been~~ was observed in the California swordfish drift gillnet fishery ~~in over 8,000 sets since 1990 when NMFS began observing the fishery~~ from over 8,600 observed sets between 1990 and 2014 (Carretta *et al*. 2016a.). Although no fin whales have been observed taken in the fishery since 1999, new model-based bycatch estimates include a very small estimate of 0.1 whales (CV=3) for the most recent 5-year period, 2010-2014 (Carretta *et al*. 2016a). The large CV of this bycatch estimate is a consequence of the mean estimate being very small. This estimate is based on inclusion of 25 years of observer data spanning 1990-2014 and reflects a very low long-term observed bycatch rate scaled up to levels of unobserved fishing effort. Mean annual takes (<0.1) for this fishery (Table 1) are based on ~~2007-2011~~ 2010-2014 data ~~(Carretta and Enriquez 2009a, 2009b, 2010, 2012a, 2012b)~~. ~~This results in an average estimate of zero fin whales taken annually~~. Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net. ~~Three~~ One fin whale~~s~~ sighted at-sea ~~were~~ was determined to be seriously injured as the result of interactions with unknown fishing gear (~~buoys and/or line~~ line cutting into the whale) during the period 2010-2014 (Carretta *et al*. 2016b.). ~~2007-2011 (Carretta *et al*. 2013)~~. Including systematic fishery observations in the CA swordfish drift gillnet fishery and opportunistic sightings of fishery-related injuries, the mean annual serious injury and mortality of fin whales for 2010-2014 is ≥0.2 whales (Table 1). Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki et al. 1993), but no recent bycatch data from Mexico are available.

Table 1. Summary of available information on the incidental mortality and injury of fin whales (CA/OR/WA stock) for commercial fisheries that might take this species.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed (or self-reported)	Estimated ~~Annual~~ Mortality (and serious injury)	Mean Annual Takes (CV in parentheses)

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed (or self-reported)	Estimated ~~Annual~~ Mortality (and serious injury)	Mean Annual Takes (CV in parentheses)
CA swordfish and thresher shark drift gillnet fishery	~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ ~~2011~~ 2010-2014	observer	~~16.4%~~ ~~13.5%~~ ~~13.3%~~ ~~11.9%~~ ~~19.5%~~ 22%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0[1]	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0.1 (CV=3)	~~0 (n/a)~~ <0.1 (CV=3)
Unidentified fishery interactions	~~2007-2011~~ 2010-2014	at-sea sightings	n/a	~~3~~ 1	~~0 (3)~~ 0 (1)	≥ ~~0.6~~ 0.2
Minimum total annual takes						≥ ~~0.6 (n/a)~~ 0.2 (CV=3)

Ship Strikes

Ship strikes were implicated in the deaths of ~~seven~~ nine fin whales ~~and the serious injury of another~~ during ~~2007-2011 Carretta et al. 2013~~ 2010-2014 (Carretta *et al*. 2015, Carretta *et al.* 2016b.). ~~One ship strike was recorded in 2008, four in 2009, two in 2010, and one in 2011. During 2007-2011~~ During 2010-2014, there ~~were~~ was an one additional ~~four~~ serious ~~injuries~~ injury ~~of~~ to an unidentified large whale~~s~~ attributed to a ship strike~~s~~. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. The average observed annual mortality and serious injury due to ship strikes is ~~1.6~~ 1.8 fin whales per year during 2010-2014 ~~2007-2011~~. Documented ship strike deaths and serious injuries are derived from actual counts of whale carcasses and should be considered minimum values. Where evaluated, estimates of detection rates of cetacean carcasses are consistently quite low across different regions and species (<1% to ~~17~~ 33%), highlighting that observed numbers ~~are unrepresentative of~~ underestimate true impacts (Carretta *et al*. 2016c, Kraus *et al*. 2005, ~~Perrin *et al*. 2011,~~ Williams *et al*. 2011, Prado *et al*. 2013, Wells *et al.* 2015).

STATUS OF STOCK

~~Approximately 46,000 fin whales were taken from the North Pacific by commercial whalers between 1947 and 1987 (C. Allison, IWC, pers. comm.). Approximately 5,000 fin whales were taken from the west coast of North America from 1919 to 1965 (Rice 1974; Tonnessen and Johnsen 1982; Clapham et al. 1997).~~ Fin whales in the North Pacific were given protected status by the IWC in 1976. Fin whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the California to Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The total ~~quantified~~ documented incidental mortality and serious injury (2.0/yr) due to fisheries (~~0.6~~ 0.2/yr) and ship strikes (~~1.6~~ 1.8/yr) is less than the calculated PBR (~~16~~ 81). Total fishery mortality is less than 10% of PBR and, therefore, may be approaching zero mortality and serious injury rate. There is strong evidence that the population has increased since the early 1990s (Moore and Barlow 2011, Nadeem *et al.* 2016). Increasing levels of anthropogenic sound in the world's oceans has been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound (Croll *et al*. 2002). Behavioral changes associated with exposure to simulated mid-frequency sonar, including no change in behavior, cessation of feeding, increased swimming speeds, and movement away from simulated sound sources has been documented in tagged *blue* whales (Goldbogen *et al*. 2013), but it is unknown if fin whales respond in the same manner to such sounds.

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[1] There were no observations of fin whale entanglements in this fishery during 2010-2014, but the model-based estimate of bycatch for this period results in a positive estimate of bycatch (Carretta *et al*. 2016a).

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SEI WHALE (*Balaenoptera borealis borealis*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) only considers one stock of sei whales in the North Pacific (Donovan 1991), but some evidence exists for multiple populations (Masaki 1977; Mizroch *et al.* 1984; Horwood 1987). Sei whales are distributed far out to sea in temperate regions of the world and do not appear to be associated with coastal features. Whaling effort for this species was distributed continuously across the North Pacific between 45-55ºN (Masaki 1977). Two sei whales that were tagged off California were later killed off Washington and British Columbia (Rice 1974) and the movement of tagged animals has been noted in many other regions of the North Pacific. Sei whales are ~~now~~ rare in the California ~~waters~~ Current (Dohl *et al.* 1983; Barlow 1997; Forney *et al.* 1995; Mangels and Gerrodette 1994, Barlow 2016), but were the fourth most common whale taken by California coastal whalers in the 1950s-1960s (Rice 1974). They are extremely rare south of California (Wade and Gerrodette 1993; Lee 1993). Lacking additional information on sei whale population structure, sei whales in the eastern North Pacific (east of longitude 180º) will be considered as a separate stock.

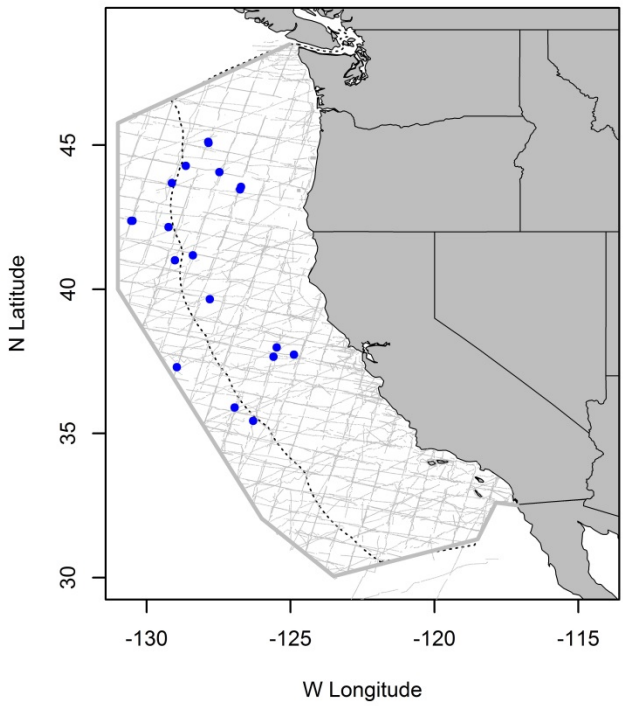

Figure 1. Sei whale sighting locations ~~based on~~ from shipboard surveys off California, Oregon, and Washington, 1991-~~2008~~ 2014 ~~(see Appendix 2 for data sources and information on timing and location of surveys)~~. Dashed line represents the U.S. EEZ; thin lines indicate completed transect effort of all surveys combined.

POPULATION SIZE

Ohsumi and Wada (1974) estimate the pre-whaling abundance of sei whales to be 58,000-62,000 in the North Pacific. Later, Tillman (1977) used a variety of different methods to estimate the abundance of sei whales in the North Pacific and revised this pre-whaling estimate to 42,000. His estimates for the year 1974 ranged from 7,260 to 12,620. All methods depend on using the history of catches and trends in CPUE or sighting rates; there have been no direct estimates of sei whale abundance in the entire (or eastern) North Pacific based on sighting surveys. ~~Only nine confirmed sightings of sei whales were made~~ Sei whale sightings in California, Oregon, and Washington waters during extensive ship and aerial surveys between 1991- ~~2008~~ 2014 have been relatively rare (Figure 1, Hill and Barlow 1992; Carretta and Forney 1993; Mangels and Gerrodette 1994; VonSaunder and Barlow 1999; Barlow 2003; Forney 2007; Barlow 2010, Barlow 2016). Green *et al.* (1992) did not report any sightings of sei whales in aerial surveys of Oregon and Washington. Abundance estimates for the two most recent line transect surveys of California, Oregon, and Washington waters in 2008 and 2014 out to 300 nmi are ~~74 (CV=0.88) and 215 (CV=0.71)~~ 311 (0.76) and 864 (0.40) sei whales, respectively (~~Forney 2007, Barlow 2010~~ Barlow 2016). The best estimate of abundance for California, Oregon, and Washington waters out to 300 nmi is the unweighted

geometric mean of the ~~2005 and~~ 2008 and 2014 estimates, or ~~126 (CV=0.53)~~ 519 (CV=0.40) sei whales (Barlow 2016 ~~and Forney 2007 ; Forney 2007; Barlow 2010~~).

Minimum Population Estimate

The minimum population estimate for sei whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from ~~2005 and~~ 2008 and 2014 shipboard line-transect surveys, or approximately ~~83~~ 374 whales.

Current Population Trend

There are no data on trends in sei whale abundance in the eastern North Pacific waters. Although the population in the North Pacific is expected to have grown since being given protected status in 1976, the possible effects of continued unauthorized take (Yablokov 1994) and incidental ship strikes and gillnet mortality make this uncertain. Barlow (2016) noted that an increase in sei whale abundance observed in 2014 in the California Current is partly due to recovery of the population from commercial whaling, but may also involve distributional shifts in the population.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of sei whale populations in the North Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~83~~ 374) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of ~~0.17~~ 0.75 whales.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The ~~offshore~~ California swordfish drift gillnet fishery is the only fishery that is likely to take sei whales from this stock, but no fishery mortality or serious injuries have been observed from over 8,600 monitored fishing sets from 1990-2014 (Carretta *et al.* 2016, ~~(~~Table 1). ~~Detailed information on this fishery is provided in Appendix 1. After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6 fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003).~~ Mean annual takes for this fishery (Table 1) are based on ~~2004-2008~~ 2010-2014 data (~~Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b.~~ Carretta *et al.* 2016). This results in an average estimate of zero sei whales taken annually. However, some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net.

Table 1. Summary of available information on the incidental mortality and injury of sei whales (eastern North Pacific stock) for commercial fisheries that might take this species. n/a indicates that data are not available. Mean annual takes are based on ~~2004-2008~~ 2010-2014 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed mortality (and injury in parentheses)	Estimated mortality (CV in parentheses)	Mean annual takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	observer	~~20.6%~~ ~~20.9%~~ ~~18.5%~~ ~~16.4%~~ ~~13.5%~~ 22%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	0 (n/a)
Total annual takes						0 (n/a)

Ship Strikes

There have been no documented ship strikes of sei whales in the most recent 5-year period, 2010-2014 (Carretta *et al.* 2016b), although ~~One~~ one ship strike death was reported in Washington in 2003 (NMFS Northwest Regional Office, unpublished data). During ~~2004-2008~~ 2010-2014, there were an

additional eight injuries of unidentified large whales attributed to ship strikes. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. The average observed annual mortality due to ship strikes is zero sei whales per year for the period ~~2004-2008~~ 2010-2014.

STATUS OF STOCK

The NMFS recovery plan for the sei whale (NMFS 2011) notes that basic information such as distribution, abundance, trends and stock structure is of poor quality or largely unknown, owing to the rarity of sightings of this species. Sei whales were estimated to have been reduced to 20% (8,600 out of 42,000) of their pre-whaling abundance in the North Pacific (Tillman 1977). The initial abundance has never been reported separately for the eastern North Pacific stock, but this stock was also probably depleted by whaling. ~~The reported take of North Pacific sei whales by commercial whalers totaled 61,500 between 1947 and 1987 (C. Allison, IWC, pers. comm.). Of these, at least 410 were taken by shore-based whaling stations in central California between 1919 and 1965 (Rice 1974; Clapham et al. 1997). There has been an IWC prohibition on taking sei whales since 1976, and commercial whaling in the U.S. has been prohibited since 1972.~~ Sei whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the eastern North Pacific stock is automatically considered as a "depleted" and "strategic" stock under the Marine Mammal Protection Act (MMPA). Total known estimated fishery mortality is zero and therefore is approaching zero mortality and serious injury rate. Although the current known rate of ship strike deaths and serious injuries is zero, it is likely that some sei whale ship strikes are unreported. Increasing levels of anthropogenic sound in the world's oceans has been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound (Croll *et al.* 2002). Behavioral changes associated with exposure to simulated mid-frequency sonar, including no change in behavior, cessation of feeding, increased swimming speeds, and movement away from simulated sound sources has been documented in tagged blue whales (Goldbogen *et al.* 2013), but it is unknown if sei whales respond in the same manner to such sounds.

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Revised ~~01/15/2011~~ 8/16/2016

MINKE WHALE (*Balaenoptera acutorostrata scammoni*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) recognizes 3 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 180ºN, and one in the "remainder" of the Pacific (Donovan 1991). The "remainder" stock only reflects the lack of exploitation in the eastern Pacific and does not imply that only one population exists in that area (Donovan 1991). In the "remainder" area, minke whales are relatively common in the Bering and Chukchi seas and in the Gulf of Alaska, but are not considered abundant in any other part of the eastern Pacific (Leatherwood et al. 1982; Brueggeman et al. 1990). In the Pacific, minke whales are usually seen over continental shelves (Brueggeman et al. 1990). In the extreme north, minke whales are believed to be migratory, but in inland waters of Washington and in central California they appear to establish home ranges (Dorsey et al. 1990). Minke whales occur year-round in California (Dohl et al. 1983; Forney et al. 1995; Barlow 1997) and in the Gulf of California (Tershy et al. 1990). Minke whales are present at least in summer/fall along the Baja California peninsula (Wade and Gerrodette 1993). Because the "resident" minke whales from California to Washington appear behaviorally distinct from migratory whales further north, minke whales in coastal waters of California, Oregon, and Washington (including Puget Sound) are considered as a separate stock. Minke whales in Alaskan waters are considered in a separate stock assessment report.

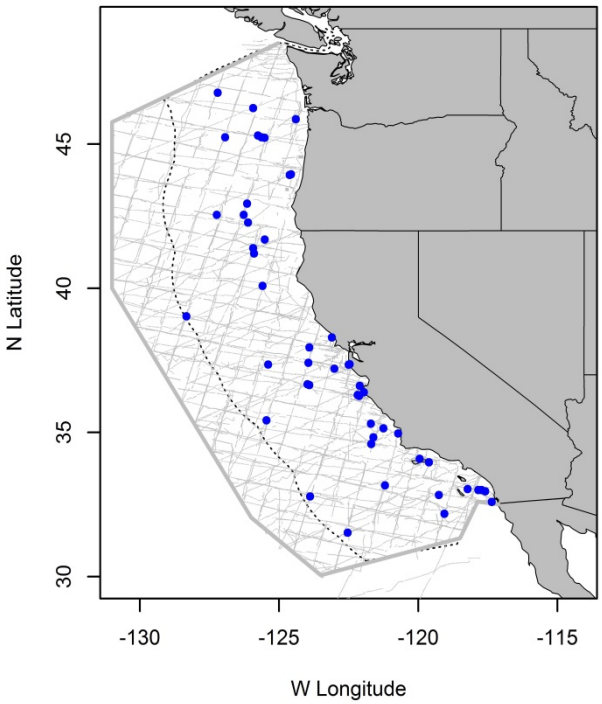

Figure 1. Minke whale sighting locations based on shipboard surveys off California, Oregon, and Washington, 1991-~~2008~~2014 ~~(see Appendix 2 for data sources and information on timing and location of surveys)~~. Dashed line represents the U.S. EEZ; thin lines indicate completed transect effort of all surveys combined.

POPULATION SIZE

No estimates have been made for the number of minke whales in the entire North Pacific. ~~Forney (2007) estimated 957 (CV=1.36) during a 2005 ship survey off California, Oregon, and Washington, while the most recent survey in 2008 did not record any minke whales while on survey effort (Barlow 2010). The number of minke whales off California, Oregon, and Washington is estimated to be the arithmetic mean of two recent ship line transect surveys conducted in summer and autumn 2005 and 2008 (Barlow and Forney 2007 ; Forney 2007; Barlow 2010); or 478 (CV=1.36) whales.~~ The most recent abundance estimate for this stock is based on the geometric mean of estimates obtained from ship line transect surveys in summer and autumn in 2008 and 2014, or 636 (CV=0.72) whales (Barlow 2016). ~~Two minke whales were seen during 1996 aerial surveys in Washington and British Columbia inland waters (Calambokidis et al. 1997), but no abundance estimates are available for this area.~~

Minimum Population Estimate

The minimum population estimate for minke whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from ~~2005 and 2008~~ 2008 and 2014 summer/fall ship surveys in California, Oregon, and Washington waters (~~Barlow and Forney 2007; Forney 2007; Barlow 2010~~ Barlow 2016) or approximately ~~202~~ 369 whales.

Current Population Trend

There are no data on trends in minke whale abundance in waters of California, Oregon and/or Washington.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of minke whale populations in the North Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (~~202~~ 369) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.5~~ 0.48 (for a stock of unknown status with a mortality estimate CV > 0.30 and < 0.60), resulting in a PBR of ~~2.0~~ 3.5 whales.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information on historic whaling has been moved to the Status of Stock section.

Table 1. Summary of available information on the incidental mortality and injury of minke whales (CA/OR/WA stock) for commercial fisheries that might take this species (Carretta *et al.* 2016a). ~~Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b~~). Mean annual takes are based on ~~2004-2008~~ 2010-2014 data ~~unless noted otherwise~~.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed mortality (and serious injury ~~in parentheses~~)	Estimated mortality (CV ~~in parentheses~~)	Mean annual takes (CV ~~in parentheses~~)
CA/OR thresher shark/swordfish drift gillnet fishery	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	observer	~~20.6%~~ ~~20.9%~~ ~~18.5%~~ ~~16.4%~~ ~~13.5%~~ 22%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 1[1]	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 4.5 (0.58)	~~0 (n/a)~~ 0.9 (0.58)
CA halibut and other species large mesh (>3.5") set gillnet fishery	~~2004~~ ~~2005~~ ~~2006~~ ~~2007~~ ~~2008~~ 2010-2014	observer	~~0%~~ ~~0%~~ ~~<1%~~ ~~17.8%~~ ~~0%~~ 9%	0	0	n/a
Unidentified fisheries	2010-2014	Sightings and strandings	n/a	1 (0.75)	1.75 (n/a)	≥ 0.35 (n/a)
Total annual takes						~~0~~ ≥1.3 (0.58)

Fishery Information

Minke whales may occasionally be caught in coastal set gillnets off California, in salmon drift gillnet in Puget Sound, Washington, and in offshore drift gillnets off California ~~and Oregon~~. Four minke whales were observed entangled (2 dead, 2 released alive) between 1990-2014 in the California swordfish drift gillnet fishery from over 8,600 monitored fishing sets (Carretta *et al.* 2016a). One animal 'released alive' in 1999 occurred in a set with a large hole in the net from which a skin sample was collected and positively-identified as a minke whale with genetic sequencing. It is unknown whether or not gear remained on the whale. Estimates of minke whale bycatch for the fishery are not prorated for released alive vs mortality cases and the estimate for the drift gillnet fishery in Table 1 (4.5 whales / 5 years = 0.9

[1] One minke whale was observed entangled in this fishery during the 2010-2014 period. The entanglement occurred in 2011 (Carretta *et al.* 2016a).

annually) currently reflects total bycatch, regardless of animal condition (Carretta *et al.* 2016a). Two additional minke whale fishery interactions were recorded during 2010-2014: an entangled whale sighted at sea with rope and net material (=0.75 serious injury) and a live stranding of an animal that later died and appeared to have been previously entangled in unknown cable material (Carretta *et al.* 2016b). The mean annual mortality and serious injury of minke whales from this stock during 2010-2014 is 1.3 animals (Table 1). ~~A summary of known fishery mortality and injury for this stock of minke whales is given in Table 1 for the period 2004-2008. Detailed information on these fisheries is provided in Appendix 1. After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the California drift gillnet fishery dropped considerably (Barlow and Cameron 2003). Mean annual takes for this fishery (Table 1) are based on 2004-2008 data (Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b). This results in an average estimate of zero minke whales taken annually. In 1999, a whale skin sample was retrieved from a large hole that had been punched through a drift gillnet (trip DN-SD-0941). The sample was later identified as coming from a minke whale using genetic sequencing methods.~~

~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~

Ship Strikes

~~Ship strikes were implicated in the death of one minke whale in 1977 (J. Heyning and J. Cordaro, pers. comm.). The reported minke whale mortality due to ship strikes is zero for the period 2004-2008.~~ No ship strikes of minke whales were reported during the most recent 5-year period of 2010-2014. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma.

STATUS OF STOCK

~~The estimated take of western North Pacific minke whales by commercial whalers was approximately 31,000 from 1930 to 1987 (C. Allison, IWC, pers. comm.). Minke whales were not harvested commercially in the eastern North Pacific (Rice 1974; Clapham et al. 1997). Reported aboriginal takes of minke whales in Alaska totaled 7 between 1930 and 1987 (C. Allison, IWC, pers. comm.).~~ Minke whales are not listed as "endangered" under the Endangered Species Act and are not considered "depleted" under the MMPA. The greatest uncertainty in their status is whether entanglement in commercial gillnets and ship strikes could have reduced this relatively small population. Because of this, the status of the west-coast stock is considered "unknown". The annual mortality and serious injury due to fisheries (~~0.0/yr~~ 1.3/yr) and ship strikes (0.0/yr) is less than the calculated PBR for this stock (~~2.0~~ 3.5), so they are not considered a "strategic" stock under the MMPA. Fishery mortality is not less than 10% of the PBR; therefore, total fishery mortality is not approaching zero mortality and serious injury rate. There is no information on trends in the abundance of this stock. Harmful algal blooms are a habitat concern for minke whales and at least one death along the U.S. west coast has been attributed to domoic acid toxicity resulting from the consumption of northern anchovy prey items (Fire *et al.* 2010). Increasing levels of anthropogenic sound in the world's oceans has been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound (Croll *et al.* 2002). Behavioral changes associated with exposure to simulated mid-frequency sonar, including no change in behavior, cessation of feeding, increased swimming speeds, and movement away from simulated sound sources has been documented in tagged blue whales (Goldbogen *et al.* 2013), but it is unknown if minke whales respond in the same manner to such sounds..

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FALSE KILLER WHALE (*Pseudorca crassidens*): Hawaiian Islands Stock Complex – Main Hawaiian Islands Insular, Northwestern Hawaiian Islands, and Hawaii Pelagic Stocks

STOCK DEFINITION AND GEOGRAPHIC RANGE

False killer whales are found worldwide in tropical and warm-temperate waters (Stacey *et al.* 1994). In the North Pacific, this species is well known from southern Japan, Hawaii, and the eastern tropical Pacific. False killer whales were encountered during two shipboard line-transect surveys of the U.S. Exclusive Economic Zone (EEZ) around the Hawaiian Islands in 2002 and 2010 (Figure 1; Barlow 2006, Bradford *et al.* 2014) and focused studies near the main and Northwestern Hawaiian Islands indicate that false killer whales occur in near shore waters throughout the Hawaiian archipelago (Baird et al 2008, 2013). This species also occurs in U.S. EEZ waters around Palmyra and Johnston Atolls (e.g., Barlow *et al.* 2008, Bradford & Forney 2013) and American Samoa (Johnston *et al.* 2008, Oleson 2009).

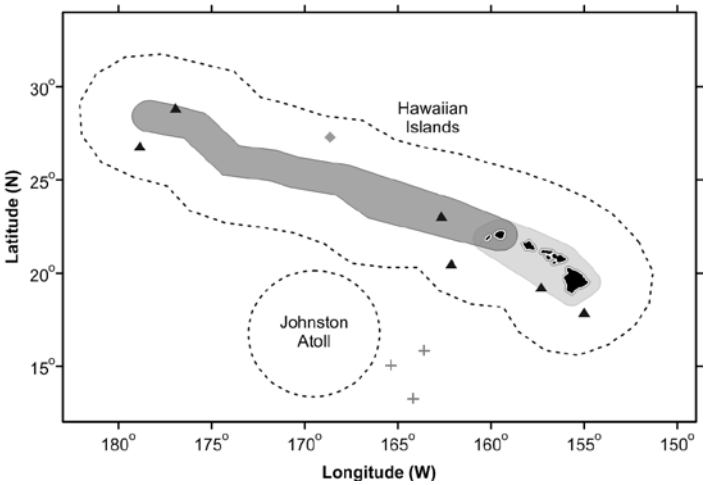

Figure 1. False killer whale on-effort sighting locations during standardized shipboard surveys of the Hawaiian Islands U.S. EEZ (2002, gray diamond, Barlow 2006; 2010, black triangles, Bradford *et al.* 2014, pelagic waters of the central Pacific south of the Hawaiian Islands (2005, gray crosses, Barlow and Rankin 2007) and the Johnston Atoll EEZ. Outer dashed lines represent approximate boundary of U.S. EEZs; light shaded gray area is the main Hawaiian Islands insular false killer whale stock area, including overlap zone between MHI insular and pelagic false killer whale stocks; dark shaded gray area is the Northwestern Hawaiian Islands stock area, which overlaps the pelagic false killer whale stock area and part of the MHI insular false killer whale stock area. Detail of stock boundaries shown in Figure 2.

Genetic, photo-identification, and telemetry studies indicate there are three demographically-independent populations of false killer whales in Hawaiian waters. Genetic analyses indicate restricted gene flow between false killer whales sampled near the main Hawaiian Islands (MHI), the Northwestern Hawaiian Islands (NWHI), and in pelagic waters of the Eastern (ENP) and Central North Pacific (CNP) (Chivers *et al.* 2010; Martien *et al.* 2011, 2014). Martien *et al.* (2014) analyzed mitochondrial DNA (mtDNA) control region sequences and genotypes from 16 nuclear DNA (nuDNA) microsatellite loci from 206 individuals from the MHI, NWHI, and offshore waters of the CNP and ENP and showed highly significant differentiation between populations confirming limited gene flow in both sexes. Their analysis using mtDNA reveals strong phylogeographic patterns consistent with local evolution of haplotypes unique to false killer whales occurring nearshore within the Hawaiian Archipelago and their assessment of nuDNA suggests that NWHI false killer whales are at least as differentiated from MHI animals as they are from offshore animals. Photographic–identification and social network analyses of individuals seen near the MHI indicate a tight social network with no connections to false killer whales seen near the NWHI or in offshore waters, and assessment of satellite telemetry collected from 27 tagged MHI false killer whales shows movements restricted to the MHI (Baird *et al.* 2010, 2012). Further evaluation of photographic and genetic data from individuals seen near the MHI suggests the occurrence of three separate social clusters (Baird *et al.* 2012, Martien *et al.* 2011), where mating occurs primarily, though not exclusively within clusters (Martien *et al.* 2011). Additional details on data and analyses supporting the separation of false killer whales in Hawaiian waters into three separate stocks are summarized within Oleson *et al.* (2010, 2012).

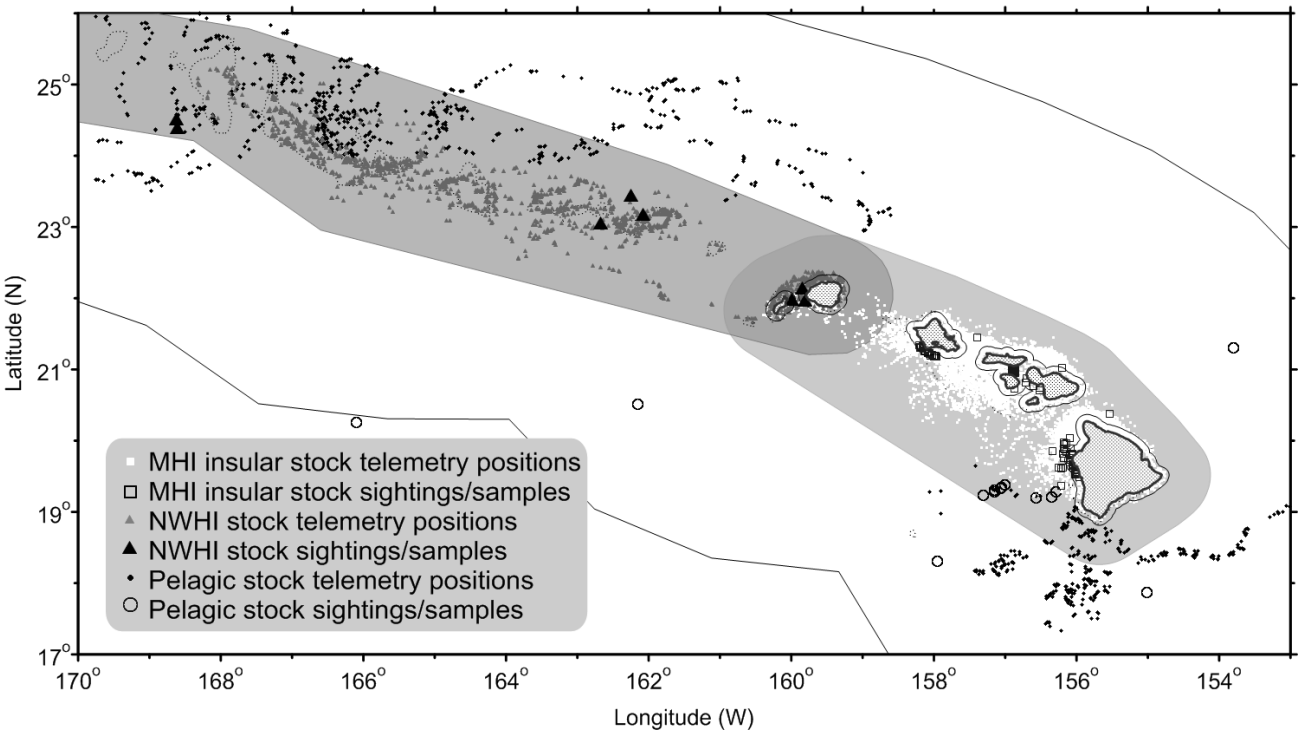

Figure 2. Sighting, biopsy sample, and telemetry record locations of false killer whale identified as being part of the MHI insular (square symbols), NWHI (triangle symbols), or pelagic (circle symbols) stocks. The MHI stock area is shown in light gray; the NWHI stock area is shown in dark gray; the pelagic stock area includes the entire EEZ excluding the region delineated by the black line around each of the MHI (reproduced from Bradford et al 2015). The MHI insular, pelagic, and NWHI stocks overlap around Kauai and Niihau.

Fishery observers have collected tissue samples for genetic analysis from cetaceans incidentally caught in the Hawaii-based longline fishery since 2003. Between 2003 and 2010, eight false killer whale samples, four collected outside the Hawaiian EEZ and four collected within the EEZ but more than 100 nautical miles (185km) from the main Hawaiian Islands were determined to have Pacific pelagic haplotypes (Chivers *et al.* 2010). At the broadest scale, significant differences in both mtDNA and nuDNA are evident between pelagic false killer whales in the ENP and CNP strata (Chivers *et al.* 2010), although the sample distribution to the east and west of Hawaii is insufficient to determine whether the sampled strata represent one or more stocks, and where pelagic stock boundaries would be drawn.

The stock range and boundaries of the three Hawaiian stocks of false killer whales were recently reevaluated, given significant new information on the occurrence and movements of each stock and are reviewed in detail in Bradford *et al.* (2015) and shown in Figure 2. The stocks have partially overlapping ranges. MHI insular false killer whales have been satellite tracked as far as 115 km from the main Hawaiian Islands, while pelagic stock animals have been tracked to within 11 km of the main Hawaiian Islands and throughout the NWHI. NWHI false killer whales have been seen as far as 93 km from the NWHI and near-shore around Kauai and Oahu (Baird *et al.* 2012, Bradford *et al.* 2015). Stock boundary descriptions are complex, but can be summarized as follows. The MHI insular stock boundary is derived from a Minimum Convex Polygon (MCP) of a 72-km radius extending around the main Hawaiian Islands, with the offshore extent of the radii connected on the leeward sides of Hawaii Island and Niihau to encompass the offshore movements of MHI individuals within that region. The NWHI stock boundary is defined by a 93-km radius around the NWHI, or the boundary of the Papahānaumokuākea Marine National Monument, with this radial boundary extended to the southeast to encompass Kauai and Niihau. The NWHI boundary is latitudinally expanded at the eastern end of the NWHI to encompass animal movements observed outside of the 93-km radius (see Figure 2). The pelagic stock has no outer boundary. Throughout the MHI the pelagic stock inner boundary is placed at 11 km from shore. There is no inner boundary within the NWHI. The construction of these stock boundaries results in a number of stock overlap zones. The waters outside of 11km from shore from Oahu to Hawaii Island out to the MHI insular stock boundary are an overlap zone between the MHI insular and pelagic stocks. The entirety of the NWHI stock range, with the exception of the area within 11km around

Kauai and Niihau is an overlap zone between NWHI and pelagic false killer whales. All three stocks overlap between 11 km from shore around Kauai and Niihau out to the MHI insular stock boundary between Kauai and Nihoa and to the NWHI stock boundary between Kauai and Oahu (see Figure 2).

The pelagic stock includes animals found within the Hawaiian Islands EEZ and in adjacent international waters; however, because data on false killer whale abundance, distribution, and human-caused impacts are largely lacking for international waters, the status of this stock is evaluated based on data from U.S. EEZ waters of the Hawaiian Islands (NMFS 2005). The Palmyra Atoll stock of false killer whales is still considered to be a separate stock because comparisons amongst false killer whales sampled at Palmyra Atoll and those sampled from the MHI insular stock and the pelagic ENP reveal restricted gene flow, although the sample size remains too low for robust comparisons (Chivers *et al.* 2010). NMFS will obtain and analyze additional samples for genetic studies of Hawaii pelagic and Palmyra stock structure, and will evaluate new information on stock ranges as it becomes available.

For the Marine Mammal Protection Act (MMPA) stock assessment reports, there are currently five Pacific Islands Region management stocks : 1) the Main Hawaiian Islands insular stock, which includes animals inhabiting waters within a modified 72km radius around the main Hawaiian Islands, 2) the Northwestern Hawaiian Islands stock, which includes animals inhabiting waters within the 93-km radius of the Papahānaumokuākea Marine National Monument and around Kauai, with a slight latitudinal expansion of this area at the eastern end of the range~~and to the east around Kauai~~, 3) the Hawaii pelagic stock, which includes false killer whales inhabiting waters greater than 11 km from the main Hawaiian Islands, including adjacent high seas waters, 4) the Palmyra Atoll stock, which includes animals found within the U.S. EEZ of Palmyra Atoll, and 5) the American Samoa stock, which includes animals found within the U.S. EEZ of American Samoa. Estimates of abundance, potential biological removal, and status determinations for the first three stocks are presented below; the Palmyra Atoll and American Samoa stocks are covered in separate reports.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~New Serious Injury Guidelines~~

~~NMFS uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to distinguish serious from non-serious injury (Angliss and DeMaster 1998, Andersen et al. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*".~~

Fishery Information

Interactions with false killer whales, including depredation of catch of a variety of pelagic fishes, have been identified in logbooks and NMFS observer records from Hawaii pelagic longline fishing trips (Nitta and Henderson 1993, Oleson *et al.* 2010, PIRO 2015). False killer whales have been observed feeding on mahi mahi, *Coryphaena hippurus*, and yellowfin tuna, *Thunnus albacares* (Baird 2009), and they have been reported to take large fish from the trolling lines of commercial and recreational fishermen (Shallenberger 1981). There are anecdotal reports of marine mammal interactions in the commercial Hawaii shortline fishery which sets gear at Cross Seamount and possibly around the main Hawaiian Islands. The commercial shortline fishery is licensed to sell their catch through the State of Hawaii Commercial Marine License program, and until recently, no reporting systems existed to document marine mammal interactions. Baird and Gorgone (2005) documented high rates of dorsal fin disfigurements consistent with injuries from unidentified fishing line for false killer whales belonging to the MHI insular stock. A recent report included evaluation of additional individuals with dorsal fin injuries and suggested that the rate of interaction between false killer whales and various forms of hook and line gear may vary by population and social cluster, with the MHI insular stock showing the highest rate of dorsal fin disfigurements (Baird *et al.* 2014). The commercial or recreational fishery or fisheries responsible for these injuries is unknown. Examination of a stranded MHI insular false killer whale in October 2013 revealed that this individual had five fishing hooks and fishing line in its stomach (NMFS PIR Marine Mammal Response Network). Although the fishing gear is not believed to have caused the death of the whale, the finding confirms that MHI insular false killer whales are consuming previously hooked fish or are interacting with hook and line fisheries in the MHI. Many of the hooks within the whale's stomach were not consistent with those currently allowed for use within the commercial longline fisheries and could have come from a variety of near-shore fisheries. No estimates of human-caused mortality or serious injury are currently available for near-shore hook and line or other fisheries because these fisheries are not observed or monitored for protected species bycatch.

Because of high rates of false killer whale mortality and serious injury in Hawaii-based longline fisheries, a Take Reduction Team was established in January 2010 (75 FR 2853, 19 January, 2010). The Team was charged with developing recommendations to reduce incidental mortality and serious injury of the Hawaii pelagic, MHI insular and Palmyra stocks of false killer whales in Hawaii-based longline fisheries. The Team submitted a draft Take Reduction Plan (TRP) to NMFS (http://www.nmfs.noaa.gov/pr/pdfs/interactions/fkwtrp_draft.pdf), and NMFS

published a final TRP based on the Team's recommendations (77 FR 71260, 29 November, 2012). Take reduction measures include gear requirements, time-area closures, and measures to improve captain and crew response to hooked and entangled false killer whales. The seasonal contraction of the Longline Exclusion Zone (LLEZ) around the MHI was also eliminated. The TRP became effective December 31, 2012, with gear requirements effective February 27, 2013. These measures were not in effect during 2008-2012, the majority of the period for which bycatch was estimated in this report. Adjustments to bycatch estimation methods are implemented for 2013 to account for changes in fishing gear and captain training intended to reduce the false killer whale serious injury rate (see below, McCracken 2015).

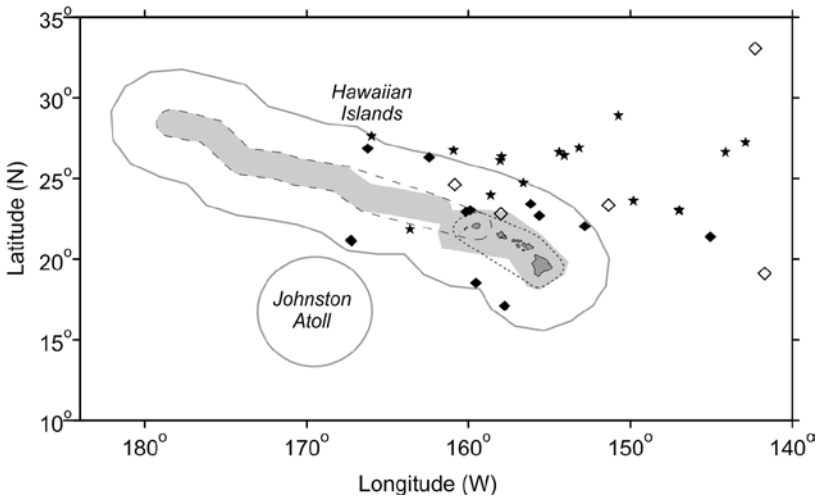

Figure 3. Locations of observed false killer whale takes (black symbols) and possible takes (blackfish) of this species (open symbols) in the Hawaii-based longline fisheries, 2009-2013. Takes occurring prior to the implementation of Take-Reduction Plan (~~2009~~2010-2012) regulations are shown as diamonds, and those since the TRP regulations (2013-2014) are shown as stars. Some take locations overlap. Solid gray lines represent the U.S. EEZ; the dotted line is the MHI insular stock area; the dashed line is the NWHI stock area; both MHI and NWHI stocks overlap with the pelagic stock. The gray shaded area represents the longline exclusion zone, implemented year-round since December 31, 2012, and Papahānaumokuākea Marine National Monument. Both areas are currently closed to longline fishing.

There are two distinct longline fisheries based in Hawaii: a deep-set longline (DSLL) fishery that targets primarily tunas, and a shallow-set longline fishery (SSLL) that targets swordfish. Both fisheries operate within U.S. waters and on the high seas, but are prohibited from operating within the Papahānaumokuākea Marine National Monument and within the LLEZ around the main Hawaiian Islands. Stock Assessment Reports generally describe fishery interaction details for the most recent five years, and as such, only years 2010 ~~2009~~ through 2014 ~~2013~~ are described here. Years 2008 and 2009 are ~~is~~ also included in Table 1 to allow for computation of a 5-yr annual bycatch estimate for the period prior to the implementation of the TRP. Between 2010 ~~2009~~ and 2014 ~~2013~~, three false killer whales were observed hooked or entangled in the SSLL fishery (100% observer coverage) within the U.S. EEZ of the Hawaiian Islands, and 25 ~~24~~ false killer whales were observed taken in the DSLL fishery (20-22% observer coverage) within Hawaiian waters or adjacent high-seas waters (excluding Palmyra Atoll EEZ waters) (Bradford & Forney 2016 ~~2015~~). The severity of injuries resulting from interactions with longline gear is determined based on an evaluation of the observer's description of each interaction and following the most recently developed criteria for assessing serious injury in marine mammals (NMFS 2012). Of the three animals taken in the SSLL fishery, ~~one was considered seriously injured,~~ two were ~~one was~~ considered not seriously injured and one could not be determined based on the information provided by the observer. In the DSLL fishery, 12 ~~13~~ false killer whales were taken within the Hawaiian EEZ. Two of those takes occurred in 2012 within the pelagic-NWHI overlap zone north of Kauai ~~in 2012~~ before this area was closed to longline fishing. ~~and b~~Both animals were considered to be seriously injured. Of the remaining 10 ~~11~~ interactions within the Hawaiian EEZ, all were within the range of the pelagic stock, with six ~~and eight were~~ considered seriously injured, one ~~was~~ not considered seriously injured, and three ~~two~~ could not be determined based on the information provided by the observer. Outside of the Hawaii EEZ, ~~one animal was dead,~~ ten ~~eight~~ were considered seriously injured, and three ~~two~~ were ~~not~~ considered not seriously injured. Five additional unidentified "blackfish" (unidentified cetaceans known to be either false killer whales or short-finned pilot whales) were also taken, one within the SSLL fishery and four in the DSLL fishery. The single SSLL interaction occurred outside the Hawaiian EEZ and the animal was considered seriously injured. Of the four DSLL interactions, two occurred inside the Hawaii EEZ, with both considered seriously injured, and two occurred outside the Hawaii EEZ, with one considered seriously injured and one considered not seriously injured. ~~In 2014, 2 false killer whales were taken inside the Hawaii EEZ and 9 outside of the EEZ (NMFS PIRO Observer Program). Serious injury determinations are not yet available for these takes.~~

Table 1. Summary of available information on incidental mortality and serious injury (MSI) of false killer whales and unidentified blackfish (false killer whale or short-finned pilot whale) in commercial longline fisheries, by stock and EEZ area, as applicable (McCracken 2016 ~~2015~~). 5-yr mean annual takes are presented for 2008-2012, prior to the implementation of the TRP, for 2013-2014 due to changes in fishing gear under the TRP intended to reduce serious injury rate, and for 2010-2014, ~~2009-2013~~ ignoring any ~~assuming no significant~~ change in mortality rate (see Forney 2015). Information on all observed takes (T) and combined mortality & serious injury is included. Unidentified blackfish are pro-rated as either false killer whales or short-finned pilot whales according to their distance from shore (McCracken 2010). CVs are estimated based on the combined variances of annual false killer whale and blackfish take estimates and the relative density estimates for each stock within the overlap zones. Values of '0' presented with no further precision are based on observation at 100% coverage and are not estimates.

				Observed takes		Estimated M&SI (CV)			
				FKW T/MSI UB T/MSI		Pelagic Stock			
Fishery Name	**Year**	**Data Type**	**Percent Observer Coverage**	**Outside U.S EEZ**	**Within Hawaii EEZ**	**Outside U.S EEZ**	**Within Hawaii EEZ**	**MHI insular Stock**	**NWHI Stock**
Hawaii-based deep-set longline fishery	2008	Observer data	22%	0 0	3/3 3/3	0 (-)	16.2 (0.4)	0.3 (0.4)	0.5 (1.1)
	2009		21%	7/7 0	3/3 0	38.5 (0.2)	11.8 (0.9)	0.2 (0.8)	0.4 (1.3)
	2010		21%	1/1 0	3/2 1/1	5.6 (1.5)	13.2 (0.4)	0.4 (0.5)	0.2 (1.0)
	2011		20%	0 1/0	3/~~2~~3[†] 1/1	2.2 (3.6)	12.2 (0.4)	0.1 (0.6)	0.3 (1.2)
	2012		20%	0 1/1	3/~~2~~3*[‡] 0	3.6 (2.3)	13.0 (0.4)	0.1 (3.9)	1.6 (1.3)
	2013		20%	3/1 0	1/1 0	6.6 (0.9)	4.1 (1.4)	0.0 (1.9)	0.0 (-)
	2014		21%	9/8 0	2/1[†] 0	35.8 (0.5)	8.4 (0.7)	0.0 (0.8)	0.0 (1.5)
Pre-TRP Mean Estimated Annual Take (CV) 2008-2012						**10.0 (0.4)**	**13.3 (0.2)**	**0.2 (0.4)**	**0.6 (0.8)**
Estimated Annual Take (CV) under TRP ~~[2013-2014 only]~~						**21.2 (0.5)** **~~6.6 (0.9)~~**	**6.2 (0.7)** **~~4.1 (1.4)~~**	**0.0 (0.7)** **~~0.0 (1.9)~~**	**0.0 (1.3)** **~~0 (-)~~**
Mean Estimated Annual Take (CV) 2010-2014 ~~2009-2013~~						**10.7 (0.4)** **~~11.3 (0.3)~~**	**10.2 (0.2)** **~~10.9 (0.3)~~**	**0.1 (0.6)** **~~0.2 (0.5)~~**	**0.4 (1.0)** **~~0.5 (0.9)~~**
Hawaii-based shallow-set longline fishery	2008	Observer data	100%	0 1/1	1/0 0	0.6	0.0	0	0.0
	2009		100%	0 0	1/1 0	0	1.0	0	0.0
	2010		100%	0 0	0 0	0	0	0	0
	2011		100%	0 1/1	1/0 0	0.7	0.0	0	0
	2012		100%	0 0	1/~~0~~1[†] 0	0	0.3	0	0.0
	2013		100%	0 0	0 0	0	0	0	0
	2014		100%	0 0	1/0 0	0	0	0	0
Mean Annual Takes (100% coverage) 2008-2012						**0.3**	**0.3**	**0**	**0.0**
Mean Annual Take (CV) under TRP ~~[2013-2014 only]~~						**0**	**0**	**0**	**0**
Mean Annual Takes (100% coverage) 2010-2014~~2009-2013~~						**0.1**	**0.1~~0.27~~**	**0**	**0.0**

Pre-TRP Minimum total annual takes within U.S. EEZ (2008-2012)	**13.6 (0.2)**	**0.2 (0.4)**	**0.6 (0.8)**
Minimum total take under TRP within U.S. EEZ [2013-2014 only]	**6.2 (0.7)** **4.1 (1.4)**	**0.0 (0.7)** **0.0 (1.9)**	**0.0 (1.3)** **0 (-)**
Minimum total annual takes within U.S EEZ (2010-2014)2009-2013)	**10.3 (0.2)** **11.1 (0.3)**	**0.1 (0.6)** **0.2 (0.5)**	**0.4 (1.0)** **0.5 (0.9)**

* Two observed takes occurred within the NWHI-pelagic overlap zone and are therefore allocated for proration between NWHI and pelagic stocks. Remaining estimated takes are prorated among stocks as described for each overlap zone.
† Injury status could not be determined based on information collected by the observer. Injury status is prorated (see text).

The injury status of estimated takes is prorated to serious versus non-serious using the historic rate of serious injury within the observed takes. For the period 2008 to 2012, the rate of serious injury for false killer whales was 93% (McCracken 2014). Because the implementation of weak hooks under the TRP was intended to reduce the serious injury rate, Following the implementation of the TRP these historic averages were not used for 2013-2014. The allocation of estimated serious versus non-serious injuries in 2013-2014 takes was based on the proportion of serious versus non-serious injuries of observed takes in those years 2013 (McCracken 2016 2015). The proration of serious injury status will be updated as additional data become available to better estimate serious versus non-serious injury proportion under TRP measures.

Takes of false killer whales of unknown stock within the stock overlap zones must be prorated to MHI insular, pelagic, or NWHI stocks. No genetic samples are available to establish stock identity for the two takes inside the NWHI-pelagic overlap zone north of Kauai, but both stocks are considered at risk of interacting with longline gear. The pelagic stock is known to interact with longline fisheries in waters offshore of the overlap zone, based on two genetic samples obtained by fishery observers (Chivers *et al.* 2010). MHI insular and NWHI false killer whales have been documented via telemetry to move far enough offshore to reach longline fishing areas (Bradford *et al.* 2015), and animals from the MHI insular stock have a high rate of dorsal fin disfigurements consistent with injuries from unidentified fishing line (Baird and Gorgone 2005, Baird *et al.* 2014). Annual bycatch estimates are prorated to stock using the following process. Takes of unidentified blackfish are prorated to false killer whale and short-finned pilot whale based on distance from shore (McCracken 2010). The distance-from-shore model was chosen following consultation with the Pacific Scientific Review Group, based on the model's logic and performance relative to a number of other models with similar output (McCracken 2010). Following proration of unidentified blackfish takes to species, Hawaii EEZ and high-seas estimates of false killer whale take are calculated by summing the annual false killer whale take and the annual blackfish take prorated as false killer whale within each region (McCracken 2016 2015). For the deep-set fishery within the Hawaii EEZ, annual takes are apportioned to each stock overlap zone and the pelagic-only stock area based on relative annual fishing effort in each zone. The total annual EEZ bycatch estimate is multiplied by the proportion of total fishing effort (by set) within each zone to estimate the bycatch within that zone. Because the shallow-set longline fishery is fully observed, takes are assigned to the zone in which they were observed and there is no further apportionment based on fishing effort. For each longline fishery, the zonal bycatch estimates are then multiplied by the relative density of each stock in the respective zone to prorate bycatch to stock. For the deep-set fishery, if bycatch was observed within a specific overlap zone, the observed takes were assigned to that zone and the remaining estimated bycatch was assigned among zones and stocks according to the described process. Following proration by fishing effort and stock density within each zone, stock-specific bycatch estimates are summed across zones to yield the total stock-specific annual bycatch by fishery. Uncertainty in stock-specific bycatch estimates combines variances of total annual false killer whale bycatch and the fractional variance of false killer whale density according to which stock is being estimated. Enumeration of fishing effort within stock overlap zones is assumed to be known without error.

Based on this approach, estimates of annual mortality and serious injury of false killer whales, by stock and EEZ area, are shown in Table 1. Three mortality and serious injury estimates are provided (Table 1): a A 5-yr average mortality and serious injury estimate is provided for the period prior to TRP-implementation years (2008-2012), a 2-yr single year estimate is provided for 2013 average for the period following TRP implementation given the change in fishing regulations that occurred with the implementation of the TRP (2013-2014), and a 5-yr average is provided for the most recent 5 years for years 2009-2013 assuming no significant change in mortality rate within the fishery (2010-2014) (Table 1). The bycatch rate (per 1000 sets) and of the proportion of non-serious injuries prior to and following TRP implementation were examined as part of the FKW TRT monitoring strategy. Various analyses suggest no statistically-significant difference in overall take rate or the proportion of non-serious injuries since TRP implementation, though the proportion of non-serious injuries would need to increase to 40-50% to be detectable within 2 years (Forney 2015).

Proration of false killer whale takes within the overlap zones and of unidentified blackfish takes introduces unquantified uncertainty into the bycatch estimates, but until methods of determining stock identity for animals observed taken within the overlap zone are available, and all animals taken can be identified to species (e.g., photos,

tissue samples), these proration approaches are needed ensure that potential impacts to all stocks are assessed in the overlap zones.

MAIN HAWAIIAN ISLANDS INSULAR STOCK

POPULATION SIZE

A Status Review for the MHI insular stock in 2010 (Oleson *et al.* 2010) used recent, unpublished estimates of abundance for two time periods, 2000-2004 and 2006-2009 in a Population Viability Analysis (PVA). These estimates were based on open population models, for the two time periods. The abundance estimate for the 2000-2004 period is 162 (CV=0.23) animals. Two separate estimates for 2006-2009 were presented in the Status Review; 151 (CV=0.20) and 170 (CV=0.21), depending on whether animals photographed near Kauai are included in the estimate. The animals seen near Kauai included in the higher estimate have now been associated with the NWHI stock (Baird *et al.* 2013), such that the best estimate of population size for the MHI insular stock is the smaller estimate of 151 animals. ~~However, it should be noted that even this smaller estimate may be positively biased, because missed photo-ID matches were discovered after the analyses were complete (discussed in Oleson et al. 2010).~~Half the data used in the derivation of this population estimate are more than 8 years old and are now considered outdated under NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005).

Minimum Population Estimate

The minimum population estimate for the MHI insular stock of false killer whales is the number of distinctive individuals identified during 2011 to 2014 photo-identification studies, or 92 false killer whales (Baird *et al.* 2015). A portion of the data used in 2006-2009 ~~Recent~~ mark-recapture estimates (Oleson *et al.* 2010) of abundance ~~are known to have a positive bias of unknown magnitude due to missed matches~~are considered outdated, and therefore are not suitable for deriving a minimum abundance estimate.

Current Population Trend

Reeves *et al.* (2009) suggested that the MHI insular stock of false killer whales may have declined during the last two decades, based on sightings data collected near Hawaii using various methods between 1989 and 2007. Baird (2009) reviewed trends in sighting rates of false killer whales from aerial surveys conducted using consistent methodology around the main Hawaiian Islands between 1994 and 2003 (Mobley *et al.* 2000). Sighting rates during these surveys showed a statistically significant decline that could not be attributed to any weather or methodological changes. The Status Review of MHI insular false killer whales (Oleson *et al.* 2010) presented a quantitative analysis of extinction risk using a Population Viability Analysis (PVA). The modeling exercise was conducted to evaluate the probability of actual or near extinction, defined as a population reduced to fewer than 20 animals, given measured, estimated, or inferred information on population size and trends, and varying impacts of catastrophes, environmental stochasticity and Allee effects. All plausible models indicated the probability of decline to fewer than 20 animals within 75 years was greater than 20%. Though causation was not evaluated, all plausible models indicated the population has declined since 1989, at an average rate of -9% per year (95% probability intervals -5% to -12.5%), though some two-stage models suggested a lower rate of decline over the past decade (Oleson *et al.* 2010).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the MHI insular false killer whale stock is calculated as the minimum population estimate (92) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (for a stock listed as Endangered under the ESA and with minimum population size less than 1500 individuals; Taylor *et al.* 2000) resulting in a PBR of 0.18 false killer whales per year, or approximately one animal every 5.5 years.

STATUS OF STOCK

The status of MHI insular stock false killer whales relative to OSP is unknown, although this stock appears to have declined during the past two decades (Oleson *et al.* 2010, Reeves *et al.* 2009; Baird 2009). MHI insular false killer whales are listed as "endangered" under the Endangered Species Act (1973) (77 FR 70915, 28 November, 2012). The Status Review report produced by the Biological Review Team (BRT) (Oleson *et al.* 2010) found that Hawaiian insular false killer whales are a Distinct Population Segment (DPS) of the global false killer whale taxon. Of the 29 identified threats to the population, the BRT considered the effects of small population size, including

inbreeding depression and Allee effects, exposure to environmental contaminants (Ylitalo *et al.* 2009), competition for food with commercial fisheries (Boggs & Ito, 1993, Reeves *et al.* 2009), and hooking, entanglement, or intentional harm by fishermen to be the most substantial threats to the population. The BRT concluded that Main Hawaiian Islands insular false killer whales were at high risk of extinction. Following additional information on the occurrence of another island-associated stock in the NWHI, the BRT reevaluated the DPS decision and concluded that the population still met the standard to be listed as a DPS (Oleson *et al.* 2012). Because MHI insular false killer whales are formally listed as "endangered" under the ESA, they are automatically considered as a "depleted" and "strategic" stock under the MMPA. For the 5-yr period prior to the implementation of the TRP, the average estimated mortality and serious injury to MHI insular stock false killer whales (0.21 animals per year) exceeded the PBR (0.18 animals per year). For years 2013-2014, the estimate of mortality and serious injury (0) is below the PBR (0.18), and ignoring any ~~even if no~~ change in mortality rates is assumed under the TRP, the mortality and serious injury to MHI insular false killer whales for the most recent 5-yr period, 2010-2014 ~~2009-2013~~ (0.1 ~~0.15~~) is less than PBR (0.18). The total fishery mortality and serious injury for the MHI insular stock of false killer whales cannot be considered to be insignificant and approaching zero, as it is greater than 10% of PBR. Following implementation of the TRP a significant portion of the recognized stock range is inside of the expanded year-round LLEZ around the MHI, providing significant protection for this stock from longline fishing. Prior to that time, a seasonal contraction to the LLEZ potentially exposed a significant portion of the offshore range of the stock to longline fishing. Additional monitoring of bycatch rates for this stock will be required before assessing whether the expansion of the LLEZ and other take-reduction measures have reduced fishery takes below PBR. Effects of other threats have yet to be assessed, e.g., nearshore hook and line fishing and environmental contamination. There is significant geographic overlap between various nearshore fisheries and evidence of interactions with hook-and-line gear (e.g. Baird *et al.* 2015), such that these fisheries may pose a threat to the stock. Recent research has indicated that concentrations of polychlorinated biphenyls (PCBs) exceeded proposed threshold levels for health effects in 84% of sampled MHI insular false killer whales (Foltz *et al.* 2014).

HAWAII PELAGIC STOCK

POPULATION SIZE

Analyses of a 2002 shipboard line-transect survey of the Hawaiian Islands EEZ resulted in an abundance estimate of 484 (CV = 0.93) false killer whales within the Hawaiian Islands EEZ outside of about 75 nmi of the main Hawaiian Islands (Barlow & Rankin 2007). A new abundance survey was completed in 2010 within the Hawaiian Islands EEZ and resulted in five on-effort detections of false killer whales attributed to the Hawaii pelagic stock. Analysis of the 2010 HICEAS shipboard line-transect data resulted in an abundance estimate of 1,540 (CV=0.66) false killer whales outside of 11 km of the main Hawaiian Islands (Bradford *et al.* 2014, 2015). Bradford *et al.* (2014) reported that most (64%) false killer whale groups seen during the 2010 HICEAS survey were seen moving toward the vessel when detected by the visual observers. Together with an increase in sightings close to the trackline, these behavioral data suggest vessel attraction is likely occurring and may be significant. Although Bradford *et al.* (2014, 2015) employed a half-normal model to minimize the effect of vessel attraction, the abundance estimate may still be positively biased as a result of vessel attraction because groups originally outside of the survey strip, and therefore unavailable for observation by the visual survey team, may have moved within the survey strip and been sighted. There is some suggestion of such attractive movement within the acoustic data and visual data (Bradford *et al.* 2014), though the extent of any bias created by this movement is unknown. –A 2005 survey (Barlow and Rankin 2007) resulted in a separate abundance estimate of 906 (CV=0.68) false killer whales in international waters south of the Hawaiian Islands EEZ and within the EEZ of Johnston Atoll, but it is unknown how many of these animals might belong to the Hawaii pelagic stock.

Minimum Population Estimate

The minimum population size is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al.* 1995) of the 2010 abundance estimate for the Hawaiian Islands EEZ outside of 11 km from the main Hawaiian Islands (Bradford *et al.* 2014, 2015) or 928 false killer whales. The minimum abundance estimate has not been corrected for vessel attraction and may be ~~an over-estimate of minimum population size~~ positively-biased.

Current Population Trend

No data are available on current population trend. It is incorrect to conclude that ~~interpret~~ the increase in the abundance estimate from 2002 to 2010 represents an ~~as an~~ increase in population size, given changes to the survey design in 2010 and the analytical framework specifically intended to better enumerate and account for overall group size (Bradford *et al.* 2014), the low precision of each estimate, and a lack of understanding of the oceanographic processes that may drive the distribution of this stock over time. Further, estimation of the detection

function for the 2002 and 2010 estimates relied on shared data, such that the resulting abundance estimates are not statistically independent ~~estimates~~ and cannot be compared in standard statistical tests. Only a portion of the overall range of this population has been surveyed, precluding evaluation of abundance of the entire stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Hawaii pelagic stock of false killer whales is calculated as the minimum population estimate for the U.S. EEZ of the Hawaiian Islands (928) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a stock of unknown status with a Hawaiian Islands EEZ mortality and serious injury rate CV <= 0.30; Wade and Angliss 1997), resulting in a PBR of 9.3 false killer whales per year.

STATUS OF STOCK

The status of the Hawaii pelagic stock of false killer whales relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Concentrations of ~~-~~polychlorinated biphenyls (PCBs) exceeded proposed threshold levels for health effects in 84% of sampled MHI insular false killer whales (Foltz *et al.* 2014), and elevated concentrations are also expected in pelagic false killer whales given the amplification of these contaminants through the food chain and likely similarity in false killer whale diet across the region. This stock is not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor designated as "depleted" under the MMPA. Following the NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005), the status of this transboundary stock of false killer whales is assessed based on the estimated abundance and estimates of mortality and serious injury within the U.S. EEZ of the Hawaiian Islands because estimates of human-caused mortality and serious injury from all U.S. and non-U.S. sources in high seas waters are not available, and because the geographic range of this stock beyond the Hawaiian Islands EEZ is poorly known. For the 5-yr period prior to the implementation of the TRP, the average rate of mortality and serious injury to pelagic stock false killer whales within the Hawaiian Islands EEZ (13.6 animals per year) exceeded the PBR (9.3 animals per year). In most cases, the NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005) suggest pooling estimates of mortality and serious injury across 5 years to reduce the effects of sampling variation. If there have been significant changes in fishery operation that are expected to affect take rates, such as the 2013 implementation of the TRP, the guidelines recommend using only the years since regulations were implemented. ~~However, recent studies (Carretta and Moore 2014) have demonstrated that estimates from a single year of data are biased when take events are rare, as with false killer whales in the Hawaii based longline fisheries.~~ Using only bycatch information from 2013-2014, the ~~Although the~~ estimated mortality and serious injury of false killer whales within the HI EEZ ~~during 2013~~ (6.2~~4.1~~) is below the PBR (9.3). However, further consideration of available data and analyses conducted as part of the FKW TRP monitoring strategy suggest the false killer whale take rate has not declined and that the proportion of non-serious injuries has not significantly decreased (Forney 2015)~~, this estimate is within the range of past, pre-TRP estimates, so there is not yet sufficient information to determine whether take rates in the fishery have decreased as a result of the TRP.~~ Indeed, in 2014 the total number of false killer whales taken in the deep-set fishery (55) is the highest recorded since 2003 and the total estimated mortality and serious injury of ~~number of~~ false killer whales (44) ~~takes during 2014 (for which no overall bycatch estimates are yet available), are the highest recorded~~ is the second highest since 2003. ~~One of the goals of the TRP is to reduce the severity of injury (from serious to non-serious) by allowing hooked animals to free themselves.~~ The proportion of non-serious injuries is lower in 2013-2014 than the aggregate of all prior years; however, similar 2-year average non-serious injury rates have been observed previously. Further, recent studies (Carretta and Moore 2014) have argued that estimates from a single year of data can be biased when take events are rare, as are takes of false killer whales in the Hawaii-based longline fisheries, and that several years of data may need to be pooled to reduce error. ~~However, even if the serious injury rate were halved under TRP measures, a rough approximation of 2014 total mortality and serious injury (approximately 27 total false killer whales within and outside the EEZ), would be the second highest mortality and serious injury estimate available for this fishery.~~ For these reasons, the strategic status for this stock has been evaluated relative to the most recent 5 years of estimated mortality and serious injury. The total 5-year mortality and serious injury for 2010-2014 ~~2009-2013~~ (10.3~~-11.2~~) exceeds PBR (9.3), and this stock is considered a "strategic stock" under the MMPA. Additional monitoring of bycatch rates for this stock will be required before assessing whether TRP measures have reduced fishery takes below PBR. The total fishery mortality and serious injury for the Hawaii pelagic stock of false killer whales cannot be considered to be insignificant and approaching zero.

NORTHWESTERN HAWAIIAN ISLANDS STOCK

POPULATION SIZE

A 2010 line transect survey that included the waters surrounding the Northwestern Hawaiian Islands produced an estimate of -617 (CV = 1.11) false killer whales attributed to the Northwestern Hawaiian Islands stock (Bradford *et al.* 2014, 2015). This is the best available abundance estimate for false killer whales within the Northwestern Hawaiian Islands. Bradford *et al.* (2014) reported that most (64%) false killer whale groups seen during the 2010 HICEAS survey were seen moving toward the vessel when detected by the visual observers. Together with an increase in sightings close to the trackline, these behavioral data suggest vessel attraction is likely occurring and may be significant. Bradford *et al.* (2014, 2015) employed a half-normal model to minimize the effect of vessel attraction, because groups originally outside of the survey strip, and therefore unavailable for observation by the visual survey team, may have moved within the survey strip and been sighted. There is some suggestion of such attractive movement within the acoustic and visual data (Bradford *et al.* 2014) though the extent of any bias created by this movement is unknown.

Minimum Population Estimate

The minimum population size is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al.* 1995) of the 2010 abundance estimate for the Northwestern Hawaiian Islands stock (Bradford *et al.* 2015) or 290 false killer whales. This estimate has not been corrected for vessel attraction and may be positively-biased.

Current Population Trend

No data are available on current population trend because there is only one estimate of abundance from 2010.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in the waters surrounding the Northwestern Hawaiian Islands.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Northwestern Hawaiian Islands false killer whale stock is calculated as the minimum population estimate (290) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.40 (for a stock of unknown status, with a Hawaiian Islands EEZ mortality and serious injury rate CV > 0.8; Wade and Angliss 1997), resulting in a PBR of 2.3 false killer whales per year.

STATUS OF STOCK

The status of false killer whales in Northwestern Hawaiian Islands waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Concentrations of polychlorinated biphenyls (PCBs) exceeded proposed threshold levels for health effects in 84% of sampled MHI insular false killer whales (Foltz et al 2014), and elevated concentrations are also expected in NWHI false killer whales given the amplification of these contaminants through the food chain and likely similarity in false killer whale diet across the region. Biomass of some false killer whale prey species may have declined around the Northwestern Hawaiian Islands (Oleson *et al.* 2010, Boggs & Ito 1993, Reeves *et al.* 2009), though waters within the Papahānaumokuākea Marine National Monument have been closed to commercial longlining since 1991 and to other fishing since 2006. This stock is not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. The rate of mortality and serious injury to NWHI false killer whales, (0.6 for 2008-2012, ~~0.1~~ 0 for 2013-2014, ~~0.5~~ 0.4 for 2010-2014~~2009-2013~~) is less than the PBR (2.3 animals per year), but is not approaching zero mortality and serious injury rate because it exceeds 10% of PBR (NMFS 2004). A significant portion of the recognized stock range is within the Marine National Monument and the expanded LLEZ, such that this stock is likely not exposed to high levels of fishing effort because commercial and recreational fishing is prohibited within Monument waters and longlines are excluded from the majority of the stock range. Additional monitoring of bycatch rates for this stock will be required before assessing whether TRP measures have reduced fishery takes to below 10% of PBR.

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Appendix 3. Pacific reports revised in 2016 are highlighted. S=strategic stock, N=non-strategic stock. unk=unknown, undet=undetermined, n/a=not applicable.

Species (Stock Area)	N est	CV N est	N min	R max	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fishery Mortality + Serious Injury	Strategic Status	Recent Abundance Surveys			SAR Last Revised
California sea lion (U.S.)	296,750	n/a	153,337	0.12	1	9,200	389	331	N	2007	2008	2011	2014
Harbor seal (California)	30,968	n/a	27,348	0.12	1	1,641	43	30	N	2004	2009	2012	2014
Harbor seal (Oregon/Washington Coast)	unk	unk	unk	0.12	1	undet	10.6	7.4	N	1999			2013
Harbor seal (Washington Northern Inland Waters)	unk	unk	unk	0.12	1	undet	9.8	2.8	N	1999			2013
Harbor seal (Southern Puget Sound)	unk	unk	unk	0.12	1	undet	3.4	1	N	1999			2013
Harbor seal (Hood Canal)	unk	unk	unk	0.12	1	undet	0.2	0.2	N	1999			2013
Northern Elephant Seal (California Breeding)	179,000	n/a	81,368	0.12	1	4,882	8.8	4	N	2002	2005	2010	2014
Guadalupe Fur Seal (Mexico to California)	~~7,408~~	~~n/a~~	~~3,028~~	~~0.12~~	~~0.5~~	~~91~~	~~0~~	~~0~~	~~S~~	~~1993~~			~~2000~~
	20,000	n/a	15,830	0.137	0.5	542	≥3.2	≥3.2	S	2008	2009	2010	2016
Northern Fur Seal (California)	14,050	n/a	7,524	0.12	1	451	1.8	≥0.8	N	2010	2011	2013	2015
Monk Seal (Hawaii)	~~1,112~~	~~n/a~~	~~1,088~~	~~0.07~~	~~0.1~~	~~undet~~	~~≥2.6~~	~~>1.0~~	~~S~~	~~2010~~	~~2011~~	~~2013~~	~~2015~~
	1,272	n/a	1,205	0.07	0.1	undet	≥2.8	≥1.2	S	2011	2013	2014	2016
Harbor porpoise (Morro Bay)	2,917	0.41	2,102	0.04	0.5	21	≥0.6	≥0.6	N	2002	2007	2012	2013
Harbor porpoise (Monterey Bay)	3,715	0.51	2,480	0.04	0.5	25	0	0	N	2002	2007	2011	2013
Harbor porpoise (San Francisco - Russian River)	9,886	0.51	6,625	0.04	0.5	66	0	0	N	2002	2007	2011	2013
Harbor porpoise (Northern CA/Southern OR)	35,769	0.52	23,749	0.04	1	475	≥0.6	≥0.6	N	2002	2007	2011	2013
Harbor porpoise (Northern OR/Washington Coast)	21,487	0.44	15,123	0.04	0.5	151	≥3.0	≥3.0	N	2002	2010	2011	2013
Harbor porpoise (Washington Inland Waters)	~~n/a~~	~~n/a~~	~~n/a~~	~~0.04~~	~~0.4~~	~~n/a~~	~~≥2.2~~	~~≥2.6~~	~~N~~	~~1996~~	~~2002~~	~~2003~~	~~2011~~
	11,233	0.37	8,308	0.04	0.4	66	≥7.2	≥7.2	N	2013	2014	2015	2016
Dall's porpoise (California/Oregon/Washington)	~~42,000~~	~~0.33~~	~~32,106~~	~~0.04~~	~~0.4~~	~~257~~	~~≥0.4~~	~~≥0.4~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	25,750	0.45	17,954	0.04	0.48	172	0.3	0.3	N	2005	2008	2014	2016
Pacific white-sided dolphin (California/Oregon/Washington)	~~26,930~~	~~0.28~~	~~21,406~~	~~0.04~~	~~0.4~~	~~171~~	~~17.8~~	~~11.8~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2013~~
	26,814	0.28	21,195	0.04	0.45	191	6.7	5.8	N	2005	2008	2014	2016
Risso's dolphin (California/Oregon/Washington)	~~6,272~~	~~0.30~~	~~4,913~~	~~0.04~~	~~0.4~~	~~39~~	~~1.6~~	~~1.6~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	6,336	0.32	4,817	0.04	0.48	46	≥4.2	≥4.2	N	2005	2008	2014	2016
Common Bottlenose dolphin (California Coastal)	~~323~~	~~0.13~~	~~290~~	~~0.04~~	~~0.5~~	~~2.4~~	~~0.2~~	~~0.2~~	~~N~~	~~2000~~	~~2004~~	~~2005~~	~~2008~~
	453	0.06	346	0.04	0.48	2.7	≥2.0	≥1.6	N	2009	2010	2011	2016
Common Bottlenose dolphin (California/Oregon/Washington Offshore)	~~1,006~~	~~0.48~~	~~684~~	~~0.04~~	~~0.4~~	~~5.5~~	~~≥2.0~~	~~≥2.0~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2013~~
	1,924	0.54	1,255	0.04	0.45	11	≥0.7	≥0.7	N	2005	2008	2014	2016
Striped dolphin (California/Oregon/Washington)	~~10,908~~	~~0.34~~	~~8,231~~	~~0.04~~	~~0.5~~	~~82~~	~~0~~	~~0~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	29,211	0.20	24,782	0.04	0.4	198	≥0.84	≥0.84	N	2005	2008	2014	2016

Appendix 3. Pacific reports revised in 2016 are highlighted. S=strategic stock, N=non-strategic stock. unk=unknown, undet=undetermined, n/a=not applicable.

Species (Stock Area)	N est	CV N est	N min	R max	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fishery Mortality + Serious Injury	Strategic Status	Recent Abundance Surveys			SAR Last Revised
Common dolphin, short-beaked (California/Oregon/Washington)	~~411,211~~	~~0.21~~	~~343,990~~	~~0.04~~	~~0.5~~	~~3,440~~	~~64~~	~~64~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	969,861	0.17	839,325	0.04	0.5	8,393	≥22.6	≥22.6	N	2005	2008	2014	2016
Common dolphin, long-beaked (California)	~~107,016~~	~~0.42~~	~~76,224~~	~~0.04~~	~~0.4~~	~~610~~	~~13.8~~	~~13~~	~~N~~	~~2005~~	~~2008~~	~~2009~~	~~2012~~
	101,305	0.49	68,432	0.04	0.48	657	≥35.4	≥32.0	N	2005	2008	2014	2016
Northern right whale dolphin (California/Oregon/Washington)	~~8,334~~	~~0.40~~	~~6,019~~	~~0.04~~	~~0.4~~	~~48~~	~~4.8~~	~~3.6~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	26,556	0.44	18,608	0.04	0.48	179	3.5	3.5	N	2005	2008	2014	2016
Killer whale (Eastern N Pacific Offshore)	240	0.49	162	0.04	0.5	1.6	0	0	N	2005	2008	2014	2016
Killer whale (Eastern N Pacific Southern Resident)	~~78~~	~~n/a~~	~~78~~	~~0.035~~	~~0.1~~	~~0.14~~	~~0~~	~~0~~	~~S~~	~~2012~~	~~2013~~	~~2014~~	~~2015~~
	81	n/a	81	0.035	0.1	0.14	0	0	S	2013	2014	2015	2016
Short-finned pilot whale (California/Oregon/Washington)	~~760~~	~~0.64~~	~~465~~	~~0.04~~	~~0.5~~	~~4.6~~	~~0~~	~~0~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	836	0.79	466	0.04	0.48	4.5	1.2	1.2	N	2005	2008	2014	2016
Baird's beaked whale (California/Oregon/Washington)	847	0.81	466	0.04	0.5	4.7	0	0	N	2001	2005	2008	2013
Mesoplodont beaked whales (California/Oregon/Washington)	694	0.65	389	0.04	0.5	3.9	0	0	S	2001	2005	2008	2013
Cuvier's beaked whale (California/Oregon/Washington)	6,590	0.55	4,481	0.04	0.5	45	0	0	S	2001	2005	2008	2013
Pygmy Sperm whale (California/Oregon/Washington)	~~579~~	~~1.02~~	~~271~~	~~0.04~~	~~0.5~~	~~2.7~~	~~0~~	~~0~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	4,111	1.12	1,924	0.04	0.5	19.2	0	0	N	2005	2008	2014	2016
Dwarf sperm whale (California/Oregon/Washington)	~~unk~~	~~unk~~	~~unk~~	~~0.04~~	~~0.5~~	~~undet~~	~~0~~	~~0~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	unk	unk	unk	0.04	0.5	undet	0	0	N	2005	2008	2014	2016
Sperm whale (California/Oregon/Washington)	2,106	0.58	1,332	0.04	0.1	2.7	1.7	1.7	S	2001	2005	2008	2014
Gray whale (Eastern N Pacific)	20,990	0.05	20,125	0.062	1.0	624	132	4.25	N	2009	2010	2011	2014
Gray whale (Western N Pacific)	140	0.04	135	0.062	0.1	0.06	unk	unk	S			2011	2014
Humpback whale (California/Oregon/Washington)	~~1,918~~	~~0.03~~	~~1,855~~	~~0.08~~	~~0.3~~	~~11.0~~	~~≥ 5.5~~	~~≥ 4.4~~	~~S~~	~~2009~~	~~2010~~	~~2011~~	~~2013~~
	1,918	0.03	1,876	0.08	0.3	11.0	≥ 6.5	≥ 5.3	S	2005	2008	2014	2016
Blue whale (Eastern N Pacific)	1,647	0.07	1,551	0.04	0.3	2.3	0.9	0	S	2005	2008	2011	2015
Fin whale (California/Oregon/Washington)	~~3,051~~	~~0.18~~	~~2,598~~	~~0.04~~	~~0.3~~	~~16~~	~~2.2~~	~~0.6~~	~~S~~	~~2001~~	~~2005~~	~~2008~~	~~2013~~
	9,029	0.12	8,127	0.04	0.5	81	≥ 2.0	≥ 0.2	S	2005	2008	2014	2016
Sei whale (Eastern N Pacific)	~~126~~	~~0.53~~	~~83~~	~~0.04~~	~~0.1~~	~~0.17~~	~~0~~	~~0~~	~~S~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	519	0.4	374	0.04	0.1	0.75	0	0	S	2005	2008	2014	2016
Minke whale (California/Oregon/Washington)	~~478~~	~~1.36~~	~~202~~	~~0.04~~	~~0.5~~	~~2~~	~~0~~	~~0~~	~~N~~	~~2001~~	~~2005~~	~~2008~~	~~2010~~
	636	0.72	369	0.04	0.48	3.5	≥ 1.3	≥ 1.3	N	2005	2008	2014	2016
Bryde's whale (Eastern Tropical Pacific)	unk	unk	unk	0.04	0.5	undet	unk	unk	N	n/a	n/a	n/a	2015

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Species (Stock Area)	N est	CV N est	N min	R max	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fishery Mortality + Serious Injury	Strategic Status	Recent Abundance Surveys			SAR Last Revised
Rough-toothed dolphin (Hawaii)	6,288	0.39	4,581	0.04	0.5	46	unk	unk	N		2002	2010	2013
Rough-toothed dolphin (American Samoa)	unk	unk	unk	0.04	0.5	undet	unk	unk	unk	n/a	n/a	n/a	2010
Risso's dolphin (Hawaii)	7,256	0.41	5,207	0.04	0.5	42	0.6	0.6	N		2002	2010	2013
Common Bottlenose dolphin (Hawaii Pelagic)	5,950	0.59	3,755	0.04	0.5	38	0.2	0.2	N		2002	2010	2013
Common Bottlenose dolphin (Kaua'i and Ni'ihau)	184	0.11	168	0.04	0.5	1.7	unk	unk	N	2003	2004	2005	2013
Common Bottlenose dolphin (O'ahu)	743	0.54	485	0.04	0.5	4.9	unk	unk	N	2002	2003	2006	2013
Common Bottlenose dolphin (4 Islands Region)	191	0.24	156	0.04	0.5	1.6	unk	unk	N	2002	2003	2006	2013
Common Bottlenose dolphin (Hawaiian Island)	128	0.13	115	0.04	0.5	1.1	unk	unk	N	2002	2003	2006	2013
Pantropical Spotted dolphin (Hawaii Pelagic)	15,917	0.40	11,508	0.04	0.5	115.0	0	0	N		2002	2010	2013
Pantropical Spotted dolphin (O'ahu)	unk	unk	unk	0.04	0.5	undet	unk	unk	N			n/a	2013
Pantropical Spotted dolphin (4 Islands Region)	unk	unk	unk	0.04	0.5	undet	unk	unk	N			n/a	2013
Pantropical Spotted dolphin (Hawaii Island)	unk	unk	unk	0.04	0.5	undet	unk	unk	N			n/a	2013
Spinner dolphin (Hawaii Pelagic)	unk	unk	unk	0.04	0.5	undet	0	0	N		2002	2010	2013
Spinner dolphin (Hawaii Island)	631	0.04	585	0.04	0.5	5.9	unk	unk	N	1994	2003	2011	2013
Spinner dolphin (O'ahu / 4 Islands)	355	0.09	329	0.04	0.5	3.3	unk	unk	N	1993	1998	2007	2013
Spinner dolphin (Kaua'i / Ni'ihau)	601	0	509	0.04	0.5	5.1	unk	unk	N	1995	1998	2005	2013
Spinner dolphin (Kure / Midway)	unk	unk	unk	0.04	0.5	undet	unk	unk	N		1998	2010	2013
Spinner dolphin (Pearl and Hermes Reef)	unk	unk	unk	0.04	0.5	undet	unk	unk	N			n/a	2013
Spinner dolphin (American Samoa)	unk	unk	unk	0.04	0.5	undet	unk	unk	unk			n/a	2010
Striped dolphin (Hawaii Pelagic)	20,650	0.36	15,391	0.04	0.5	154	unk	unk	N		2002	2010	2013
Fraser's dolphin (Hawaii)	16,992	0.66	10,241	0.04	0.5	102	0	0	N		2002	2010	2010
Melon-headed whale (Hawaiian Islands)	5,794	0.20	4,904	0.04	0.5	49	0	0	N		2002	2010	2013
Melon-headed whale (Kohala Resident)	447	0.12	404	0.04	0.5	4.0	0	0	N			2009	2013
Pygmy killer whale (Hawaii)	3,433	0.52	2,274	0.04	0.5	23.0	0	0	N		2002	2010	2013
False killer whale (NW Hawaiian Islands)	~~617~~	~~1.11~~	~~290~~	~~0.04~~	~~0.4~~	~~2.3~~	~~0.5~~	~~0.5~~	~~N~~			~~2010~~	~~2015~~
	617	1.11	290	0.04	0.4	2.3	0.4	0.4	N			2010	2016
False killer whale (Hawaii Pelagic)	~~1,540~~	~~0.66~~	~~928~~	~~0.04~~	~~0.4~~	~~9.3~~	~~11.2~~	~~11.2~~	~~S~~		~~2002~~	~~2010~~	~~2015~~
	1,540	0.66	928	0.04	0.4	9.3	10.3	10.3	S		2002	2010	2016
False killer whale (Palmyra Atoll)	1,329	0.65	806	0.04	0.4	6.4	0.3	0.3	N			2005	2013
False killer whale (Main Hawaiian Islands Insular)	~~151~~	~~0.20~~	~~92~~	~~0.04~~	~~0.1~~	~~0.18~~	~~0.21~~	~~0.21~~	~~S~~	~~2012~~	~~2013~~	~~2014~~	~~2015~~
	151	0.20	92	0.04	0.1	0.18	0.1	0.1	S	2012	2013	2014	2016

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Species (Stock Area)	N est	CV N est	N min	R max	Fr	PBR	Total Annual Mortality + Serious Injury	Annual Fishery Mortality + Serious Injury	Strategic Status	Recent Abundance Surveys			SAR Last Revised
False killer whale (American Samoa)	unk	unk	unk	0.04	0.5	undet	unk	unk	unk	n/a	n/a	n/a	2010
Killer whale (Hawaii)	101	1.00	50	0.04	0.5	1.0	0	0	N		2002	2010	2013
Pilot whale, short-finned (Hawaii)	12,422	0.43	8,782	0.04	0.4	70	0.1	0.1	N		2002	2010	2013
Blainville's beaked whale (Hawaii Pelagic)	2,338	1.13	1,088	0.04	0.5	11.0	0	0	N		2002	2010	2013
Longman's Beaked Whale (Hawaii)	4,571	0.65	2,773	0.04	0.5	28.0	0	0	N		2002	2010	2013
Cuvier's beaked whale (Hawaii Pelagic)	1,941		1,142	0.04	0.5	11.4	0	0	N		2002	2010	2013
Pygmy sperm whale (Hawaii)	unk	unk	unk	0.04	0.5	undet	0	0	N		2002	2010	2013
Dwarf sperm whale (Hawaii)	unk	unk	unk	0.04	0.5	undet	0	0	N		2002	2010	2013
Sperm whale (Hawaii)	3,354	0.34	2,539	0.04	0.1	10.2	0.7	0.7	S		2002	2010	2013
Blue whale (Central N Pacific)	81	1.14	38	0.04	0.1	0.1	0	0	S		2002	2010	2013
Fin whale (Hawaii)	58	1.12	27	0.04	0.1	0.1	0	0	S		2002	2010	2013
Bryde's whale (Hawaii)	798	0.28	633	0.04	0.5	6.3	0	0	N		2002	2010	2013
Sei whale (Hawaii)	178	0.90	93	0.04	0.1	0.2	0.2	0.2	S		2002	2010	2013
Minke whale (Hawaii)	unk	unk	unk	0.04	0.5	undet	0	0	N		2002	2010	2013
Humpback whale (American Samoa)	unk	unk	150	0.106	0.1	0.4	0	0	S	2006	2007	2008	2009
Sea Otter (Southern)	2,826	n/a	2,723	0.06	0.1	8	≥0.8	≥0.8	S	2006	2007	2008	2008
Sea Otter (Washington)	n/a	n/a	1,125	0.2	0.1	11	≥0.2	≥0.2	N	2006	2007	2008	2008