U.S. PACIFIC DRAFT MARINE MAMMAL STOCK ASSESSMENTS: 2015

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Stock assessment reports and appendices revised in 2015 are highlighted and underlined; all others will be reprinted as they appear in the 2014 Pacific Region Stock Assessment Reports (Carretta *et al.* 2015).

PINNIPEDS

CETACEANS - U.S. WEST COAST

CETACEANS – HAWAII & WESTERN PACIFIC

APPENDICES

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 2015 Pacific marine mammal stock assessments include revised reports for eight Pacific marine mammal stocks under NMFS jurisdiction, including five"strategic" stocks: Hawaiian monk seal, Southern Resident killer whale, Eastern North Pacific blue whale, Main Hawaiian Islands Insular false killer whale, and Hawaii Pelagic false killer whale. New abundance estimates are available for three stocks in the Pacific Islands region (Hawaiian monk seal, Hawaii Pelagic and Northwestern Hawaiian Islands false killer whales) and two U.S. west coast stocks (Southern Resident killer whale and California northern fur seal). The stock range and boundaries of the three Hawaiian stocks of false killer whales were recently reevaluated based on new information on the occurrence and movements of each stock. The three stocks have partially overlapping ranges. New information on fishery-related serious injury and mortality of false killer whales has been updated. A stock assessment report for the Eastern Tropical Pacific stock of Bryde's whale has been reinstated into the Pacific reports in response to a regular and increasing presence of this species in southern California waters (Kerosky *et al*. 2012, Smultea *et al*. 2012). The Eastern Tropical Pacific Bryde's whale report last appeared in the Pacific stock assessments in 2007. The genus of Hawaiian monk seal has been updated from *Monachus* to *Neomonachus* to reflect new genetic and skull morphology data (Scheel *et al*. 2014). The report for Eastern North Pacific blue whales includes significant new information on historic whaling removals, the population's status relative to carrying capacity, and risk of ship strikes to the population (Monnahan *et al*. 2014, 2015).

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 2015 stock assessment reports were reviewed by the Pacific Scientific Review Group at the March 2015 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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NORTHERN FUR SEAL (*Callorhinus ursinus*): California Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

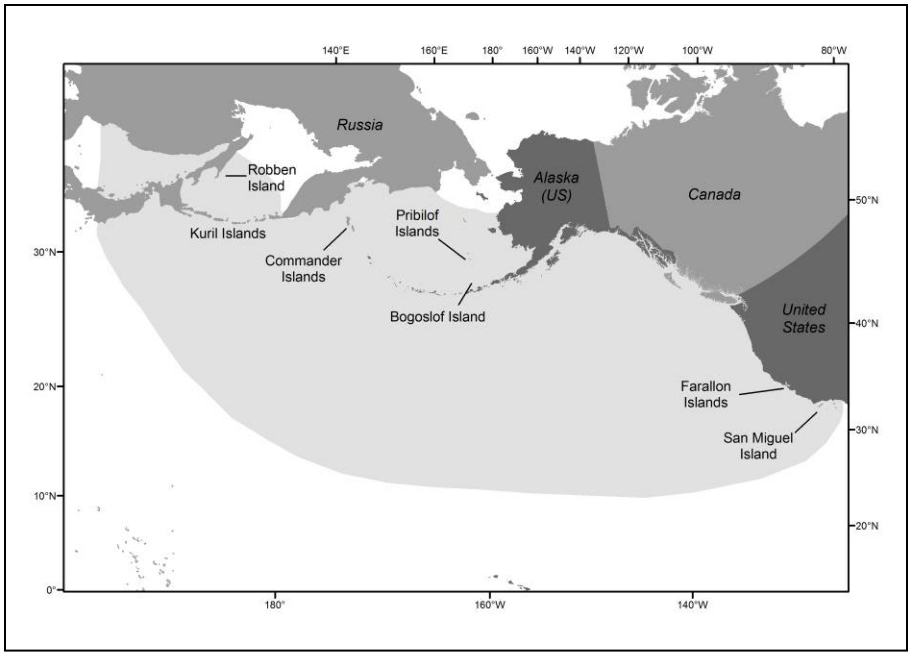

Figure 1. Approximate distribution of northern fur seals in the North Pacific (shaded area).

Northern fur seals occur from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan (Fig. 1). During the breeding season, approximately 74% of the worldwide population is found on the Pribilof Islands in the southern Bering Sea, with the remaining animals spread throughout the North Pacific Ocean (Lander and Kajimura 1982). Of the seals in U.S. waters outside of the Pribilofs, approximately 1% of the population is found on Bogoslof Island in the southern Bering Sea, ~~and~~ San Miguel Island off southern California (NMFS 2007), and the Farallon Islands off central California. Northern fur seals may temporarily haul out on land at other sites in Alaska, British Columbia, and on islets along the coast of the continental United States, but generally this occurs outside of the breeding season (Fiscus 1983).

Due to differing requirements during the annual reproductive season, adult males and females typically occur ashore at different, though overlapping, times. Adult males occur ashore and defend reproductive territories during a 3-month period from June through August, though some may be present until November (well after giving up their territories). Adult females are found ashore for as long as 6 months (June-November). After their respective times ashore, fur seals of both sexes spend the next 7 to 8 months at sea (Roppel 1984). Adult females and pups from the Pribilof Islands migrate through the Aleutian Islands into the North Pacific Ocean, often to waters off Washington, Oregon, and California. Many pups may remain at sea for 22 months before returning to their natal rookery. Adult males from the Pribilof Islands generally migrate only as far south as the Gulf of Alaska (Kajimura 1984). ~~There is considerable interchange of individuals between rookeries.~~

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: continuous geographic distribution during feeding, geographic separation during the breeding season, and high natal site fidelity (DeLong 1982); 2) Population response data: substantial differences in population dynamics between the Pribilofs and San Miguel Island (DeLong 1982, DeLong and Antonelis 1991, NMFS 2007); 3) Phenotypic data: unknown; and 4) Genotypic data: little evidence of genetic differentiation among breeding islands (Ream 2002, Dickerson et al. 2010). Based on this information, two separate stocks of northern fur seals are recognized within U.S. waters: an Eastern Pacific stock and a California stock (including San Miguel Island and the Farallon Islands). The Eastern Pacific stock is reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

The population estimate for northern fur seals on San Miguel Island is calculated as the estimated number of pups at rookeries multiplied by an expansion factor. Based on research conducted on the Eastern Pacific stock of northern fur seals, Lander's (1981) life table analysis was used to estimate the number of yearlings, two-year-olds, three-year-olds, and animals at least four years old. The resulting population estimate was equal to the pup count multiplied by 4.475. The expansion factors are based on a sex and age distribution estimated after the commercial harvest of juvenile males was terminated in 1984. A more appropriate expansion factor for San Miguel Island is 4.0, because immigration of recruitment-aged females is occurring in the population (DeLong 1982), as well as mortality and possible emigration of adults associated with the El Niño ~~Southern Oscillation~~ events in 1982-1983 and 1997-1998 (Melin et al. 2008). A 1998 pup count resulted in an 80% decrease from the 1997 count (Melin et al. 2005). In 1999, the population began to recover, and in 2010 the highest total pup count of ~~3,574~~ 3,408 was recorded (Orr et al. ~~2012~~ in review). A possible cause for the decline in total pup counts from 2010 to 2011 was a combination of oceanographic events that occurred in the California Current in 2009, a coastal upwelling relaxation event in May and June and an El Niño event from Fall 2009 to Spring 2010. The oceanographic events caused fewer reproductive males and females to return to San Miguel Island to breed in 2010. During 2012, the population increased 9.4% from 2011 and this level was maintained during 2013. No counts were conducted at Castle Rock in 2014; however, a record number of pups (2,289) was counted at Adam's Cove that year. Additionally, the second highest number of territorial bulls (224) was observed in 2014 (Orr et al. in review). ~~A maximum of 65 territorial bulls was observed in 2010 compared to 116 in 2009 and 148 in 2011. Fewer pups were born in 2011 because fewer animals were ashore to breed the previous year. During 2011, the total pup count decreased 13.5% from 2010 levels to 3,092.~~ Based on these factors, and assuming the trends were similar at Castle Rock, the population size during 2014 would have been the highest recorded. However, ~~B~~based on the ~~2011~~2013 count (the most recent complete data set) and the expansion factor, the most recent population estimate of northern fur seals at San Miguel Island is ~~12,368~~ 13,384 (~~3,092~~ 3,346 x 4.0) northern fur seals (Orr et al. in review). Currently, a coefficient of variation (CV) for the expansion factor is unavailable; however, studies are underway to determine the accuracy and precision of the expansion factor.

The population estimate for northern fur seals on the Farallon Islands is calculated as the highest number of pups, juveniles, and adults counted at the rookery. The long-term population estimate at the Farallon Islands should be regarded as an index of abundance rather than a precise indicator of population size for several reasons: 1) ~~P~~population censuses are incomplete because researchers do not enter rookery areas until the end of the breeding/pupping season in order to reduce human disturbance to other breeding pinnipeds and nesting seabirds; 2) mortality occurring early in the season is not accounted for; and 3) estimates of the number of pups ~~is~~ are compromised because by the time counts are conducted, many pups have learned to swim and may not be present at the rookery. Additionally, yearlings may be present at rookeries and misidentified as pups. Keeping these factors in mind, the peak counts of northern fur seals increased steadily from 1995 to 2006 and have increased exponentially from 2008 to ~~2011~~ 2013 (Tietz 2012, Berger et al. 2013). Based solely on the count, the ~~most recent~~ population estimate of northern fur seals at the Farallon Islands ~~is~~was ~~476~~ 666 in 2013 and increased to 1,019 in 2014 (Orr et al. in review).

The most recent population estimate for the entire stock of California northern fur seals, which ~~Incorporating~~incorporates estimates ~~of numbers~~ from San Miguel Island and the Farallon Islands in 2013, ~~the most recent population estimate of the California stock~~ is ~~12,844~~ 14,050 (13,384 + 666).

Minimum Population Estimate

Minimum population size is calculated as the sum of the minimum number of animals at San Miguel Island and the Farallon Islands in ~~2011~~ 2013 (Tietz 2012, Berger et al. 2013, Orr et al. ~~2012~~ in review~~, Tietz 2012~~). The minimum number of animals at San Miguel Island is twice the pup count (~~3,092~~ 3,346 x 2 = ~~6,184~~ 6,692), to account for pups and mothers, plus the number of territorial males (~~247~~ 166) counted the same year (i.e., 2013), or ~~6,431~~6,858 ~~animals~~fur seals. The minimum number at the Farallon Islands is the total number of individuals (666) counted during the survey in 2013. It should be noted that 1,019 individuals were counted in 2014, but this number is not used here to be consistent with data collected at San Miguel Island~~twice the pup count (122 x 2 = 244), plus the number of males (47), or 291 animals~~. The total minimum population size is the sum of the minimum population sizes at San Miguel Island (~~6,431~~ 6,858) and the Farallon Islands (~~291~~ 666) in ~~2011~~ 2013, or ~~6,722~~ 7,524 northern fur seals.

Current Population Trend

Northern fur seals were extirpated on San Miguel Island and the Farallon Islands during the late 1700s and early 1800s. Immigrants from the Pribilof Islands and Russian populations recolonized San Miguel Island during the late 1950s or early 1960s (DeLong 1982). The colony has increased steadily, since its discovery in 1968, except for severe declines in 1983 and 1998 associated with El Niño events in 1982-1983 and 1997-1998 (DeLong and Antonelis 1991, Melin et al. 2005). El Niño events, which occur periodically along the California coast, impact population growth of northern fur seals at San Miguel Island and are an important regulatory mechanism for this population (DeLong and Antonelis 1991; Melin and DeLong 1994, 2000; Melin et al. 1996, 2005, 2008; Orr et al. 2012, in review).

Live pup counts increased about 24% annually from 1972 through 1982 (Fig. 2), an increase due, in part, to immigration of females from the Bering Sea and the western North Pacific Ocean (DeLong 1982). The 1982-1983 El Niño event resulted in a 60.3% decline in the northern fur seal population at San Miguel Island (DeLong and Antonelis 1991). It took the population 7 years to recover from this decline, because adult female mortality or emigration occurred in addition to pup mortality (Melin and DeLong 1994). The 1992-1993 El Niño conditions resulted in reduced pup production in 1992, but the population recovered in 1993 and increased during ~~during~~ 1994 (Melin et al. 1996).

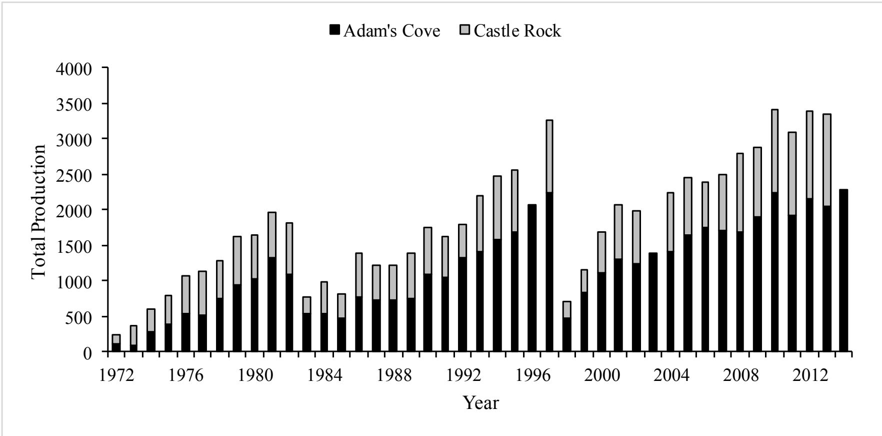

Figure 2. Total production of northern fur seal pups counted on San Miguel Island, ~~(~~including the mainland (Adam's Cove) and the offshore islet (Castle Rock), ~~1972-2011~~1972-2014.

From July 1997 through May 1998, the most severe El Niño event in recorded history affected California coastal waters (Lynn et al. 1998). In 1997, total fur seal pup production was the highest recorded since the colony has been monitored. However, it appears that up to 87% of the pups born in 1997 died before weaning, and total production in 1998 declined 80% from 1997 (Melin et al. 2005). Total production increased to a record high of ~~3,574~~3,408 in 2010 and, except for a slight decrease during 2011, levels have remained around 3,350 individuals in subsequent years ~~but decreased to 3,092 in 2011~~ (Orr et al. ~~2012~~ in review). The northern fur seal population appears to be greatly affected by El Niño events. These events cause changes in marine communities by altering sea-level height, sea-surface temperature, thermocline and nutricline depths, current-flow patterns, and upwelling strength. Fur seal prey generally move to more productive areas farther north and deeper in the water column and, thereby, become less accessible for fur seals. Consequently, fur seals at San Miguel Island are in poor physical condition during El Niño events and the population experiences reduced reproductive success and high mortality of pups and, occasionally, adults. Because El Niño events occur periodically along the California coast, and impact the population growth of fur seals at San Miguel Island, they directly influence the dynamics of this population. The total production of northern fur seals has exceeded the 1997 levels during three of the last four years with complete counts; therefore, ~~It appears that~~ the San Miguel Island population has recovered from the 1997-1998 El Niño event. ~~However, the population is still below the highest number recorded (in 1997), and does not appear to be at carrying capacity.~~

Compared to San Miguel Island, less information is known about the population of northern fur seals on the Farallon Islands. Based on tag-resight data, it appears that the population originated from emigrants from San Miguel Island. The first pup was observed on the Farallon Islands in 1996 (Pyle et al. 2001). After this discovery, annual ground surveys were conducted in early fall to document population trends of the colony (Tietz 2012). The colony increased steadily from 1996 to the early 2000s. However, the population has grown exponentially during the past several years, with an occasional decline (Tietz 2012). Because counts are conducted during the fall after the breeding season, population trends and demographic information ~~is~~are less clear than for San Miguel Island.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Currently, productivity rates for northern fur seals on the Farallon Islands are unavailable. A growth rate of 20% was calculated for northern fur seals on San Miguel Island in 1972-1982 by linear regression of the natural logarithm of pup count against year. However, it is clear that this rate of increase was due in part to immigration of females from Russian and Pribilof Islands populations (DeLong 1982). Immigration was also occurring from the early 1980s to 1997~~ and from 1998 to 2010~~. In the absence of a reliable estimate of the maximum net productivity rate for the California stock of northern fur seals, the pinniped default maximum theoretical net productivity rate (R_{MAX}) of 12% (Wade and Angliss 1997) is used as a conservative estimate of R_{MAX}.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population estimate (~~6,722~~ 7,524) times one-half the default maximum net growth rate (½ of 12%) times a recovery factor of 1.0 (for stocks of unknown status that are increasing in size: Wade and Angliss 1997), resulting in a PBR of ~~403~~ 451 northern fur seals from the California stock 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.~~

Fisheries Information

Northern fur seals taken by commercial fisheries during the winter/spring along the west coast of the continental U.S. could be from either the Eastern Pacific or California stock; therefore, any mortality or serious injury of northern fur seals reported off the coasts of California, Oregon, or Washington during December through May will be assigned to both the Eastern Pacific and California stocks of northern fur seals.~~ However, NMFS considers any takes of northern fur seals by commercial fisheries in waters off California, Oregon, and Washington as being from the California stock.~~ There were no observer reports of northern fur seal deaths or serious injuries in any observed fishery along the west coast of the continental U.S. in ~~2007-2011~~2009-2013 (Carretta and Enriquez ~~2009a, 2009b,~~ 2010, 2012a, 2012b; Jannot et al. 2011; Carretta et al. 2014a, 2015).

Table 1. Summary of available information on the incidental mortality and serious injury of the California stock of northern fur seals ~~(California stock)~~ in commercial fisheries that might take this species and calculation of the mean annual mortality and serious injury rate; n/a indicates that data are not available. Mean annual takes are based on ~~2007-2011~~2009-2013 data unless noted otherwise.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality	Mean annual takes (CV in parentheses)
Unknown West Coast fisheries	~~2007-2011~~ 2009-2013	stranding data	n/a	~~0, 0, 1, 0, 1~~ 1, 0, 2, 1, 0	n/a	≥~~0.4~~0.8 (n/a)
Minimum total annual takes						≥~~0.4~~0.8 (n/a)

Strandings of northern fur seals entangled in fishing gear or with serious injuries caused by interactions with gear are a final source of fishery-related mortality information. According to ~~Marine Mammal Stranding Network~~ stranding records~~, maintained~~ for California, ~~by the NMFS Southwest Region (NMFS, Southwest Regional Office, unpublished data) and for~~ Oregon, and Washington ~~by the NMFS Northwest Region~~ (~~NMFS, Northwest Regional Office, unpublished data~~ Carretta et al. 2014b, 2015), ~~two~~four fishery-related deaths (in unidentified net and unknown trawl fisheries ~~entanglements~~) were reported between ~~2007 and 2011~~2009 and 2013 (Table 1), resulting in a mean annual mortality and serious injury rate of ~~0.4~~0.8 California northern fur seals. 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). Two of the fishery-related deaths (one in an unidentified fishing net in February 2009 and one in trawl gear in April 2011) were also assigned to the Eastern Pacific stock of northern fur seals.~~ One~~

~~northern fur seal stranded in 2008 with serious injuries related to a hook and line fishery interaction and was treated and released with non-serious injuries (Carretta et al. 2013).~~ Two additional northern fur seals that stranded in 2012 (one in May and one in July) with serious injuries due to fishery interactions were treated and released with non-serious injuries (Carretta et al. 2014b). Both of these animals were assigned to the California stock of northern fur seals and the animal that stranded in May 2012 was also assigned to the Eastern Pacific stock.

Other Mortality

Since the Eastern Pacific and California stocks of northern fur seals overlap off the west coast of the continental U.S. during December through May, non-fishery mortality and serious injury reported off the coasts of California, Oregon, or Washington during that time will be assigned to both stocks. Mortality and serious injury of northern fur seals may occur incidental to research fishery activities. In 2007 and 2008, four northern fur seals were incidentally killed in California waters during scientific sardine trawling operations conducted by NMFS (~~NMFS, Southwest Regional Office, unpublished data~~Carretta et al. 2013): one death ~~occurred~~ in 2007 and ~~three~~one in 2008~~. After marine mammal deaths, including one northern fur seal,~~ occurred ~~in April 2008 trawls,~~before NMFS scientists ~~met to discuss and~~ implemented a mitigation plan to avoid future mortality. The initial mitigation plan included use of 162 dB acoustic pingers, a marine mammal watch, and scheduling trawls to occur when the ship first arrived on station to avoid attracting animals to a stationary vessel. Two additional northern fur seals were killed in subsequent 2008 trawls~~, including one in July and one in August. In 2009~~, so a marine mammal excluder device was added to the trawls in 2009 and no ~~additional~~ northern fur seal deaths or serious injuries were observed ~~during 42 trawls~~in this research fishery in 2009-2013. However, one northern fur seal was killed in a scientific rockfish trawling operation conducted by NMFS (~~NMFS, Southwest Regional Office, unpublished data~~Carretta et al. 2014b) in California waters in May 2009. This death was assigned to both the California and Eastern Pacific stocks of northern fur seals. The mean annual research-related mortality and serious injury rate of California northern fur seals from ~~2007 to 2011~~2009 to 2013 is ~~1.0~~0.2 ~~animal~~northern fur seals.

According to ~~the Marine Mammal Stranding Network~~ stranding records ~~maintained by the NMFS Southwest (NMFS, Southwest Regional Office, unpublished data) and Northwest Regions (NMFS, Northwest Regional Office, unpublished data)~~ for California, Oregon, and Washington (Carretta et al. 2014b, 2015), ~~six~~four human-caused northern fur seal deaths were reported from non-fisheries sources in ~~2007-2011~~2009-2013. ~~One animal was shot (in 2007) and five~~Three northern fur seals were entangled in marine debris ~~(1 in 2008, 3~~ in Oregon waters in April 2009~~, and 1 in 2011)~~, and one was entrained in the cooling water system of a California power plant in May 2012. All four of these deaths were assigned to both the California and Eastern Pacific stocks of northern fur seals. ~~resulting in a~~The mean annual mortality and serious injury rate from non-fishery sources in 2009-2013 is ~~of 1.2~~ 0.8 ~~animals~~ California northern fur seals ~~from this stock between 2007 and 2011~~. 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). ~~Two additional northern fur seals were disentangled from marine debris in 2008, treated at a rehabilitation facilities, and released with non-serious injuries (Carretta et al. 2013).~~

STATUS OF STOCK

The California northern fur seal stock is not considered to be "depleted" under the Marine Mammal Protection Act (MMPA) or listed as "threatened" or "endangered" under the Endangered Species Act. Based on currently available data, the minimum annual level of total human-caused mortality and serious injury (~~2.6~~ 1.8) does not exceed the PBR (~~403~~ 451). Therefore, the California stock of northern fur seals is not classified as a "strategic" stock. The minimum annual commercial fishery mortality and serious injury rate for this stock (~~0.4~~ 0.8) is not known to exceed 10% of the calculated PBR (~~40.3~~ 45) and, therefore, appears to be insignificant and approaching zero mortality and serious injury rate. The stock (based on San Miguel Island data) decreased 80% from 1997 to 1998, began to recover in 1999, and ~~is~~ currently ~~at 96% of~~has surpassed the 1997 level by 2%. The status of this stock relative to its Optimum Sustainable Population (OSP) level is unknown, unlike the Eastern Pacific northern fur seal stock which is formally listed as "depleted" under the MMPA.

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HAWAIIAN MONK SEAL (~~*Monachus*~~ *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 ~~considerable~~ demographic ~~independence~~ parameters (such as abundance trends and survival rates), they are connected by animal movement throughout the species' range (Johanos *et al*. 2013). Genetic ~~stock structure~~ analysis (Schultz *et al*. 2011) ~~further supports management of~~ indicates the species ~~as~~ is a single panmictic population. The Hawaiian monk seal is therefore considered a single stock. ~~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 ~~1,153~~ 1,112. This estimate is the sum of estimated abundance 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, for the second 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. ~~2012, there was a marked reduction in field effort in the NWHI due to reduced program funding. Researchers were in the field in the NWHI from 30 to 44 days at each field site; a reduction of some 50% to 80% compared to typical recent years. The short field season resulted in greater uncertainty in population abundance and trends.~~ The number of individual seals identified ~~was~~ is used as the population estimate at NWHI sites where total enumeration ~~was~~ is achieved, according to the criteria established by Baker *et al*. (2006). Where total enumeration ~~was~~ is not achieved, capture-recapture estimates from Program CAPTURE ~~were~~ are used (Baker 2004; Otis *et al*. 1978, Rexstad & Burnham 1991, White *et al*. 1982). When no reliable estimator ~~was~~ is obtainable in Program CAPTURE (i.e., the model selection criterion ~~was~~ is < 0.75, following Otis *et al*. 1978), the total number of seals identified ~~was~~ 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 ~~was~~ is used. In 2013 ~~2012~~, total enumeration was not achieved for any subpopulation, and ~~. C~~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, ~~and~~ Pearl and Hermes Reef, Midway Atoll and Kure Atoll. ~~Minimum abundance was used for Laysan Island, Midway Atoll and Kure Atoll.~~ Abundance at these six ~~main~~ NWHI subpopulations was estimated to be 781 ~~862~~ (including 104 ~~111~~ pups). Counts at Necker and Nihoa Islands are conducted from zero to a few times ~~in a single~~ per year. 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 ~~2008~~ and 2013 ~~2012~~ was 15.9 ~~16.1~~ ± 5.6 ~~5.8~~ at Necker Island and 32.3 ~~32.2~~ ± 5.7 ~~6.4~~ 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 ~~2008–2012~~ 2009-2013) are ~~49.9 ± 16.8~~ 50.0 ± 16.2 at Necker Island and ~~103.1 ± 18.5~~ 102.1 ± 16.5 at Nihoa Island.

Complete, systematic surveys for monk seals in the MHI were conducted in 2000 and 2001 (Baker and Johanos 2004). NMFS continues to collect information on seal sightings reported by a variety of sources, including a volunteer network, the public, and directed NMFS observation effort. The total number of individually identifiable seals documented in ~~2012~~ 2013 was ~~138~~ 179, the current best minimum abundance estimate for the MHI.

Minimum Population Estimate

The total number of seals (781 ~~853~~) identified at the six main NWHI reproductive sites is the best estimate of minimum population size at those sites. Minimum population sizes for Necker and Nihoa Islands (based on the formula provided by Wade and Angliss (1997)) are 38.3 and 89.3, respectively. The minimum abundance estimate for the ~~main Hawaiian Islands~~MHI in 2013 is 179 ~~138~~ seals. The minimum population size for the entire ~~stock~~

~~(~~species~~)~~ is the sum of these estimates, or 1,088 ~~1,118~~ seals.

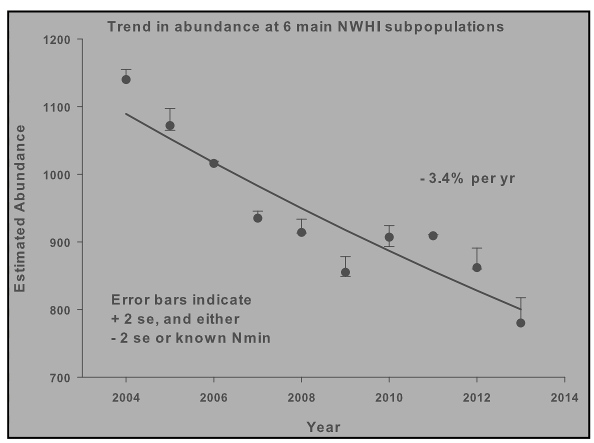
Current Population Trend

~~Current population trend~~ The total stock population trend cannot be assessed currently, because logistical factors vary such that total abundance estimates are not being obtained throughout the species' range. For example, total abundance is estimated at the ~~is based solely on the~~ six most-studied NWHI subpopulations. However, rare visits to Necker and Nihoa Islands do not allow for either total population enumeration nor capture-recapture estimates. Only a minimum abundance tally is available for the MHI, and this is suspected to be negatively-biased because very little data are available from Ni'ihau, the single island where the largest concentration of seals likely occurs.

The following describes trends within different portions of the monk seal's range. ~~because these sites have historically comprised virtually the entire species, while information on the remaining smaller seal aggregations has been inadequate to reliably evaluate abundance or trends. The total of mean non-pup beach counts at the six main reproductive NWHI subpopulations in 2012 is 69% lower than in 1958.~~ The trend in total abundance at the six ~~main~~ most-studied NWHI subpopulations estimated with a ~~as described above~~ ~~is shown in Figure 1. A~~ log-linear regression of estimated abundance on year for the past 10 years (2004-2013~~2003-2012~~) ~~estimates~~ yields a decline of ~~that abundance declined~~ -3.4 ~~-3.3~~% yr^{-1} (95% CI = -4.3~~-4.2~~% to -2.4~~-2.3~~% yr^{-1}). 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 with an intrinsic population growth rate (λ) estimated at 6.5% per year based on simulation modeling (Baker *et al*. 2011). However, the realized growth rate may differ considerably from λ, depending upon the unknown current age and sex structure. ~~Likewise, sporadic beach counts at Necker and especially Nihoa Islands, suggest positive growth.~~ 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 ~~Necker,~~ 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% ~~25%~~ of the stock's estimated total abundance in 2013 ~~2012~~. ~~Unfortunately, because of a lack reliable abundance estimates for these areas, their influence cannot currently be determined.~~ NMFS is ~~experimenting with remote camera systems that may improve data collection~~ 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% yr^{-1} 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.



~~Figure 1. Trend in abundance of monk seals at the six main Northwestern Hawaiian Islands subpopulations, based on a combination of total enumeration and capture-recapture estimates. Error bars indicate ±2 s.e. (from variances of capture-recapture estimates). Fitted log-linear regression line is shown.~~

POTENTIAL BIOLOGICAL REMOVAL

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%~~3.3%~~ a year since 2004 at the six most-studied NWHI, which comprise some 70% of total abundance.~~2002.~~ Thus, the stock's dynamics do not conform to the underlying model for calculating PBR such that PBR for the Hawaiian monk seal is undetermined.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~**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*".~~

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 ~~trend~~ issue (Table 1).

Table 1. Intentional and potentially intentional killings of Hawaiian monk seals in the MHI since 2009. 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

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 ~~2012~~ 2013, 14 ~~16~~ seals were observed hooked, ~~four of which died as a result of ingesting hooks~~ all of which either were captured and had the hooks removed, or the hooks detached without intervention. 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. These ~~foregoing~~ hookings and the spearing case were all classified as non-serious injuries, ~~The remaining 12 were non-serious hookings,~~ although ~~5~~ 7 of these would have been deemed serious had they not been mitigated by ~~capture and hook removal~~ 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 1). 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). ~~Recent q~~ 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 2. 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.

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	~~2008~~ 2009 2010 2011 2012 2013	observer observer observer observer observer	~~[21]21.7% & 100%[2]~~ 20.6% & 100%[2] 21.1% & 100%[2] 20.3% & 100%[2] 20.4% & 100%[2] 20.4% & 100%[2]	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 (0)
MHI Bottomfish[3]	~~2008~~ 2009 2010 2011 2012 2013	Incidental observations of seals	none	0 0 0 0 0	n/a	0 0 0 0 0	n/a
Nearshore[4]	~~2008~~ 2009 2010 2011 2012 2013	Incidental observations of seals	none	~~0~~ 0 1 0 4 0	n/a	~~9(3)~~ 12(3) 11(2) 9 (3) 12 (5) 15 (6)	≥1.0
Minimum total annual takes							≥ 1.0

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

[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] Observer coverage for deep and shallow-set components of the fishery, respectively.

[3] 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.

[4] 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.

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 ~~purpose-designed~~ 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., 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 ~~331~~ cases of seals entangled in fishing gear or other debris have been observed from 1982 to ~~2012~~ 2013 (Henderson 2001; NMFS, unpubl. data). Nine documented deaths resulted from entanglement in marine debris~~, including a pup at Midway Atoll in 2012~~ (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)~~. Yet~~, 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~~2003-2012~~) 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: six monk seal mortalities have been directly caused by 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.

~~While disease effects on monk seal demographic trends are uncertain, there is concern that diseases of livestock, feral animals, pets or humans could be transferred to naïve monk seals in the MHI and potentially spread to the core population in the NWHI. In 2003 and 2004, two deaths of free-ranging monk seals were attributable to diseases not previously found in the species: leptospirosis and toxoplasmosis (R. Braun, pers. comm.).~~ ~~*Leptospira* bacteria are found in many of Hawaii's streams and estuaries and are associated with livestock and rodents. Cats, domestic and feral, are a common source of toxoplasma~~.

Habitat Issues

Poor juvenile survival rates and variability in the relationship between weaning size and survival suggest that prey availability is ~~likely~~ 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 ~~considered and will be developed through an experimental approach in coming years~~ (Baker and Littnan 2008, Baker *et al*. 2013, Norris 2013). NMFS has produced a draft Programmatic Environmental Impact Statement on current and future anticipated research and enhancement activities[1]. A major habitat issue involves loss

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

of terrestrial habitat at French Frigate Shoals, where 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 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 ~~may be~~ are ample prey resources available, 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) ~~poses~~ is a very serious ~~new~~ 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~~2008-2012~~) was at least 2.6 animals, including fishery-related mortality in nearshore gillnets and hook-and-line gear (>=1/yr, Table 2), shooting-related deaths (>=0.8/yr), and blunt-force trauma deaths of unknown origin (>=0.8/yr, Table 1).

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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).

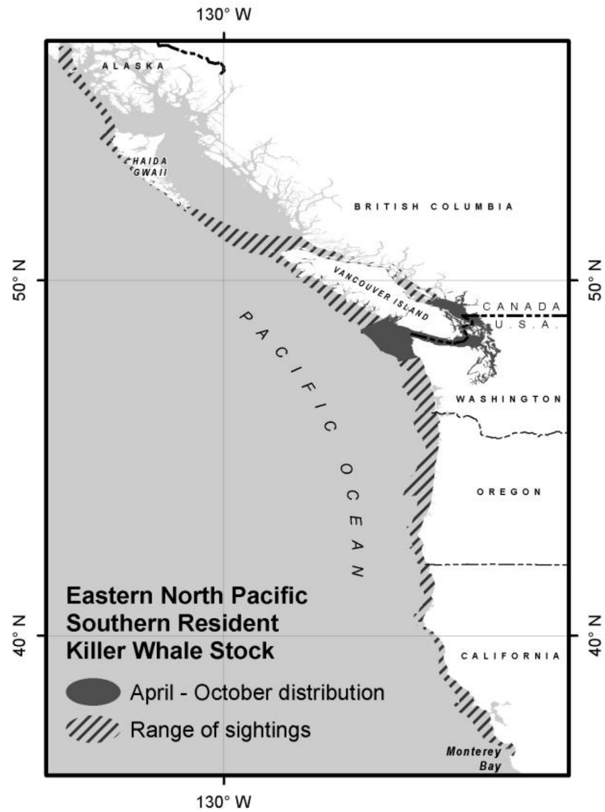

Figure 1. Approximate April - October distribution of the Eastern North Pacific Southern Resident killer whale stock (shaded area) and range of sightings (diagonal lines).

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 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 ~~82~~ 78 whales in ~~2013~~ 2014 (Fig. 2; Ford et al. 2000; Center for Whale Research, unpubl. data). 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 (J. Ford, pers. comm.). 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 ~~2012~~ 2013 through 1 July ~~2013~~ 2014 includes ~~one~~ no new calves ~~calf~~ and the deaths of one ~~three~~ post-reproductive adult female, an adult female, an adult male, and a young adult male. ~~It~~ This does not include a ~~post-~~ 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 ~~young adult male that were missing in fall 2013 a calf observed in December 2011 that did not survive six months~~ (Center for Whale Research, unpubl. data).

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 ~~82~~ 78 animals.

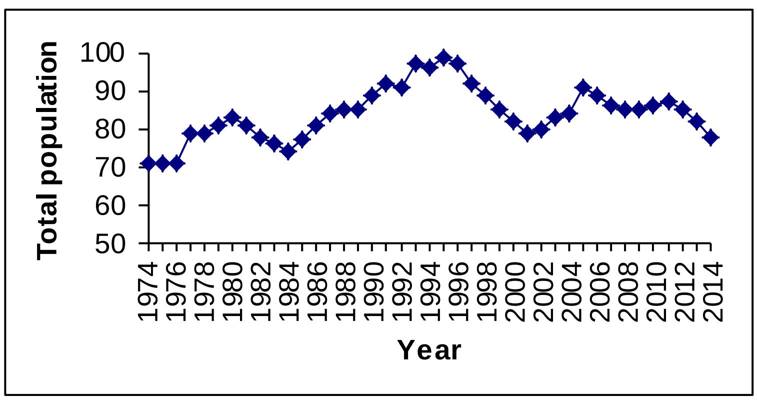

Figure 2. Population of Eastern North Pacific Southern Resident stock of killer whales, 1974-~~2013~~ 2014. Each year's count includes animals first seen and first missed; a whale is considered first missed the year after it was last seen alive (Ford et al. 2000; Center for Whale Research, unpubl. data).

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 ~~82~~ 78 animals as of the ~~2013~~ 2014 census (Ford et al. 2000; Center for Whale Research, unpubl. data).

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 (~~82~~ 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 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

~~According to Northwest Marine Mammal Stranding Network records, maintained by the NMFS Northwest Region, n~~ No human-caused killer whale mortality or serious injuries were reported from non-fisheries sources in ~~2007-2011~~ 2009-2013 (Carretta et al. ~~2013~~ 2015). 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 level of non-fishery human-caused mortality for this stock over the past five years (~~2007-2011~~ 2008-2012) 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 are formally listed as "endangered" under the ESA 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 home to a large commercial whale watch industry as well as 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' communication and foraging. 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, appear to be important in the fall (NWFSC unpubl. data). 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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BLUE WHALE (*Balaenoptera musculus musculus*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

North Pacific blue whales were once thought to belong to as many as five separate populations (Reeves *et al.* 1998), but acoustic evidence suggests only two populations, in the eastern and western north Pacific, respectively (Stafford *et al*. 2001, Stafford 2003, McDonald *et al*. 2006, Monnahan *et al*. 2014). Blue whales in the North Pacific produce two distinct, stereotypic calls that have been termed the northwestern and northeastern call types, and it has been proposed that these represent two distinct populations with some degree of geographic overlap (Stafford *et al*. 2001, Stafford 2003, Monnahan *et al*. 2014). The northeastern call predominates in the Gulf of Alaska, the U.S. West Coast, and the eastern tropical Pacific, while the northwestern call predominates from south of the Aleutian Islands to the Kamchatka Peninsula in Russia, though both call types have been recorded concurrently in the Gulf of Alaska (Stafford *et al.* 2001, Stafford 2003). Both call types are represented in lower latitudes in the central North Pacific but differ in their seasonal patterns (Stafford *et al*. 2001). Gilpatrick and Perryman (2008) showed that blue whales from California to Central America (the eastern North Pacific stock) are on average, two meters shorter than blue whales measured from historic whaling records in the central and western north Pacific. Mate *et al*. (1999) used satellite tags to show that the eastern tropical Pacific is a migratory destination for blue whales that were tagged off southern California, and photographs of blue whales on the Costa Rica Dome in the eastern tropical Pacific have matched individuals that had been previously photographed off California (Calambokidis, pers. comm.). Photographs of blue whales in California have also been matched to individuals photographed off the Queen Charlotte Islands in northern British Columbia and to one individual photographed in the northern Gulf of Alaska (Calambokidis *et al*. 2009a).

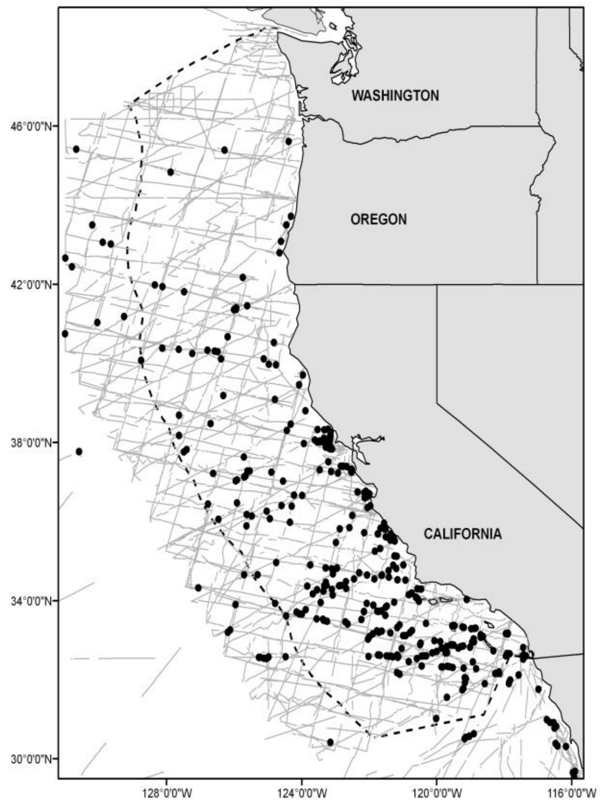

Figure 1. Blue whale sighting locations based on aerial and summer/autumn shipboard surveys off California, Oregon, and Washington, 1991-2008 (see Appendix 2 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; thin lines represent completed transect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

For the Marine Mammal Protection Act (MMPA) stock assessment reports, the Eastern North Pacific Stock of blue whales includes animals found in the eastern North Pacific from the northern Gulf of Alaska to the eastern tropical Pacific. This definition is consistent with both the distribution of the northeastern call type, photogrammetric length determinations and with the known range of photographically identified individuals. Based on locations where the northeastern call type has been recorded, some individuals in this stock may range as far west as Wake Island and as far south as the Equator (Stafford *et al*. 1999, 2001). The U.S. West Coast is certainly one of the most important feeding areas in summer and fall (Figure 1), but, increasingly, blue whales from this stock have been found feeding to the north and south of this area during summer and fall. Nine 'biologically important areas' (BIAs) for blue whale feeding are identified off the California coast by Calambokidis et al. (2015), including six in southern California and three in central California. Most of this stock is believed to migrate south to spend the winter and spring in high productivity areas off Baja California, in the Gulf of California, and on the Costa Rica Dome. Given that these migratory destinations are areas of high productivity and given the observations of feeding in these areas, blue whales can be assumed to feed year round. Some individuals from this stock may be present year-round on the Costa Rica Dome (Reilly and Thayer 1990). However, it is also possible that some Southern Hemisphere blue whales might occur north of the equator during the austral winter. One other stock of North Pacific blue whales (the Central North Pacific stock) is recognized in the Pacific Marine Mammal Protection Act (MMPA) Stock Assessment Reports.

POPULATION SIZE

The size of the feeding stock of blue whales off the U.S. West Coast ~~was~~ has been estimated recently by both line-transect and mark-recapture methods. Line-transect abundance estimates from summer/autumn research vessel surveys in the California Current ranged between approximately 400 and 800 animals from 2001 to 2008 (Barlow and Forney 2007, Barlow 2010). These estimates are considerably lower than previous line-transect estimates of approximately 1,900 animals obtained between 1991 and 1996 (Barlow 2010) (Figure 2). The lower abundance estimates appear to be related to a northward shift in the distribution of blue whales out of the study area (as far north as the Gulf of Alaska) and not a population decline (Barlow and Forney 2007, Calambokidis et al. 2009a). Mark-recapture estimates are often negatively biased by individual heterogeneity in sighting probabilities (Hammond 1986); however, Calambokidis *et al.* (2010) minimize such effects by selecting one sample that was taken randomly with respect to distance from the coast. Because some fraction of the population is always outside the survey area, the line-transect and mark recapture estimation methods provide different measures of abundance for this stock. Line transect estimates reflect the average density and abundance of blue whales in the study area during summer and autumn surveys, while mark recapture estimates provide an estimate of total population size. New photographic mark-recapture estimates of abundance for the period 2005 to 2011 presented by Calambokidis (2013) range from approximately 1,000 to 2,300 animals, with the most consistent estimates represented by a 4-yr sampling period Chao model that incorporates individual capture heterogeneity over time. The Chao model consistently yielded estimates of approximately 1,500 whales (Figure 2). The best estimate of blue whale abundance is taken from the Chao model results of Calambokidis and Barlow (2013) for the period 2008 to 2011, or 1,647 (CV=0.07) whales.

Minimum Population Estimate

The minimum population estimate for blue whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from the mark-recapture estimate, or approximately 1,551.

Current Population Trend

Mark-recapture estimates provide the best indicator of population trends for this stock, because of recent northward shifts in blue whale distribution that negatively bias line-transect estimates. Based on mark-recapture estimates shown in Figure 2, there is no evidence of a population size increase in this blue whale population since the early 1990s. While the Petersen mark-recapture estimates show an apparent increase in blue whale abundance since 1996, the estimation errors associated with these estimates are also much higher than for the Chao estimates (Figure 2). Monnahan et al. (2015) used a population dynamics model to estimate that the eastern Pacific blue whale population was at 97% of carrying capacity (95% interval 62%–99%) in 2013 and suggest that density dependence and not impacts from ship strikes, explains the observed lack of a population size increase since the early 1990s. The authors estimate that the eastern North Pacific population likely did not drop below 460 whales during the last century, despite being targeted by commercial whaling.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information exists on the overall rate of growth of blue whale populations in the Pacific (Best 1993). Based on mark-recapture estimates from the US West Coast and Baja California, Mexico, Calambokidis *et al.* (2009b) estimate a rate of increase just under 3% per year, but it is not known if that corresponds to the maximum growth rate of this stock.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,551) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.3 (for an endangered species which has a minimum abundance greater than 1,500 and a CV_{Nmin}<0.5), resulting in a

PBR of 9.3. Because whales in this stock spends approximately three quarters of their time outside the U.S. EEZ, the PBR allocation for U.S. waters is one-quarter of this total, or 2.3 whales per year.

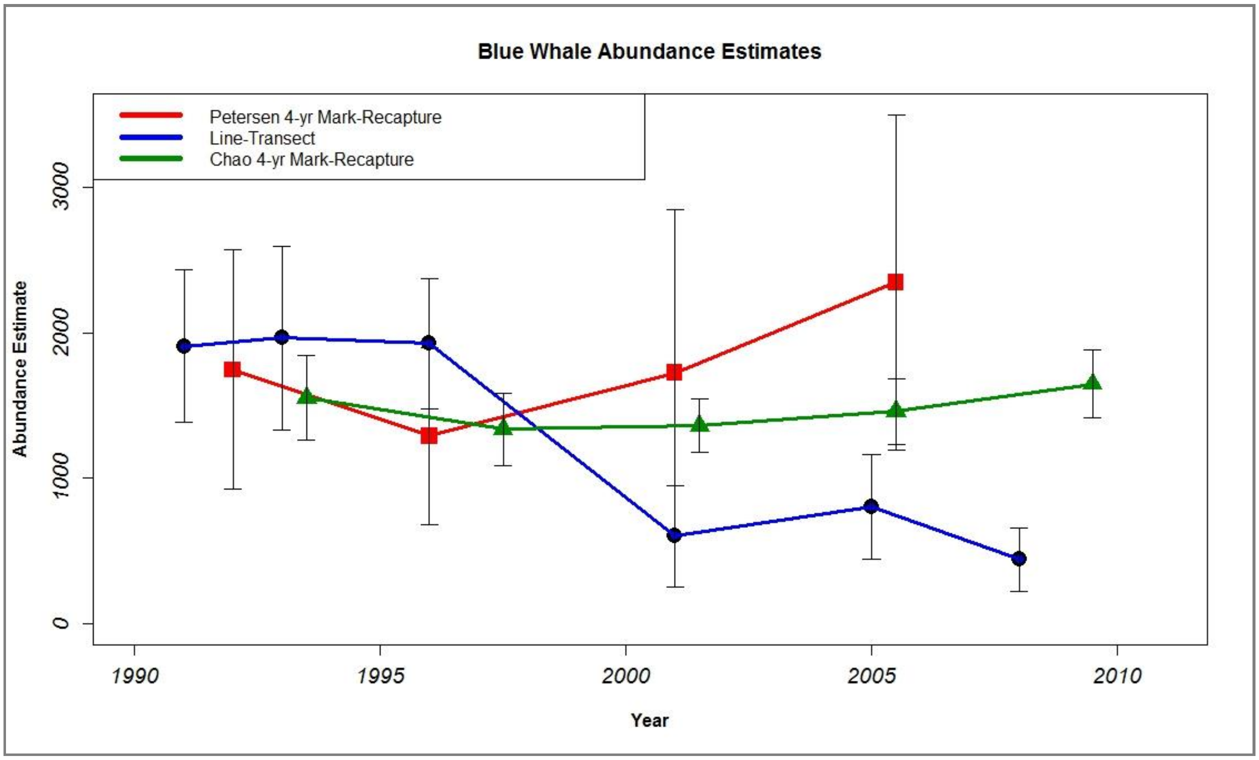

Figure 2. Estimates of blue whale abundance from line-transect and photographic mark-recapture surveys, 1991 to 2011 (Barlow and Forney 2007, Barlow 2010, Calambokidis and Barlow 2013). Vertical bars indicate ±2 standard errors of each abundance estimate.

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

The California swordfish drift gillnet fishery is the only fishery that is likely to take blue whales from this stock, but no fishery mortality or serious injuries have been observed since the observer program was initiated in 1990 (Julian and Beeson 1998, Carretta et al. 2004, Carretta and Enriquez 2009a, 2009b, 2010, 2012a, 2012b). This results in an average estimate of zero blue whales taken annually (Table 1). Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net; however, fishermen report that large rorquals ~~(blue and fin whales)~~ usually swim through nets without entangling and with very little damage to the nets.

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 blue whales (Eastern North Pacific stock) for commercial fisheries that might take this species (Carretta and Enriquez 2009a, 2009b, 2010, 2012a, 2012b). ~~Mean annual takes are based on 2007-2011 data unless noted otherwise.~~

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality (and injury)	Estimated mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~2007~~ ~~2008~~ ~~2009~~ ~~2010~~ ~~2011~~ 2001-2013	observer	~~16.4%~~ ~~13.5%~~ ~~13.3%~~ ~~11.9%~~ ~~19.5%~~ 19%	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	~~0~~ ~~0~~ ~~0~~ ~~0~~ ~~0~~ 0	0 (n/a)
Total Annual Takes						0 (n/a)

Ship Strikes

Ship strikes were implicated in the deaths of ~~nine~~ four blue whales and the serious injury of a fifth whale~~,~~ between ~~2007~~ 2009 and ~~2011~~ 2013 (Carretta *et al*. ~~2013~~2015). Five deaths occurred in 2007, the highest number recorded for any year. The remaining four ship strike deaths occurred in 2009 (2) and 2010 (2). One additional whale was seriously injured in 2010 and its prorated serious injury value is 0.56 (Carretta *et al*. 2013, 2014). During ~~2007-2011~~2009-2013, there were an additional ~~four~~ two serious injuries of unidentified large whales attributed to ship strikes, some of which may have been blue whales (Carretta *et al*. ~~2013~~2015). No methods have been developed to prorate the number of unidentified ship strike cases to species, because identified cases are likely biased towards species that are large, easy to identify, and more likely to be detected, such as blue and fin whales. Most observed blue whale ship strikes have been in the southern California Bight, where large container ship ports overlap with seasonal blue whale distribution (Berman-Kowalewski et al. 2010). Several blue whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (J. Calambokidis, pers. comm.). Including ship strike records identified to species and prorated ~~records~~serious injuries, blue whale mortality and injuries attributed to ship strikes in California waters averaged ~~1.9~~ 0.9 per year during ~~2007-2011~~2009-2013 (Carretta et al. 2015). ~~The high number of ship strikes observed in 2007 resulted in~~ NOAA previously ~~implementing~~ implemented a mitigation plan that includes NOAA weather radio and U.S. Coast Guard advisory broadcasts to mariners entering the Santa Barbara Channel to be observant for whales, along with recommendations that mariners transit the channel at 10 knots or less. The Channel Islands National Marine Sanctuary also developed a blue whale/ship strike response plan, which involved weekly overflights to record whale locations. Additional plan information can be found at http://channelislands.noaa.gov/focus/alert.html. 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%), highlighting that observed numbers are unrepresentative of true impacts (Kraus *et al*. 2005, Perrin *et al*. 2011, Williams *et al*. 2011, Prado *et al*. 2013). Due to this negative bias, Redfern *et al*. (2013) stress that the number of ship strike deaths of blue whales in the California Current likely exceeds PBR.

Impacts of ship strikes on population recovery of the eastern North Pacific blue whale population were recently assessed by Monnahan et al. (2015). Their population dynamics model incorporates data on historic whaling removals, levels of ship strikes, and projected numbers of vessels using the region through 2050. The authors conclude that this stock was at 97% of carrying capacity in 2013 and that current ship strike levels do not pose a threat to the status of this stock. Caveats to the carrying capacity analysis include~~s~~ the assumption that the population was already at carrying capacity prior to commercial whaling of this stock in the early 20th century and that carrying capacity has not changed appreciably since that time (Monnahan et al. 2015).

STATUS OF STOCK

The reported take of North Pacific blue whales by commercial whalers totaled 9,500 between 1910 and 1965 (Ohsumi and Wada 1972). Approximately 3,000 of these were taken from the west coast of North America from Baja California, Mexico to British Columbia, Canada (Tonnessen and Johnsen 1982; Rice 1992; Clapham *et al*. 1997; Rice 1974). Recently, Monnahan et al. (2014) estimated that 3,411 blue whales (95% range 2,593–4,114) were removed from the eastern North Pacific populations between 1905 and 1971. Blue whales in the North Pacific were given protected status by the IWC in 1966, but Doroshenko (2000) reported that a small number of blue whales were taken illegally by Soviet whalers after that date. As a result of commercial whaling, blue 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. Despite a current analysis suggesting that the Eastern North Pacific population is at 97% of carrying capacity (Monnahan et al. 2015), ~~eastern North Pacific blue whales~~they ~~They~~ are

~~still~~ listed as “endangered”, and consequently the Eastern North Pacific stock is automatically considered ~~as~~ a "depleted" and "strategic" stock under the MMPA. Conclusions about the population’s current status relative to carrying capacity depend upon assumptions that the population was already at carrying capacity before commercial whaling impacted the population in the early 1900s, and that carrying capacity has remained relatively constant since that time (Monnahan et al. 2015). If carrying capacity has changed significantly in the last century, conclusions regarding the status of this population would necessarily change (Monnahan et al. 2015). The observed annual incidental mortality and injury rate (~~1.9~~ 0.9/year) from ship strikes is less than the calculated PBR (2.3) for this stock, but this rate does not include unidentified large whales struck by vessels, some of which may have been blue whales, nor does it include undetected and unreported ship strikes of blue whales. The number of blue whales struck by ships in the California Current likely exceeds the PBR for this stock (Redfern *et al*. 2013). To date, no blue whale mortality has been associated with California gillnet fisheries; therefore, total fishery mortality is approaching zero mortality and serious injury rate.

Habitat Concerns

Increasing levels of anthropogenic sound in the world’s oceans (Andrew *et al*. 2002) have been suggested to be a habitat concern for blue whales (Reeves *et al*. 1998). Tagged blue whales exposed to simulated mid-frequency sonar and pseudo-random noise demonstrated a variety of behavioral responses, including no change in behavior, termination of deep dives, directed travel away from sound sources, and cessation of feeding (Goldbogen et al. 2013). Behavioral responses were highly dependent upon the type of sound source and the behavioral state of the animal at the time of exposure. Deep-feeding and non-feeding whales reacted more strongly to experimental sound sources than surface-feeding whales that typically showed no change in behavior. The authors stated that behavioral responses to such sounds are influenced by a complex interaction of behavioral state, environmental context, and prior exposure of individuals to such sound sources. One concern expressed by the authors is if blue whales did not habituate to such sounds near feeding areas that “repeated exposures could negatively impact individual feeding performance, body condition and ultimately fitness and potentially population health.” Currently, no evidence indicates that such reduced population health exists, but such evidence would be difficult to differentiate from natural sources of reduced fitness or mortality in the population. Nine blue whale feeding areas identified off the California coast by Calambokidis et al. (2015) represent a diversity of nearshore and offshore habitats that overlap with a variety of anthropogenic activities, including shipping, oil and gas extraction, and military activities.

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BRYDE'S WHALE (*Balaenoptera edeni*): Eastern Tropical Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) recognizes 3 stocks of Bryde's whales in the North Pacific (eastern, western, and East China Sea), 3 stocks in the South Pacific (eastern, western and Solomon Islands), and one cross-equatorial stock (Peruvian) (Donovan 1991). Bryde's whales are distributed widely across the tropical and warm-temperate Pacific (Leatherwood et al. 1982), and there is no real justification for splitting stocks between the northern and southern hemispheres (Donovan 1991). Recent surveys (Lee 1993; Wade and Gerrodette 1993) have shown them to be common and distributed throughout the eastern tropical Pacific with a concentration around the equator east of 110°W (corresponding approximately to the IWC's "Peruvian stock") and a reduction west of 140°W. They are also the most common baleen whale in the central Gulf of California (Tershy et al. 1990). ~~Only one was positively identified in surveys of California coastal waters (Barlow 1997).~~ Sightings and acoustic recordings of Bryde's whales in southern California waters have increased in the past decade (Kerosky *et al.* 2012, Smultea *et al.* 2012), possibly signaling a northward range expansion (Kerosky *et al.* 2012). Acoustic recordings indicate Bryde's whales are present in southern California waters from summer through early winter (Kerosky *et al.* 2012). At least seven sightings have been documented in southern / central California waters between 1991 and 2014 (Barlow and Forney 2007, Smultea *et al.* 2012, NMFS unpublished data). Bryde's whales in California are likely to belong to a larger population inhabiting at least the eastern part of the tropical Pacific. Acoustic call types of Bryde's whales in southern California waters match a type found along the west coast of Baja California (Kerosky *et al.* 2012). For the Marine Mammal Protection Act (MMPA) stock assessment reports, Bryde's whales within the Pacific U.S. Exclusive Economic Zone are divided into two areas: 1) the eastern tropical Pacific (east of 150°W and including the Gulf of California and waters off California; this report), and 2) Hawaiian waters.

~~**Figure 1.** Sighting locations of Bryde's whales based on aerial and shipboard surveys off California, Oregon, and Washington, 1991–2005 (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.~~ This figure is being deleted from the stock assessment report.

POPULATION SIZE

In the western North Pacific, Bryde's whale abundance in the early 1980s was estimated independently by tag mark-recapture and ship survey methods to be 22,000 to 24,000 (Tillman and Mizroch 1982; Miyashita 1986). Bryde's whale abundance has never been estimated for the entire eastern Pacific; however, a portion of that stock in the eastern tropical Pacific was estimated ~~recently~~ as 13,000 (CV=0.20; 95% C.I.=8,900-19,900) (Wade and Gerrodette 1993), and the minimum number in the Gulf of California ~~is~~ was estimated at 160 based on individually-identified whales (Tershy et al. 1990). The most recent verified sighting in California waters occurred in 2014 during a systematic line-transect survey designed to estimate cetacean abundance (NMFS unpublished data). That sighting did not occur during standard search effort and thus, no estimate of abundance will be available from the 2014 survey. ~~Only one confirmed sighting of Bryde's whales and five possible sightings (identified as sei or Bryde's whales) were made in California waters during extensive ship and aerial surveys between 1991 and 2005 (Barlow 2003b; Hill and Barlow 1992; Carretta and Forney 1993; Forney 2007; Mangels and Gerrodette 1994; VonSaunder and Barlow 1999). Green et al. (1992) did not report any sightings of Bryde's whales in aerial surveys off Oregon and Washington. The only sighting of Bryde's whale in this region occurred during a survey over 10 years ago, thus, there is no current estimate of abundance for California, Oregon, and Washington waters.~~

Minimum Population Estimate

The only minimum estimate of Bryde's whale abundance for the eastern tropical Pacific (11,163; Wade and Gerrodette 1993) is over 8 years old and thus, no current estimate of minimum abundance is available.

Current Population Trend

There are no data on trends in Bryde's whale abundance in the eastern tropical Pacific.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of Bryde's whale populations in the Pacific (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock cannot be calculated because a current abundance estimate is unavailable. ~~the only relevant abundance estimate (Wade and Gerrodette 1993) is more than 8 years old. Additional data on the abundance of Bryde's whales in the eastern Pacific was collected during line transect ship surveys between 1998 and 2006 but abundance estimates are currently unavailable.~~

HUMAN CAUSED MORTALITY

Historic Whaling

The reported take of North Pacific Bryde's whales by commercial whalers totaled 15,076 in the western Pacific from 1946-1983 (Holt 1986) and 2,873 in the eastern Pacific from 1973-81 (Cooke 1983). In addition, 2,304 sei-or-Bryde's whales were taken in the eastern Pacific from 1968-72 (Cooke 1983) (based on subsequent catches, most of these were probably Bryde's whales). None were reported taken by shore-based whaling stations in central or northern California between 1919 and 1926 (Clapham et al. 1997) or 1958 and 1965 (Rice 1974). There has been a prohibition on taking Bryde's whales since 1988.

Table 1. Summary of available information on the incidental mortality and injury of Bryde's whales (eastern tropical Pacific stock) for commercial fisheries that might take this species (~~Julian 1997; Julian and Beeson 1998; Cameron and Forney 1999~~ Carretta *et al*. 2014a, 2012a, 2012b, Carretta and Enriquez 2009, 2010; Carretta *et al*. 2004). n/a indicates that data are not available. Mean annual takes are based on ~~1994-98~~ 2001-2013 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	~~2000-2004~~ 2001-2013	observer	~~20-23%~~ 19%	~~0,0,0,0,0~~ 0	~~0,0,0,0,0~~ 0	0
~~**Mexico thresher**~~	~~1991-95~~	~~observer~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~

~~**shark/swordfish drift gillnet fishery**~~						
Total annual takes						0

Fishery Information

The offshore drift gillnet fishery is the only fishery that is likely to take Bryde's whales from this stock, but no fishery mortalities or serious injuries have been observed (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 2003a).~~ Mean annual takes for this fishery are zero (Table 1) and are based on ~~2000-2004~~2001-2013 data, the period during which a season/area closure has limited most fishing to southern California waters. ~~This results in an average estimate of zero Bryde's whales taken annually. However~~ Although no Bryde's whales have been observed entangled in California gillnets, some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net.

~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California 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 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 1990-95 (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 may occasionally kill Bryde's whales as they are known to kill their larger relatives: blue and fin whales. ~~No ship strikes have been reported for this species in this area. During 2000-2004, there were five injuries and three mortalities of unidentified large whales attributed to ship strikes, but it is unlikely that any of these were Bryde's whales.~~ One Bryde's whale was documented to have been killed by a ship strike in 2010 (Carretta et al. 2014b, Carretta et al. 2015). The whale was initially sighted alive in Washington state waters with propeller marks and stranded dead about a week later. The mean annual serious injury and mortality rate of Bryde's whales over the most recent 5-year period (2009-2013) is 0.2 whales annually.

STATUS OF STOCK

Commercial whaling of Bryde's whales was largely limited to the western Pacific. Bryde's whales are not listed as "threatened" or "endangered" under the Endangered Species Act (ESA). Bryde's whales in the eastern tropical Pacific would not be considered a strategic stock under the MMPA. The total human-caused mortality rate is 0.2 whales annually. Current abundance of this stock is unknown and therefore PBR cannot be calculated for this stock. Likewise, human-caused mortality cannot be evaluated in the context of PBR. ~~estimated to be zero~~; ~~therefore, under the MMPA, total fishery mortality is approaching zero mortality and serious injury rate.~~ 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.

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Revised 9/23/2015 ~~7/2/2015~~

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 ~~One on-effort sighting of false killer whales was made during a 2002 shipboard survey, and six during a 2010 shipboard survey of waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands~~ (Figure 1; Barlow 2006, Bradford et al. 2014)~~.~~ and focused studies near the ~~Smaller-scale surveys conducted around the~~ main and Northwestern Hawaiian Islands ~~(Figure 2)~~ indicate ~~show~~ that false killer whales occur ~~are also encountered~~ in near shore waters throughout the Hawaiian archipelago (~~Baird et al. 2005, Mobley et al. 2000~~Baird et al 2008, 2013)~~, and a single on-effort and three off-effort sightings during the 2010 Hawaiian Islands Cetacean Ecosystem Assessment Survey (HICEAS) shipboard survey reveal that the species also occurs near shore in the Northwestern Hawaiian Islands (Baird et al. 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).

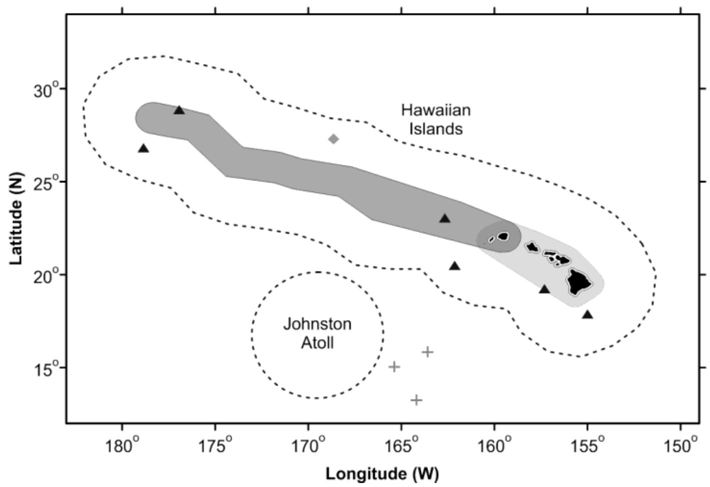

Figure 1. False killer whale on-effort sighting locations during standardized shipboard surveys of the Hawaiian Islands U.S. EEZ (2002, gray diamond, Barlow 2006; 2010, black triangles, Bradford et al. 2014, pelagic waters of the central Pacific south of the Hawaiian Islands (2005, gray crosses, Barlow 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. ~~2007,~~ 2010; Martien et al. 2011, 2014). ~~Chivers et al. (2010)~~Martien et al. (2014) ~~expanded on previous analyses~~ 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. ~~using additional samples and including analysis of 8 nuclear DNA (nDNA) microsatellites,~~ An analysis using mtDNA reveals~~ing~~ strong phylogeographic patterns consistent with local evolution of haplotypes ~~nearly~~ unique to false killer whales occurring nearshore within the Hawaiian Archipelago and ~~.~~assessment of nuDNA suggests that NWHI false killer whales are at least as differentiated from MHI animals as they are from offshore animals. ~~Analysis of 21 additional samples collected during HICEAS in 2010 reveals significant differentiation in both mitochondrial DNA (mtDNA) and nDNA between false killer whales found near the MHI and the NWHI (Martien et al. 2011).~~ 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).

~~NWHI confirms that they do not associate with individuals near the MHI south of Kauai (Baird et al. 2013). Two false killer whales previously photographed near Kauai were seen in groups observed near Nihoa in the NWHI, and are not known to associate with animals from the MHI, suggesting geographic overlap of MHI and NWHI false killer whale populations near Kauai~~ 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).

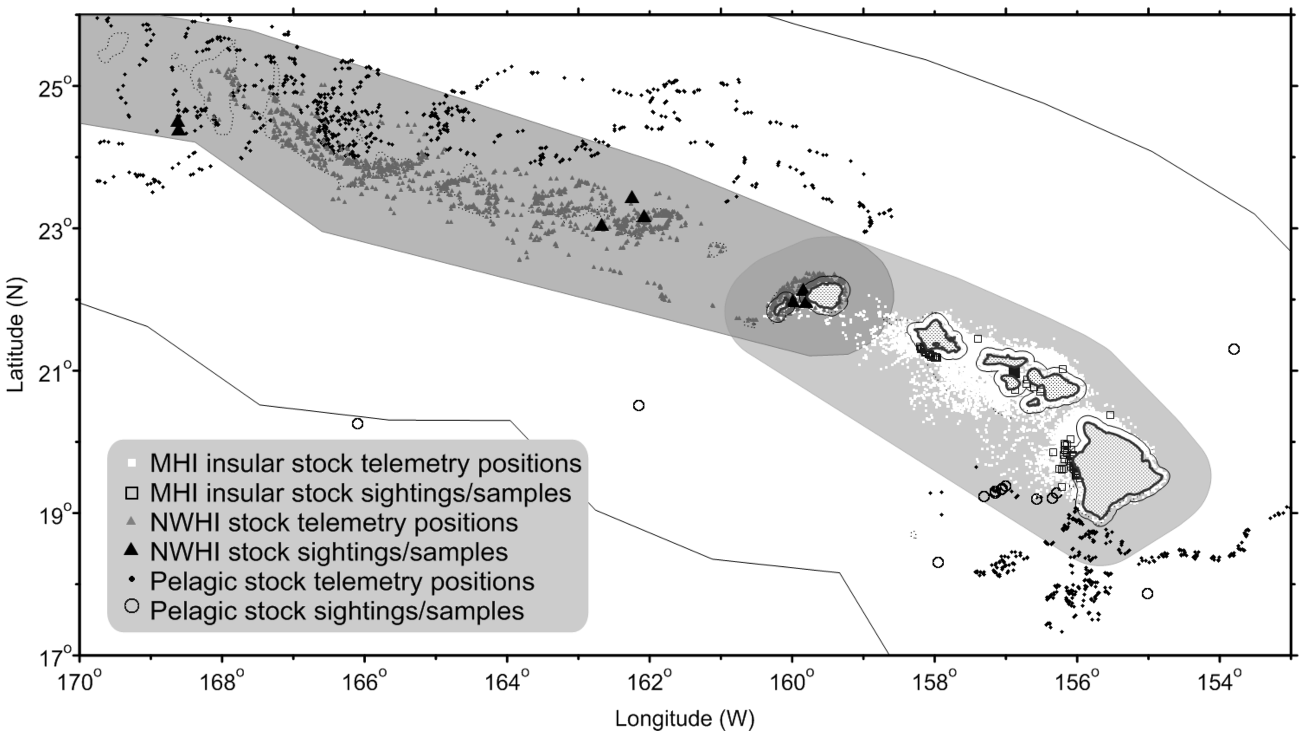

Figure 2. Sighting, biopsy sample, and telemetry record~~s~~ locations of false killer whale identified as being part of the MHI insular (square symbols), NWHI (triangle symbols), or pelagic (circle ~~open and cross~~ symbols) stocks. ~~The dark gray area is the 40-km MHI insular core area; light gray area is the 40-km to 140-km MHI insular-pelagic overlap zone (Baird et al. 2010, Baird et al. 2013,; reproduced from Forney et al. 2010); medium gray area is the 50-nmi (93-km) Monument boundary extended to the east to encompass Kauai, representing the NWHI stock boundary~~ 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 the MHI (reproduced from Bradford et al 2015).~~–~~ The MHI insular, pelagic, and NWHI stocks overlap ~~in the vicinity of Kauai.~~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). The stocks have partially overlapping ranges. MHI insular false killer whales have been satellite tracked ~~seen~~ as far as 115~~112~~ km from the main Hawaiian Islands, while pelagic stock animals have been tracked to ~~seen~~ within ~~42~~11 km of the main Hawaiian Islands and throughout the NWHI~~(Baird et al. 2008, Baird 2009, Baird et al. 2010, Forney et al. 2010)~~. 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~~2, Martien et al. 2011~~). 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). ~~Animals seen within 40 km of each of the main Hawaiian Islands from Hawaii Island to Oahu are considered to belong to the MHI insular stock. Waters within 40 km of Kauai and Niihau are an overlap zone between the MHI insular and NWHI stocks, as individuals from both populations are known to occur there. Animals seen within 93 km of the NWHI, inside the Papahānaumokuākea Marine National Monument may belong to either the NWHI or pelagic stock, as animals from both stocks have been seen inside the Monument. Animals beyond 140 km of the MHI and beyond 93 km of the NWHI are considered to belong to the pelagic stock. The MHI insular and pelagic stocks overlap between 40 km and 140 km from shore contiguously between Oahu and Hawaii Island. All three stocks overlap within 40 km and 93 km around Kauai and Niihau, and the MHI insular and pelagic stocks overlap from 93 km to 140 km around these islands (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. ~~2007,~~ 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 ~~(Forney et al. 2011, Martien et al. 2011)~~: 1) the Main Hawaiian Islands insular stock, which includes animals inhabiting waters within a modified 72km radius around ~~140 km (approx. 75 nmi) of~~ the main Hawaiian Islands, 2) the Northwestern Hawaiian Islands stock, which includes animals inhabiting waters within the Papahānaumokuākea Marine National Monument and to the east around Kauai~~93 km (50 nmi) of the NWHI and Kauai~~, 3) the Hawaii pelagic stock, which includes false killer whales inhabiting waters greater than ~~40~~11 km ~~(22 nmi)~~ 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, NMFS/PIR unpublished data). 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 ~~permitted~~ 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~~gillnet~~ fisheries because these fisheries are not observed or monitored for protected species bycatch.

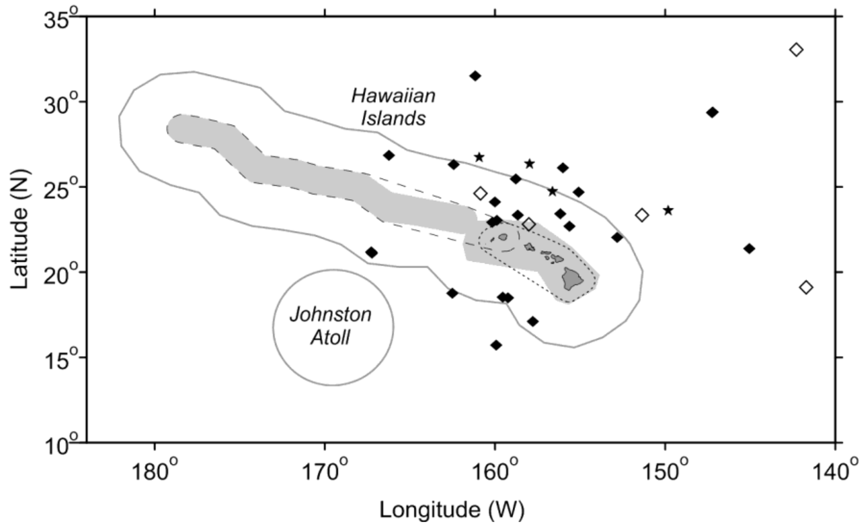

Figure 3. Locations of observed false killer whale takes (black symbols~~diamonds~~) and possible takes (blackfish) of this species (open symbols~~diamonds~~) in the Hawaii-based longline fisheries, 2009-2013~~2008-2012~~. Takes occurring prior to the implementation of Take-Reduction Plan (2009-2012) regulations are shown as diamonds, and those since the TRP regulations (2013) 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~~outer (140-km) boundary of the overlap zone between MHI insular and pelagic false killer whale stocks~~; the dashed line is the ~~93-km boundary of the~~ NWHI stock area; both MHI and NWHI stocks overlap with the pelagic stock. ~~t~~The gray shaded area represents the ~~is the February-September~~ longline exclusion zone, implemented year-round since December 31, 2012, and Papahānaumokuākea Marine National Monument. Both areas are currently closed to longline fishing.

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).

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 2015~~2014~~). 5-yr ~~M~~mean annual takes are presented for 2008-2012, prior to the implementation of the TRP, for 2013 due to changes in fishing gear under the TRP intended to reduce serious injury rate, and for 2009-2013 assuming no significant change in mortality rate. ~~based on 2008-2012 estimates unless otherwise indicated (a new alternative was explored in this report for prorating among three stocks).~~ Information on all observed takes (T) and combined mortality & serious injury is included. ~~Total takes were prorated to deaths, serious injuries, and non-serious injuries based on the observed proportions of each outcome.~~ 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. ~~and do not yet incorporate additional uncertainty introduced by prorating false killer whale takes in the overlap zone and prorating the takes of unidentified blackfish.~~ Values of '0' presented with no further precision are based on observation at 100% coverage and are not estimates.

Fishery Name	Year	Data Type	Percent Observer Coverage	Observed takes: FKW T/MSI UB T/MSI — Outside U.S EEZ	Observed takes: FKW T/MSI UB T/MSI — Within Hawaii EEZ	Estimated M&SI (CV): Pelagic Stock — Outside U.S EEZ	Estimated M&SI (CV): Pelagic Stock — Within Hawaii EEZ	Estimated M&SI (CV): MHI insular Stock	Estimated M&SI (CV): NWHI Stock
Hawaii-based deep-set longline fishery	2008	Observer data	22%	0 0	3/3 3/3	0 (-)	16.20 (0.4)	0.30 (0.4)	0.51 (1.1)
	2009		21%	7/7 0	3/3 0	38.52 (0.2)	11.81 (0.9)	0.22 (0.8)	0.37 (1.3)
	2010		21%	1/1 0	3/2 1/1	5.56 (1.5)	13.16 (0.4)	0.36 (0.5)	0.17 (1.0)
	2011		20%	0 1/0	3/2 1/1	2.24 (3.6)	12.24 (0.4)	0.11 (0.6)	0.25 (1.2)
	2012		20%	0 1/1	3/2* 0	3.55 (2.3)	12.99 (0.4)	0.07 (3.9)	1.61 (1.3)
	2013		20%	3/1 0	1/1 0	6.60 (0.9)	4.06 (1.4)	0.04 (1.9)	0.00 (-)
Pre-TRP Mean Estimated Annual Take (CV) 2008-2012						**9.97 (0.4)**	**13.28 (0.2)**	**0.21 (0.4)**	**0.58 (0.8)**
Estimated Annual Take (CV) under TRP [2013 only]						**6.60 (0.9)**	**4.06 (1.4)**	**0.04 (1.9)**	**0 (-)**
Mean Estimated Annual Take (CV) 2009-2013						**11.29 (0.3)**	**10.85 (0.3)**	**0.15 (0.5)**	**0.49 (0.9)**
Hawaii-based shallow-set longline fishery	2008	Observer data	100%	0 1/1	1/0 0	0.59	0.00	0	0.00
	2009		100%	0 0	1/1 0	0	0.99	0	0.01
	2010		100%	0 0	0 0	0	0	0	0
	2011		100%	0 1/1	1/0 0	0.70	0.00	0	0
	2012		100%	0 0	1/0 0	0	0.32	0	0.01
	2013		100%	0 0	0 0	0	0	0	0
Mean Annual Takes (100% coverage) 2008-2012						**0.26**	**0.27**	**0**	**0.00**
Mean Annual Take (CV) under TRP [2013 only]						**0**	**0**	**0**	**0**
Mean Annual Takes (100% coverage) 2009-2013						**0.14**	**0.27**	**0**	**0.00**
Pre-TRP Minimum total annual takes within U.S. EEZ (2008-2012)							**13.55 (0.2)**	**0.21 (0.4)**	**0.58 (0.8)**
Minimum total take under TRP within U.S. EEZ [2013 only]							**4.06 (1.4)**	**0.04 (1.9)**	**0 (-)**

Minimum total annual takes within U.S EEZ (2009-2013)	11.12 (0.3)	0.15 (0.5)	0.49 (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.

Fishery Name	Year	Data Type	Percent Observer Coverage	Observed total interactions (T), observed mortality events and serious injuries (MSI), and total estimated mortality and serious injury (MSI) of false killer whales by stock / EEZ region							
				Hawaii Pelagic Stock				Main Hawaiian Islands Insular Stock		Northwestern Hawaiian Islands Stock	
				Outside U.S. EEZs		Hawaiian EEZ					
				Obs. FKW T/MSI Obs. UB T/MSI	Estimated MSI (CV)	Obs. FKW T/MSI Obs. UB T/MSI	Estimated MSI (CV)	Obs. FKW T/MSI Obs. UB T/MSI	Estimated MSI (CV)	Obs. FKW T/MSI Obs. UB T/MSI	Estimated MSI (CV)
Hawaii-based deep-set longline fishery	2008	Observer data	22%	0 0	0 (-)	3/3 3/3	17 (0.4)	0 0	0 (-)	0 0	0 (-)
	2009		21%	7/7 0	39 (0.2)	3/3 0	12 (0.6)	0 0	0 (-)	0 0	0 (-)
	2010		21%	1/1 0	6 (1.4)	3/2 1/1	14 (0.4)	0 0	0 (-)	0 0	0 (-)
	2011		20%	0 1/0	2 (2.0)	2/2 1/1*	12 (0.5)	0 1/1*	0 (-)	0 0	0 (-)
	2012		20%	0/0 1/1	4 (2.0)	3/2* 0/0	8 (0.4)	2/2* 0/0	4 (0.4)	2/2* 0/0	1 (0.4)
Mean Estimated Annual Take (CV)					9.9 (0.4)		12.7 (0.2)		0.9 (2.0)		0.4 (1.5)
Hawaii-based shallow-set longline fishery	2008	Observer data	100%	0 1/1	0	1/0 0	0	0 0	0	0 0	0
	2009		100%	0 0	0	1/1 0	1	0 0	0	0 0	0
	2010		100%	0 0	0	0 0	0	0 0	0	0 0	0
	2011		100%	0 1/1	0	1/0 0	0	0 0	0	0 0	0
	2012		100%	0 0	0	1/0 0	0	0 0	0	0 0	0
Mean Annual Takes (100% coverage)					0		0.3		0		0
Minimum total annual takes within U.S. EEZ							13.0 (0.2)		0.9 (2.0)		0.4 (1.5)

~~* False killer whale and unidentified blackfish takes within the Hawaiian stock overlap zones are shown once for each stock. Within the MHI insular and pelagic overlap zones, total estimates derived from these takes are first prorated among potentially affected stocks based on the distance from shore of the take location (see text, and McCracken 2010). Then, within the 3-way NWHI/MHI insular/pelagic overlap zone, the estimates were further prorated based on the relative level of fishing effort in each zone and the density of each stock within each zone, as an alternative to assigning the entire estimated insular take to both insular stocks (MHI and NWHI).~~

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~~Longline Exclusion Area~~ around the main Hawaiian Islands. Stock Assessment Reports generally describe fishery interaction details for the most recent five years, and as such, only years 2009 through 2013 are described here. Year 2008 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 2009~~2008~~ and 2013~~2012~~, three~~four~~ 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 ~~22~~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 ~~2014~~2015). The severity of injuries resulting from interactions with longline gear is determined b~~B~~ased 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 ~~, three animals taken in the~~ SSLL fishery, one was considered seriously injured, one was ~~within the Hawaii EEZ were~~ considered not seriously injured and one could not be determined based on the information provided by the observer~~was considered seriously injured~~. In the DSLL fishery, 13 false killer whales were taken within the Hawaiian EEZ. Two of those takes occurred within the pelagic-NWHI overlap zone north of Kauai in 2012 before this area was closed to longline fishing and both animals were considered to be seriously injured. Of the remaining 11 interactions within the Hawaiian EEZ, all were within the range of the pelagic stock, and eight were considered seriously injured, one was not considered seriously injured, and two could not be determined based on the information provided by the observer. Outside of the Hawaii EEZ, one animal was dead, eight were considered seriously injured, and two were not considered seriously injured. ~~one taken in Hawaiian waters within the range of the pelagic stock was considered not seriously injured and the level of injury could not be determined for one additional animal based on the observer's descriptions of the interactions. The remaining 20 false killer whales taken in the DSLL fishery, eight in high seas waters and ten in the Hawaiian Islands EEZ pelagic stock range, and two in the three-way overlap zone between the pelagic, MHI insular, and NWHI stocks were considered seriously injured (Bradford & Forney 2014). Eight~~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. ~~seriously injured during 2008-2012 (Bradford & Forney 2014). Additionally, one unidentified blackfish was taken on the high seas in the deep set longline fishery in 2011, but was not seriously injured (Table 1). Six of the eight seriously injured false killer whales were taken in the DSLL fishery within U.S. EEZ waters, including one animal within the MHI insular/pelagic stock overlap zone and the remaining two seriously injured false killer whales were taken by the SSLL fishery on the high seas (Table 1 and Figure 3).~~

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). Following the implementation of the TRP these historic averages were not used. The allocation of estimated serious versus non-serious injuries in 2013 take was based on the proportion of serious versus non-serious injuries of observed takes in 2013 (McCracken 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~~140km of the Main Hawaiian Islands~~ must be prorated to MHI insular, pelagic, or NWHI stocks. No genetic samples are available to establish stock identity for the~~se~~ two takes inside the NWHI-pelagic overlap zone north of Kauai, ~~takes, but all~~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. ~~2008~~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~~each species~~ 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 ~~total~~ false killer whale take ~~estimates~~are calculated by summing the annual false killer whale take ~~within~~ and the annual blackfish take prorated as false killer whale within each region (McCracken 2015) ~~140km of the MHI are first prorated to the MHI insular or pelagic stock assuming that the density of MHI insular stock animals declines and pelagic stock density increases with distance from shore as in the methods of McCracken (2010)~~. Within the Hawaii EEZ, annual takes are then apportioned to each stock overlap zone and the pelagic-only stock area based on relative annual fishing effort and relative stock density in each zone, through the following process. 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. The zonal bycatch estimates are then multiplied by the relative density of each stock in the respective zone to prorate bycatch to stock. 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. 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.

~~With the McCracken (2010) proration between MHI insular and pelagic stocks as a starting point, two alternatives were examined for allocating takes among the 3 stocks in the 140-km overlap zone. The first alternative partitioned the take within the 140-km zone among the 2 and 3-way overlap zones based on the relative level of fishing effort in each zone. Because a much greater proportion of fishing has occurred in the 2-way overlap zone between MHI insular and pelagic false killer whales than in the smaller overlap zone between all three stocks, the majority of takes were assigned to the 2-way overlap zone. The distance-from-shore model implemented by McCracken (2010) provides a relative probability of occurrence and density of MHI insular versus pelagic stock take within the 140km region given individual take locations in each year. Relative density and take rate were used within the 3-way overlap zone to compute an assumed constant proportion of take between these two stocks among the overlap zones. The NWHI stock density was then joined with these adjusted MHI insular and pelagic stock densities, and the total take estimate for that zone was prorated among the three stocks based on their relative densities in this zone. A similar approach was used to prorate take between the NWHI and pelagic stocks in a small area of overlap outside of 140km that is open to longline fishing. First, total pelagic stock take outside of 140km was partitioned based on the distribution of fishing effort in the NWHI-pelagic stock overlap and pelagic-only zones, then the take assigned to the small NWHI-pelagic overlap zone was prorated between stocks based on the relative densities of each stock. Using this approach, the 5-yr annual mortality and serious injury estimates of MHI insular, NWHI, and pelagic stocks are 0.9, 0.4, and 13.0, respectively.~~

~~As an alternative to this approach, GAMMS suggests assigning all take within an overlap zone to all potentially affected stocks. Using this approach all MHI insular stock take within the 140-km zone estimated following the initial proration (McCracken 2010) could be assigned to both MHI insular and NWHI stocks. This approach results in 5-yr annual mortality and serious injury estimates of MHI insular and NWHI stocks of 1.0, and a pelagic stock estimated take of 13.0. The overall status of each stock relative to PBR does not change versus the first approach described above.~~

~~The first proration approach is preferred because it uses information about the geographic distribution of fishing effort and the relative densities of false killer whales to partition take among stocks.~~ Based on this approach~~ese bycatch analyses, including the new alternative 3-way proration~~, estimates of annual ~~and 5-yr average annual~~ mortality and serious injury of false killer whales, by stock and EEZ area, are shown in Table 1. A 5-yr average mortality and serious injury estimate is provided for years 2008-2012, a single year estimate is provided for 2013 given the change in fishing regulations that occurred with the implementation of the TRP, and a 5-yr average is provided for years 2009-2013 assuming no significant change in mortality rate within the fishery (Table 1). ~~Estimates of mortality and serious injury (M&SI) include a pro-rated portion of the animals categorized as unidentified blackfish (UB). Although annual M&SI estimates are shown as whole numbers of animals, the 5-yr average M&SI is calculated based on the unrounded annual estimates.~~ 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.

~~Because of high rates of false killer whale mortality and serious injury in Hawaii-based longline fisheries, a Take Reduction Team (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 the DSLL and SSLL fisheries. The Team submitted a draft Take Reduction Plan (Plan) to NMFS (http://www.nmfs.noaa.gov/pr/pdfs/interactions/fkwtrp_draft.pdf), and NMFS published a final Plan 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 Plan became effective December 31, 2012, with gear requirements effective February 27, 2013. Additionally, the Plan includes non-regulatory measures that NMFS will implement to improve data quality and dissemination to the Team and the public. These measures were not in effect during 2008-2012, the period for which bycatch was estimated in this report. Bycatch estimation methods will need to be adjusted when 2013 takes are considered to account for changes in fishing gear and captain training intended to reduce the false killer whale serious injury rate.~~

MAIN HAWAIIAN ISLANDS INSULAR STOCK

POPULATION SIZE

~~A photographic mark-recapture study during 2000-2004 around the main Hawaiian Islands produced an estimate of 123 (CV=0.72) MHI insular false killer whales (Baird et al. 2005). This abundance estimate is based in part on data collected more than 8 years ago, and is considered outdated as a measure of current abundance (NMFS 2005).~~ 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 ~~new~~ estimates were based on ~~more recent sighting histories and~~ open population models, ~~yielding more precise estimates~~ for the two time periods. The ~~new~~ 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).

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~~2009-2012~~ photo-identification studies, or ~~138~~92 false killer whales (Baird et al. 2015~~unpublished data~~). Recent mark-recapture estimates (Oleson et al. 2010) of abundance are known to have a positive bias of unknown magnitude due to missed matches, 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 (~~138~~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 ~~0.3~~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~~s~~ 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 year 2013, the estimate of mortality and serious injury (0) is below the PBR (0.18), and even if no change in mortality rates is assumed under the TRP, the mortality and serious injury to MHI insular false killer whales for 2009-2013 (0.15) is less than PBR (0.18). ~~Because the rate of mortality and serious injury to MHI insular false killer whales (0.9 animals per year) exceeds the PBR (0.3 animals per year)~~, ~~t~~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. Further, effects of other threats have yet to be assessed, e.g., nearshore hook and line fishing, which is still common within the MHI insular stock range, and environmental contamination. 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~~1,552~~ (CV=0.66) false killer whales outside of ~~40~~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 ~~40~~11 km from the main Hawaiian Islands (Bradford et al. 2014, 2015) or ~~935~~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.

Current Population Trend

No data are available on current population trend. It is incorrect to interpret the increase in the abundance estimate from 2002 to 2010 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, 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 (~~935~~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 ~~9.4~~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.~~ No habitat issues are known to be of concern for this stock.~~ 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 ~~Because the~~ rate of mortality and serious injury to pelagic stock false killer whales within the Hawaiian Islands EEZ (~~13.0~~13.6 animals per year) exceed~~s~~ed the PBR (~~9.4~~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. Although the estimated mortality and serious injury of false killer whales within the HI EEZ during 2013 (4.1) is below the PBR (9.3), 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, the number of false killer whale takes during 2014 (for which no overall bycatch estimates are yet available), are the highest recorded 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. 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 2009-2013 (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 ~~552 (CV = 1.09)~~ 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. ~~Although~~ 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~~2014~~) or ~~262~~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 (~~262~~290) 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 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 ~~2.6~~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. ~~Ylitalo et al. (2009) documented e~~Concentrations of ~~levated levels of~~ polychlorinated biphenyls (PCBs) exceeded proposed threshold levels for health effects in 84% of sampled MHI insular false killer whales~~ in three of nine Hawaii insular false killer whales sampled~~ (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.~~, and b~~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 for 2013, 0.5 for 2009-2013) is less than the PBR (2.3 animals per year), ~~The estimated average annual human-caused mortality and serious injury from longline fisheries for this stock (0.4 animals per year) is less than the PBR (2.6),~~ 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 ~~However, given the current recognized geographic range of this stock~~ is ~~largely~~ 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 below 10% of PBR.

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Appendix 3. 2015 Draft Pacific Marine Mammal Stock Assessment Reports. S=strategic stock; N=non-strategic stock. Shaded lines indicate reports revised in 2015. unk=unknown, undet=undetermined, n/a=not applicable.

Species	Stock Area	NMFS Center	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.	SWC	296,750	n/a	153,337	0.12	1	9,200	389	331	N	2007	2008	2011	2014
Harbor seal	California	SWC	30,968	n/a	27,348	0.12	1	1,641	43	30	N	2004	2009	2012	2014
Harbor seal	Oregon/Washington Coast	AKC	unk	unk	unk	0.12	1	undet	10.6	7.4	N	1999			2013
Harbor seal	Washington Northern Inland Waters	AKC	unk	unk	unk	0.12	1	undet	9.8	2.8	N	1999			2013
Harbor seal	Southern Puget Sound	AKC	unk	unk	unk	0.12	1	undet	3.4	1	N	1999			2013
Harbor seal	Hood Canal	AKC	unk	unk	unk	0.12	1	undet	0.2	0.2	N	1999			2013
Northern Elephant Seal	California breeding	SWC	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	SWC	7,408	n/a	3,028	0.12	0.5	91	0	0	S	1993			2000
Northern Fur Seal	California	AKC	14,050	n/a	7,524	0.12	1	451	1.8	≥0.8	N	2010	2011	2013	2015
Monk Seal	Hawaii	PIC	1,112	n/a	1,088	0.07	0.1	undet	≥2.6	≥1.0	S	2010	2011	2013	2015
Harbor porpoise	Morro Bay	SWC	2,917	0.41	2,102	0.04	0.5	21	≥0.6	≥0.6	N	2002	2007	2012	2013
Harbor porpoise	Monterey Bay	SWC	3,715	0.51	2,480	0.04	0.5	25	0	0	N	2002	2007	2011	2013
Harbor porpoise	San Francisco – Russian River	SWC	9,886	0.51	6,625	0.04	0.5	66	0	0	N	2002	2007	2011	2013
Harbor porpoise	Northern CA/Southern OR	SWC	35,769	0.52	23,749	0.04	1	475	≥0.6	≥0.6	N	2002	2007	2011	2013
Harbor porpoise	Northern Oregon/Washington Coast	AKC	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	AKC	10,682	0.38	7,841	0.04	0.4	63	≥2.2	≥2.6	N	1996	2002	2003	2011
Dall's porpoise	California/Oregon/Washington	SWC	42,000	0.33	32,106	0.04	0.4	257	≥0.4	≥0.4	N	2001	2005	2008	2010
Pacific white-sided dolphin	California/Oregon/Washington	SWC	26,930	0.28	21,406	0.04	0.4	171	17.8	11.8	N	2001	2005	2008	2013
Risso's dolphin	California/Oregon/Washington	SWC	6,272	0.30	4,913	0.04	0.4	39	1.6	1.6	N	2001	2005	2008	2010
Common Bottlenose dolphin	California Coastal	SWC	323	0.13	290	0.04	0.5	2.4	0.2	0.2	N	2000	2004	2005	2008
Common Bottlenose dolphin	California/Oregon/Washington Offshore	SWC	1,006	0.48	684	0.04	0.4	5.5	≥2.0	≥2.0	N	2001	2005	2008	2013
Striped dolphin	California/Oregon/Washington	SWC	10,908	0.34	8,231	0.04	0.5	82	0	0	N	2001	2005	2008	2010
Common dolphin, short-beaked	California/Oregon/Washington	SWC	411,211	0.21	343,990	0.04	0.5	3,440	64	64	N	2001	2005	2008	2010
Common dolphin, long-beaked	California	SWC	107,016	0.42	76,224	0.04	0.4	610	13.8	13	N	2005	2008	2009	2012
Northern right whale dolphin	California/Oregon/Washington	SWC	8,334	0.40	6,019	0.04	0.4	48	4.8	3.6	N	2001	2005	2008	2010
Killer whale	Eastern North Pacific Offshore	SWC	240	0.49	162	0.04	0.5	1.6	0	0	N	2001	2005	2008	2010
Killer whale	Eastern North Pacific Southern Resident	NWC	78	n/a	78	0.035	0.1	0.14	0	0	S	2012	2013	2014	2015
Short-finned pilot whale	California/Oregon/Washington	SWC	760	0.64	465	0.04	0.4	4.6	0	0	N	2001	2005	2008	2010
Baird's beaked whale	California/Oregon/Washington	SWC	847	0.81	466	0.04	0.5	4.7	0	0	N	2001	2005	2008	2013
Mesoplodont beaked whales	California/Oregon/Washington	SWC	694	0.65	389	0.04	0.5	3.9	0	0	S	2001	2005	2008	2013
Cuvier's beaked whale	California/Oregon/Washington	SWC	6,590	0.55	4,481	0.04	0.5	45	0	0	S	2001	2005	2008	2013
Pygmy Sperm whale	California/Oregon/Washington	SWC	579	1.02	271	0.04	0.5	2.7	0	0	N	2001	2005	2008	2010
Dwarf sperm whale	California/Oregon/Washington	SWC	unk	unk	unk	0.04	0.5	undet	0	0	N	2001	2005	2008	2010
Sperm whale	California/Oregon/Washington	SWC	2,106	0.58	1,332	0.04	0.1	2.7	1.7	1.7	S	2001	2005	2008	2014
Gray whale	Eastern North Pacific	SWC	20,990	0.05	20,125	0.062	1.0	624	132	4.25	N	2009	2010	2011	2014
Gray whale	Western North Pacific (new report)	SWC	140	0.04	135	0.062	0.1	0.06	unk	unk	S			2011	2014
Humpback whale	California/Oregon/Washington	SWC	1,918	0.03	1,855	0.08	0.3	11.0	≥ 5.5	≥ 4.4	S	2009	2010	2011	2013
Blue whale	Eastern North Pacific	SWC	1,647	0.07	1,551	0.04	0.3	2.3	0.9	0	S	2005	2008	2011	2015

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Species	Stock Area	NMFS Center	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
Fin whale	California/Oregon/Washington	SWC	3,051	0.18	2,598	0.04	0.3	16	2.2	0.6	S	2001	2005	2008	2013
Sei whale	Eastern North Pacific	SWC	126	0.53	83	0.04	0.1	0.17	0	0	S	2001	2005	2008	2010
Minke whale	California/Oregon/Washington	SWC	478	1.36	202	0.04	0.5	2.0	0	0	N	2001	2005	2008	2010
Bryde's whale	Eastern Tropical Pacific	SWC	unk	unk	unk	0.04	0.5	undet	unk	unk	N	n/a	n/a	n/a	2015
Rough-toothed dolphin	Hawaii	SWC	6,288	0.39	4,581	0.04	0.5	46	unk	unk	N		2002	2010	2013
Rough-toothed dolphin	American Samoa	PIC	unk	unk	unk	0.04	0.5	undet	unk	unk	unk	n/a	n/a	n/a	2010
Risso's dolphin	Hawaii	SWC	7,256	0.41	5,207	0.04	0.5	42	0.6	0.6	N		2002	2010	2013
Common Bottlenose dolphin	Hawaii Pelagic	SWC	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	SWC	184	0.11	168	0.04	0.5	1.7	unk	unk	N	2003	2004	2005	2013
Common Bottlenose dolphin	O'ahu	SWC	743	0.54	485	0.04	0.5	4.9	unk	unk	N	2002	2003	2006	2013
Common Bottlenose dolphin	4 Islands Region	SWC	191	0.24	156	0.04	0.5	1.6	unk	unk	N	2002	2003	2006	2013
Common Bottlenose dolphin	Hawaii Island	SWC	128	0.13	115	0.04	0.5	1.1	unk	unk	N	2002	2003	2006	2013
Pantropical Spotted dolphin	Hawaii Pelagic	PIC	15,917	0.40	11,508	0.04	0.5	115.0	0	0	N		2002	2010	2013
Pantropical Spotted dolphin	O'ahu	PIC	unk	unk	unk	0.04	0.5	undet	unk	unk	N			n/a	2013
Pantropical Spotted dolphin	4 Islands Region	PIC	unk	unk	unk	0.04	0.5	undet	unk	unk	N			n/a	2013
Pantropical Spotted dolphin	Hawaii Island	PIC	unk	unk	unk	0.04	0.5	undet	unk	unk	N			n/a	2013
Spinner dolphin	Hawaii Pelagic	PIC	unk	unk	unk	0.04	0.5	undet	0	0	N		2002	2010	2013
Spinner dolphin	Hawaii Island	PIC	631	0.04	585	0.04	0.5	5.9	unk	unk	N	1994	2003	2011	2013
Spinner dolphin	Oahu / 4 Islands	PIC	355	0.09	329	0.04	0.5	3.3	unk	unk	N	1993	1998	2007	2013
Spinner dolphin	Kaua'I / Ni'ihau	PIC	601	0	509	0.04	0.5	5.1	unk	unk	N	1995	1998	2005	2013
Spinner dolphin	Kure / Midway	PIC	unk	unk	unk	0.04	0.5	undet	unk	unk	N		1998	2010	2013
Spinner dolphin	Pearl and Hermes Reef	PIC	unk	unk	unk	0.04	0.5	undet	unk	unk	N			n/a	2013
Spinner dolphin	American Samoa	PIC	unk	unk	unk	0.04	0.5	undet	unk	unk	unk			n/a	2010
Striped dolphin	Hawaii Pelagic	PIC	20,650	0.36	15,391	0.04	0.5	154	unk	unk	N		2002	2010	2013
Fraser's dolphin	Hawaii	PIC	16,992	0.66	10,241	0.04	0.5	102	0	0	N		2002	2010	2010
Melon-headed whale	Hawaiian Islands	PIC	5,794	0.20	4,904	0.04	0.5	49	0	0	N		2002	2010	2013
Melon-headed whale	Kohala Resident	PIC	447	0.12	404	0.04	0.5	4.0	0	0	N			2009	2013
Pygmy killer whale	Hawaii	PIC	3,433	0.52	2,274	0.04	0.5	23.0	0	0	N		2002	2010	2013
False killer whale	Northwestern Hawaiian Islands	PIC	617	1.11	290	0.04	0.4	2.3	0.5	0.5	N			2010	2015
False killer whale	Hawaii Pelagic	PIC	1,540	0.66	928	0.04	0.4	9.3	11.2	11.2	S		2002	2010	2015
False killer whale	Palmyra Atoll	PIC	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	PIC	151	0.20	92	0.04	0.1	0.18	0.21	0.21	S	2012	2013	2014	2015
False killer whale	American Samoa	PIC	unk	unk	unk	0.04	0.5	undet	unk	unk	unk	n/a	n/a	n/a	2010
Killer whale	Hawaii	PIC	101	1.00	50	0.04	0.5	1.0	0	0	N		2002	2010	2013
Pilot whale, short-finned	Hawaii	PIC	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	PIC	2,338	1.13	1,088	0.04	0.5	11.0	0	0	N		2002	2010	2013
Longman's Beaked Whale	Hawaii	PIC	4,571	0.65	2,773	0.04	0.5	28.0	0	0	N		2002	2010	2013
Cuvier's beaked whale	Hawaii Pelagic	PIC	1,941		1,142	0.04	0.5	11.4	0	0	N		2002	2010	2013

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Species	Stock Area	NMFS Center	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
Pygmy sperm whale	**Hawaii**	**PIC**	**unk**	**unk**	**unk**	**0.04**	**0.5**	**undet**	**0**	**0**	**N**		**2002**	**2010**	**2013**
Dwarf sperm whale	**Hawaii**	**PIC**	**unk**	**unk**	**unk**	**0.04**	**0.5**	**undet**	**0**	**0**	**N**		**2002**	**2010**	**2013**
Sperm whale	**Hawaii**	**PIC**	**3,354**	**0.34**	**2,539**	**0.04**	**0.1**	**10.2**	**0.7**	**0.7**	**S**		**2002**	**2010**	**2013**
Blue whale	**Central North Pacific**	**PIC**	**81**	**1.14**	**38**	**0.04**	**0.1**	**0.1**	**0**	**0**	**S**		**2002**	**2010**	**2013**
Fin whale	**Hawaii**	**PIC**	**58**	**1.12**	**27**	**0.04**	**0.1**	**0.1**	**0**	**0**	**S**		**2002**	**2010**	**2013**
Bryde's whale	**Hawaii**	**PIC**	**798**	**0.28**	**633**	**0.04**	**0.5**	**6.3**	**0**	**0**	**N**		**2002**	**2010**	**2013**
Sei whale	**Hawaii**	**PIC**	**178**	**0.90**	**93**	**0.04**	**0.1**	**0.2**	**0.2**	**0.2**	**S**		**2002**	**2010**	**2013**
Minke whale	**Hawaii**	**PIC**	**unk**	**unk**	**unk**	**0.04**	**0.5**	**undet**	**0**	**0**	**N**		**2002**	**2010**	**2013**
Humpback whale	**American Samoa**	**SWC**	**unk**	**unk**	**150**	**0.106**	**0.1**	**0.4**	**0**	**0**	**S**	**2006**	**2007**	**2008**	**2009**
Sea Otter	**Southern**	**USFWS**	**2,826**	**n/a**	**2,723**	**0.06**	**0.1**	**8**	**≥0.8**	**≥0.8**	**S**	**2006**	**2007**	**2008**	**2008**
Sea Otter	**Washington**	**USFWS**	**n/a**	**n/a**	**1,125**	**0.2**	**0.1**	**11**	**≥0.2**	**≥0.2**	**N**	**2006**	**2007**	**2008**	**2008**