U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 2012 (DRAFT)

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Stock assessment reports and appendices revised in 2012 are highlighted; all others will be reprinted in the as they appear in the 2011 Pacific Region Stock Assessment Reports (Carretta *et al.* 2012).

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. The 2012 Pacific marine mammal stock assessments include revised reports for 15 Pacific marine mammal stocks under NMFS jurisdiction, including 5 "strategic" stocks: Hawaiian monk seal, Southern Resident killer whale, Hawaii Insular false killer whale, Hawaii Pelagic false killer whale, and California/Oregon/Washington Sperm Whale; and 10 "non-strategic" stocks: Long-beaked common dolphin, Eastern North Pacific Gray Whale, Northwestern Hawaiian Islands false killer whale, Palmyra Atoll false killer whale, Hawaii Island spinner dolphin, Oahu/4 Islands spinner dolphin, Kauai/Niihau spinner dolphin, Pearl and Hermes Reef spinner dolphin, Midway Atoll/Kure spinner dolphin, and Hawaii Pelagic spinner dolphin. Information on the remaining Pacific region stocks can be found in the final 2011 reports (Carretta *et al.* 2012). The stock assessment report for Palmyra false killer whale now appears separately from false killer whale reports that focus on the Hawaiian Islands region and a new stock of Northwestern Hawaiian Islands false killer whales is presented for the first time. New abundance estimates are available for 8 stocks (Hawaiian monk seal, Long-beaked common dolphin, Southern Resident killer whale, 3 stocks of spinner dolphin (Hawaii Island, Oahu/4 Islands, and Kauai/Niihau), Hawaii Pelagic false killer whale and Northwestern Hawaiian Islands false killer whale). The stock assessment report for gray whales is now included in the Pacific Region stock assessment reports. Stock Assessments for Alaska region marine mammals are published by the National Marine Mammal Laboratory (NMML) in a separate report.

Pacific region stock assessments include those studied by the Southwest Fisheries Science Center (SWFSC, La Jolla, California), the Pacific Islands Fisheries Science Center (PIFSC, Honolulu, Hawaii), the National Marine Mammal Laboratory (NMML, Seattle, Washington), and the Northwest Fisheries Science Center (NWFSC, Seattle, WA).

Draft versions of the 2012 stock assessment reports were reviewed by the Pacific Scientific Review Group at the November 2011 meeting.

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.

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

References:

Carretta, J.V., K.A. Forney, E. Oleson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, D. Lynch, L. Carswell, R.L. Brownell Jr., J. Robbins, D.K. Mattila, K. Ralls, and Marie C. Hill. 2012. U.S. Pacific Marine Mammal Stock Assessments: 2011. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-488, 356 p.

Wade, P.R. and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12. Available from Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD. 93p.

Cover photograph: Gray whale off Sakhalin Island, Russia. Photographed by Dave Weller.

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HAWAIIAN MONK SEAL (*Monachus schauinslandi*)

STOCK DEFINITION AND GEOGRAPHIC RANGE

Hawaiian monk seals are distributed ~~predominantly in six~~ throughout the Northwestern Hawaiian Islands (NWHI), with subpopulations at French Frigate Shoals, Laysan Island~~, and~~ Lisianski Island~~s~~, Pearl and Hermes Reef, Midway Atoll, ~~and~~ Kure Atoll, and Necker and Nihoa Islands. ~~Small numbers~~ They also occur ~~at Necker, Nihoa, and~~ throughout the main Hawaiian Islands (MHI). Genetic variation among ~~NWHI~~ Hawaiian monk seals is extremely low and may reflect ~~both~~ a long-term history at low population levels and more recent human influences (Kretzmann et al. 1997, 2001, Schultz et al. 2009). On average, 10-15% of the seals migrate among the NWHI subpopulations (Johnson and Kridler 1983; Harting 2002). Thus, the NWHI subpopulations are not isolated, though ~~the~~ different island subpopulations have exhibited considerable demographic independence. Observed interchange of individuals among the NWHI and MHI regions is uncommon, and genetic stock structure analysis (Schultz et al. 2011 ~~in review~~) supports management of the species as a single stock.

POPULATION SIZE

The best estimate of the total population size is ~~1,125~~ 1,212. 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. The number of individual seals identified was used as the population estimate at NWHI sites where total enumeration was achieved, according to the criteria established by Baker et al. (2006). Where total enumeration was not achieved, capture-recapture estimates from Program CAPTURE were used (Baker 2004; Otis et al. 1978, Rexstad & Burnham 1991, White et al. 1982). When no reliable estimator was obtainable in Program CAPTURE (i.e., the model selection criterion was < 0.75, following Otis et al. 1978), the total number of seals identified was the best available estimate. Finally, 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 used. In ~~2008~~ 2010, total enumeration was ~~not definitively~~ achieved at Laysan Island and Midway Atoll based on ~~any site, however~~ analysis of discovery curves (Baker et al. 2006). ~~suggested that nearly all seals were identified at Lisianski Island,and Midway Atoll~~. ~~Laysan Island and Kure Atoll.~~ ~~Except at Midway Atoll, capture-recapture analysis either found no suitable estimator was available or the estimate was lower than known minimum abundance.~~ Capture-recapture estimates larger than known minimum abundance were available for ~~French Frigate Shoals,~~ Lisianski Island and Pearl and Hermes Reef ~~Kure Atoll~~. Thus, abundance at the six main subpopulations was estimated to be ~~855~~ 893 (including ~~118~~ 147 pups). ~~Monk seals also occur~~ Counts at Necker and Nihoa Islands ~~, where counts~~ are conducted from zero to a few times in a single 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 ~~2005~~ 2006 and ~~2009~~ 2010 was ~~16.7 (±5.6)~~ 16.0 ±6.6 at Necker Island and ~~29.2 (±6.4)~~ 32.1 (±6.6) at Nihoa Island ~~(Johanos and Baker in press, in prep., Johanos in prep.)~~. The relationship between mean counts and total abundance at the reproductive sites indicates that ~~the~~ 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 2006-2010 ~~2004-2008)~~ are ~~51.3 (±16.2)~~ 49.2 (±19.1) at Necker Island and ~~93.4 (±18.5)~~ 102.4 (±19.1) at Nihoa Island.

~~The only c~~ Complete, systematic surveys for monk seals in the MHI were conducted in 2000 and 2001 (Baker and Johanos 2004). NMFS continues to collect~~s~~ information on seal sightings reported by a variety of sources, including a volunteer network, reports from the public and directed NMFS observation effort. The total number of individually identifiable seals documented ~~in this way~~ in ~~2009~~ 2010 was ~~125~~ 153, the current best minimum abundance estimate for the MHI.

Minimum Population Estimate

The total number of seals (~~849~~ 893) 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 ~~40 and 79~~ 36 and 88, respectively. The minimum abundance estimate for the main Hawaiian Islands in 2008 is ~~125~~ 153 seals. The minimum population size for the entire stock (species) is the sum of these estimates, or ~~1,093~~ 1,170 seals.

Current Population Trend

Current population trend is based solely on the six NWHI subpopulations because these sites have historically comprised virtually the entire species, while information on the remaining smaller seal aggregations have been inadequate to reliably evaluate abundance or trends. The total of mean non-pup beach counts at the six main reproductive NWHI subpopulations in ~~2008~~ 2010 is ~~68%~~ 71% lower than in 1958. The trend in total abundance at the six main NWHI subpopulations estimated as described above is shown in Figure 1. A log-linear regression of estimated abundance on year for the past 10 years (~~1999-2008~~ 2001-2010) estimates that abundance declined ~~-4.5%~~ 4.0% yr^{-1} (95% CI = ~~-5.1% to -3.9%~~ -4.7% to -3.2% yr^{-1}).

The MHI monk seal population appears to be increasing with an intrinsic population growth rate estimated at ~~5.6%~~ 6.5% per year based upon ~~Leslie matrix analysis~~ simulation modeling (Baker et al. ~~2010~~ 2011). 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 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 ~~24%~~ 25% of the stock's estimated total abundance in ~~2009~~ 2010. Unfortunately, because of a lack reliable abundance estimates for these areas, their influence cannot currently be determined. A remote camera system is slated for installation ~~in 2011~~ on Nihoa Island, which should result in improved abundance information at this site.

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. ~~Since 2000, low juvenile survival, thought to be due largely to food limitation, has resulted in population decline in the six main NWHI subpopulations (Fig. 1).~~

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 ~~4.5%~~ 4.0% a year since ~~1999~~ 2000. 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

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 trends at several sites appear to have been determined by human disturbance from military or U.S. Coast Guard activities (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. Three seals (including a pregnant female) were shot and killed in the MHI in 2009 (Baker et al. 2010). This level

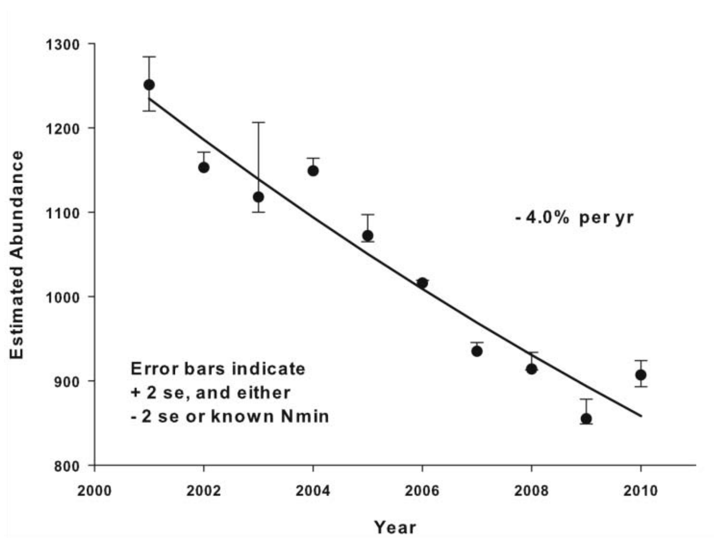

Figure 1. Trend in abundance of monk seals at the six main Northwestern Hawaiian Islands subpopulations, based on a combination of total enumeration and capture–recapture estimates. Error bars indicate ±2 s.e. (from variances of capture-recapture estimates). Fitted log-linear regression line is shown.

of intentional killing is unprecedented in recent decades and represents a disturbing new threat to the species. More seals are likely intentionally killed than are reported or discovered.

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 State of Hawaii managed nearshore fisheries. ~~Three~~ Four seals have been ~~found~~ confirmed dead in nearshore gillnets (in 1994, 2006, 2007, and 2010), and one additional seal in 2010 may have also died in similar circumstances but the carcass was not recovered. A seal was also found dead in 1995 with a hook lodged in its esophagus. A total of ~~64~~ 75 seals have been observed with embedded hooks in the MHI during 1989~~-2009~~ 2010 (including ~~12~~ 11 in ~~2009~~ 2010, none of which constituted serious injuries ~~entered in Table 1~~) . Several incidents, including the dead hooked seal mentioned above, involved hooks used to catch ulua (jacks, *Caranx* spp.). ~~Interactions in the MHI appear to be on the rise, as m~~ Most reported hookings have occurred since 2000, and six ~~five~~ seals have been observed entangled in nearshore gillnets during 2002~~-2009~~ -2010 (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 seal-mounted video revealed some 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 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 individuals. These results highlight the need to better understand potential ecological interactions with the MHI bottomfish handline fishery.

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 (NMFS 2002). 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 either the swordfish or tuna components of the longline fishery have been observed. Possible reduction of monk seal prey by the NWHI lobster fishery has also been raised as a concern, though whether the fishery indirectly affected monk seals remains unresolved. However, the NWHI lobster fishery closed in 2000. In 2006, the Northwestern Hawaiian Islands (later renamed *Papahanaumokuokea*) Marine National Monument was established. Subsequent regulations prohibited commercial fishing in the Monument, except for the bottomfish fishery (and associated pelagic species catch), which had potential to continue until 2011 (U.S. Department of Commerce and Department of the Interior, 2006). However, in 2009 the remaining permit holders surrendered their permits to NMFS in exchange for compensation from the Federal Government and the fishery was closed. ~~The total NWHI bottomfish catch in 2009 was 29 metric tons.~~

Table 1. Summary of mortality and 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	Mean Takes (CV)
Pelagic Longline	2006	observer	22.1% & 100%[1]	0	0	0 (0)
	2007	observer	20.1% & 100%[1]	0	0	
	2008	observer	21.7% & 100%[1]	0	0	
	2009	observer	20.6% & 100%[1]	0	0	
	2010	observer	21.1% & 100%[1]	0	0	
NWHI Bottomfish	2004	observer	18.3%	0	0	0 (0)
	2005	observer	25.0%	0	0	
	2006	observer	3.9%	0	0	

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

MHI Bottomfish[1]	2006 2007 2008 2009 2010	Incidental observations of seals	none	0 0 0 0 0	n/a	n/a
Nearshore[2]	2006 2007 2008 2009 2010	Incidental observations of seals	none	~~1~~2 ~~1~~2 3 4 1	n/a	n/a

Fishery Mortality Rate

Total fishery mortality and serious injury cannot be 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 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 countries), 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 the 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 ~~298~~ 311 cases of seals entangled in fishing gear or other debris have been observed from 1982 to ~~2009~~ 2010 (Henderson 2001; NMFS, unpubl. data), including eight documented deaths resulting from entanglement in marine debris (Henderson 1990, 2001; NMFS, unpubl. data). The fishing gear fouling the reefs and beaches of the NWHI and entangling monk seals only rarely includes types used in Hawaii fisheries. For example, trawl net and monofilament gillnet accounted for approximately 35% and 34% 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, 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

From1982 to 1994, 23 seals (many of which had been in poor health when brought into captivity) died during rehabilitation efforts. Additionally, two died in captivity, two died when captured for translocation, one was euthanized (an aggressive male known to cause mortality), four died during captive research and four died during field research (Baker and Johanos 2002; NMFS unpubl. data).

Other sources of mortality that impede recovery include food limitation (see Habitat Issues below), single and intra-species multiple-male aggression (mobbing), shark predation, and disease/parasitism. Multiple-male aggression has primarily been identified as a problem at Laysan and Lisianski Islands, though it has also been documented at other subpopulations. Past removals of adult males from Laysan Island effectively reduced, but did not entirely eliminate, male-aggression caused mortality at this site (Johanos et al. 2010).

Attacks by single adult male seals have resulted in several monk seal deaths, most notably at French Frigate Shoals in 1997, where at least 8 pups died from this cause. Many more pups were likely killed in the same way but the cause of their deaths could not be confirmed. Two males that killed pups in 1997 were translocated to Johnston Atoll, 870 km to the southwest. Subsequently, mounting injury to pups has decreased.

Shark-related injury and mortality incidents appeared to have increased in the late 1980s and early 1990s at French Frigate Shoals, but such mortality was probably not the primary cause of the decline at this site (Ragen 1993). However, shark predation has accounted for a significant portion of pup mortality in recent years. At French

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1 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.

2 Includes seals entangled/drowned in nearshore gillnets, recognizing that it is not possible to determine whether the nets involved were being used for commercial purposes.

Frigate Shoals in 1999, 17 pups were observed injured by large sharks, and at least 3 were confirmed to have died from shark predation (Johanos and Baker 2001). As many as 22 pups of a total 92 born at French Frigate Shoals in 1999 were likely killed by sharks. After 1999, losses of pups to shark predation have been fewer, but this source of mortality remains a serious concern. Various mitigation efforts have been undertaken by NMFS (Gobush 2010), yet shark predation remains a serious problem at French Frigate Shoals. 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.

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 OSP and has not recovered from past declines. Therefore, the Hawaiian monk seal is characterized as a strategic stock.

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 are being considered and will be developed through an experimental approach in coming years (Baker and Littnan 2008). NMFS has produced ~~is currently developing~~ a draft Programmatic Environmental Impact Statement on current and future anticipated research and enhancement activities[1]. A major habitat issue involves loss 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, Littnan and Johnston, 2006).

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). ~~Preliminary studies to describe the foraging habitat of monk seals in the MHI are reported in Littnan et al. (2006)~~. Cahoon (2011) described diet and foraging behavior of MHI monk seals, and found no striking difference in prey selection between the NWHI and MHI.

Degradation of the seawall at Tern Island, French Frigate Shoals, created entrapment hazards for seals and other wildlife and raised concerns about the potential release of toxic wastes into the ocean. The USFWS began construction on the Tern Island sea wall in 2004 to reduce entrapment hazards and protect the island shoreline. 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 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 1.2 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 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. Thus, issues surrounding monk seals in the main Hawaiian Islands will likely become an increasing focus for management and recovery of this species.

REFERENCES

Antonelis, G. A., J. D. Baker, T. C. Johanos, R. C. Braun, and A. L. Harting. 2006. Hawaiian monk seal (*Monachus schauinslandi*): Status and Conservation Issues.Atoll Res. Bull. 543:75-101.Bailey, A. M. 1952. The Hawaiian monk seal. Museum Pictorial, Denver Museum of Natural History 7:1-32.

Baker, J. D. 2004. Evaluation of closed capture-recapture methods to estimate abundance of Hawaiian monk seals,

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

Monachus schauinslandi. Ecological Applications 14:987-998.
Baker J.D. 2008. Variation in the relationship between offspring size and survival provides insight into causes of mortality in Hawaiian monk seals. Endangered Species Research 5:55-64.
Baker, J.D., A.L. Harting, and T.C. Johanos. 2006. Use of discovery curves to assess abundance of Hawaiian monk seals. Marine Mammal Science 22:847-861.
Baker J.D., A. L. Harting, T. A. Wurth, and T. C, Johanos. 2011. Dramatic shifts in Hawaiian monk seal distribution predicted from divergent regional trends. Marine Mammal Science 27(1): 78–93.
Baker, J.D. and T. C. Johanos. 2003. Abundance of Hawaiian monk seals in the main Hawaiian Islands. Biological Conservation 116:103-110.
Baker, J.D. and T. C. Johanos. 2002. Effects of research handling on the endangered Hawaiian monk seal. Mar. Mamm. Sci. 18:500-512.
Baker J.D., and Littnan CL. 2008. Report of the Hawaiian Monk Seal Captive Care Workshop, Honolulu, Hawaii, June 11–13, 2007. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Pacific Islands Fish. Sci. Cent. Admin. Rep. H-08-02, 42 p.
Baker J.D., C. L. Littnan, and D. W. Johnston. 2006. Potential effects of sea-level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 4:1-10.
Baker, J.D., J.J. Polovina, and E.A. Howell. 2007. Effect of variable oceanic productivity on the survival of an upper trophic predator, the Hawaiian monk seal, Monachus schauinslandi. Marine Ecology Progress Series 346:277-283.
Baker J.D. and P.M. Thompson. 2007. Temporal and spatial variation in age-specific survival rates of a long-lived mammal, the Hawaiian monk seal. Proceedings of the Royal Society B 274:407-415.
Cahoon, M.K. 2011. The foraging ecology of monk seals in the main Hawaiian Islands. MSc thesis, University of Hawaii, 172 p.
Clapp, R. B., and P. W. Woodward. 1972. The natural history of Kure Atoll, Northwestern Hawaiian Islands, Atoll Res. Bull. 164:303-304.
Dameron OJ, Parke M, Albins M, Brainard R. 2007. Marine debris accumulation in the Northwestern Hawaiian Islands: An examination of rates and processes. Marine Pollution Bulletin 54(4): 423-433.
Dill, H. R., and W. A. Bryan. 1912. Report on an expedition to Laysan Island in 1911. U.S. Dept. of Agric. Surv. Bull. 42:1-30.
Donohue, M. J., R. Brainard, M. Parke, and D. Foley. 2000. Mitigation of environmental impacts of derelict fishing gear through debris removal and environmental monitoring. *In* Hawaiian Islands Humpback Whale National Marine Sanctuary, Proceedings of the International Marine Debris Conference on Derelict Fishing Gear and the Ocean Environment, 6-11 August 2000, Honolulu, Hawaii. p. 383-402. http://hawaiihumpbackwhale.noaa.gov/special_offerings/sp_off/proceedings.html.
Donohue, M.J., R.C. Boland, C.M. Sramek, and G.A. Antonelis. 2001. Derelict fishing gear in the Northwestern Hawaiian Islands: diving surveys and debris removal in 1999 confirm threat to coral reef ecosystems. Marine Pollution Bulletin 42(12):1301_1312.
~~Forney, K.A., J. Barlow, M.M. Muto, M. Lowry, J. Baker, G. Cameron, J. Mobley, C. Stinchcomb, and J.V. Carretta. 2000. U.S. Pacific Marine Mammal Stock Assessments: 2000. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SWFSC-300. 276 p.~~
Gerrodette, T. M., and W. G. Gilmartin. 1990. Demographic consequences of changed pupping and hauling sites of the Hawaiian monk seal. Conserv. Biol. 4:423-430.
Gobush, K. S. 2010. Shark predation on Hawaiian monk seals: Workshop II & post-workshop developments, November 5-6, 2008. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-21, 43 p. + Appendices.
Goodman-Lowe, G. D. 1998. Diet of the Hawaiian monk seal (*Monachus schauinslandi*) from the northwestern Hawaiian islands during 1991 to 1994. Marine Biology 132:535-546.
Harting, A.L. 2002. Stochastic simulation model for the Hawaiian monk seal. PhD thesis, Montana State University, 328 p.
Henderson, J. R. 1990. Recent entanglements of Hawaiian monk seals in marine debris. In R. S. Shomura and M. L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, April 2-7, 1989, Honolulu, Hawaii, p. 540-553. U.S. Dep. Commer., NOAA, Tech. Memo. NMFS-SWFSC-154.
Henderson, J.R. 2001. A Pre_ and Post_MARPOL Annex V Summary of Hawaiian Monk Seal Entanglements and Marine Debris Accumulation in the Northwestern Hawaiian Islands, 1982_1998. Marine Pollution Bulletin 42:584-589.

Iverson, S., J. Piché, and W. Blanchard. 2011. Hawaiian monk seals and their prey: assessing characteristics of prey species fatty acid signatures and consequences for estimating monk seal diets using Quantitative Fatty Acid Signature Analysis. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-23, 114 p. + Appendices.

Johanos, T. C. and J. D. Baker (editors). 2001. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 1999. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-310, 130 p.

~~Johanos, T. C. and J. D. Baker (editors). In prep. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 2005. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-PIFSC-XXX, XXX p.~~

~~Johanos, T. C. and J. D. Baker (editors). In prep. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 2006. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-PIFSC-XXX, XXX p.~~

~~Johanos, T. C. (editor). In prep. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 2007. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-PIFSC-XXX, XXX p.~~

~~Johanos, T. C. (editor). In prep. The Hawaiian monk seal in the Northwestern Hawaiian Islands, 2008. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-PIFSC-XXX, XXX p.~~

Johanos T. C., B. L. Becker, J. D. Baker, T. C. Ragen, W. G. Gilmartin, and T. Gerrodette. 2010. Impacts of sex ratio reduction on male aggression in the critically endangered Hawaiian monk seal *Monachus schauinslandi.* Endangered Species Research 11: 123–132.

Johnson, A. M., and E. Kridler. 1983. Interisland movement of Hawaiian monk seals. 'Elepaio 44(5):43-45.

Kenyon, K. W. 1972. Man versus the monk seal. J. Mammal. 53(4):687-696.

Kretzmann, M. B., W. G. Gilmartin, A. Meyer, G. P. Zegers, S. R. Fain, B. F. Taylor, and D. P. Costa. 1997. Low genetic variability in the Hawaiian monk seal. Conserv. Biol. 11(2):482-490.

Kretzmann, M. B., N. J. Gemmell, and A. Meyer. 2001. Microsatellite analysis of population structure in the endangered Hawaiian monk seal. Conserv. Biol. 15(2):457-466.

Littnan, C. L., B. S. Stewart, P. K. Yochem, and R. Braun. 2006. Survey for selected pathogens and evaluation of disease risk factors for endangered Hawaiian monk seals in the main Hawaiian Islands. EcoHealth 4.

Goodman-Lowe, G. D. 1998. Diet of the Hawaiian monk seal (*Monachus schauinslandi*) from the Northwestern Hawaiian islands during 1991 to 1994. Marine Biology 132:535-546.

Otis, D. L., K. P. Burnham, G. C. White, and D. R. Anderson. 1978. Statistical inference from capture data on closed animal populations. Wildl. Monogr. 62:1-135.

Parrish, F. A., M. P. Craig, T. J. Ragen, G. J. Marshall, and B. M. Buhleier. 2000. Identifying diurnal foraging habitat of endangered Hawaiian monk seals using a seal-mounted video camera. Mar. Mamm. Sci. 16:392-412.

~~Pooley, S. G., and K. E. . 1998. Annual report of the 1995-97 western Pacific lobster fishery. Admin. Rep. H-98-09. Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 34 pp.~~

Ragen, T. J. 1993. Status of the Hawaiian monk seal in 1992. Admin. Rep. H-93-05. Southwest Fisheries Science Center, National Marine Fisheries Service, 2570 Dole St., Honolulu, HI 96822-2396. 79 pp.

Ragen, T.J. 1999. Human activities affecting the population trends of the Hawaiian monk seal. Pages 183-194 *in* J.A. Musick, ed. Life in the slow lane: Ecology and conservation of long-lived marine animals. American Fisheries Society Symposium 23, American Fisheries Society, Bethesda, MD.

Rexstad, E. A., and K. P. Burnham. 1991. User's manual for interactive Program CAPTURE. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, CO. 29 pp.

Rice, D. W. 1960. Population dynamics of the Hawaiian monk seal. J. Mammal. 41:376-385.

Schultz JK, Baker JD, Toonen RJ, Bowen BW. 2009. Extremely low genetic diversity in the endangered Hawaiian monk seal (*Monachus schauinslandi*). Journal of Heredity 100:25-33.

Schultz J.K., Baker J.D., Toonen RJ, Harting AL, Bowen BW. ~~In press~~ 2011. Range-wide genetic connectivity of the Hawaiian monk seal and implications for translocation. Conservation Biology 25:124-132 .

Stewart B. S., G. A. Antonelis, J. D. Baker, and P.Y.Yochem. 2006. Foraging biogeography of the Hawaiian monk seal in the Northwestern Hawaiian Islands. Atoll Res Bull 543:131-145.

U.S. Department of Commerce and Department of the Interior. 2006. Northwestern Hawaiian Islands Marine National Monument. Federal Register 71:51,134-51,142.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

Wade, P. R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. Marine Mammal Science 14:1-37.

Wetmore, A. 1925. Bird life among lava rock and coral sand. The Natl. Geograp. Mag. 48:77-108.
White, G. C., D. R. Anderson, K. P. Burnham, and L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory, Los Alamos, New Mexico.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Long-beaked common dolphins ~~have only recently been~~ were recognized as a distinct species in the 1990s (Heyning and Perrin 1994; Rosel et al. 1994). Along the U.S. west coast, their distribution overlaps with that of the short-beaked common dolphin, and much historical information has not distinguished between these two species. Long-beaked common dolphins are commonly found within about 50 nmi of the coast, from Baja California (including the Gulf of California) northward to about central California (Figure 1). Along the west coast of Baja California, long-beaked common dolphins primarily occur inshore of the 250 m isobath, with very few sightings (< 15%) in waters deeper than 500 meters (Gerrodette and Eguchi 2011). Stranding ~~data~~ and sighting records indicate that the ~~relative~~ abundance of this species off California changes both seasonally and inter-annually. Although long-beaked common dolphins are not restricted to U.S. waters, cooperative management agreements with Mexico exist only for the tuna purse seine fishery and not for other fisheries which may take this species (e.g. gillnet fisheries). Under the Marine Mammal Protection Act (MMPA), long-beaked ~~("Baja neritic")~~ common dolphins involved in eastern tropical Pacific tuna fisheries are managed separately as part of the 'northern common dolphin' stock (Perrin et al. 1985), and these animals are not included in the assessment reports. For the MMPA stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of California.

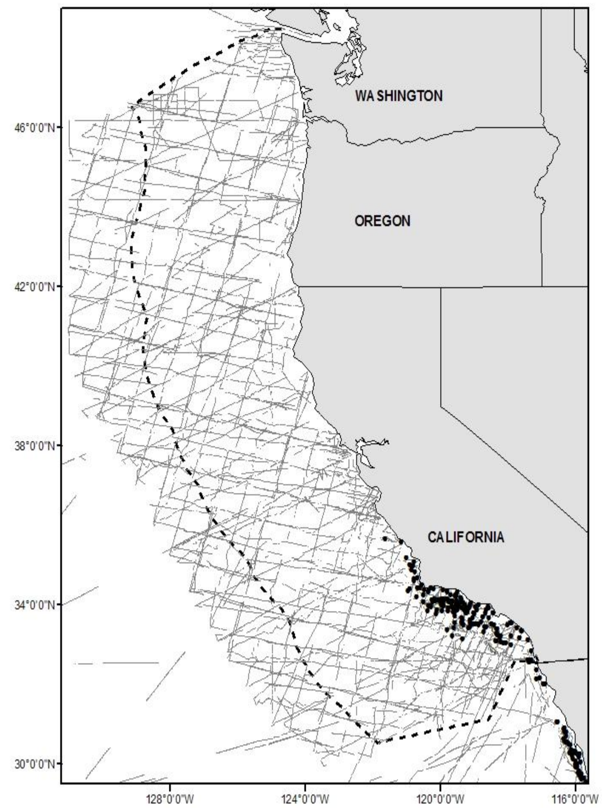

Figure 1. Long-beaked common dolphin sightings based on shipboard surveys off California, Oregon, and Washington, 1991-~~2008~~ 2010 (see Appendix 2 for information on timing and location of survey effort). No Delphinus sightings have been made off Washington. Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined.

POPULATION SIZE

The most recent abundance estimates are ~~11,714 (CV= 0.99) and~~ 62,447 (CV= 0.80) and 183,396 (CV= 0.41) ~~long-beaked common~~ dolphins, based on ~~2005 and~~ 2008 and 2009 ship line-transect surveys, respectively, of California, Oregon, and Washington waters (~~Forney 2007;~~ Barlow 2010; Carretta *et al.* 2011). The distribution and abundance of long-beaked common dolphins off California appears to be variable ~~on~~ inter-annually and seasonally ~~time scales~~ (Heyning and Perrin 1994). As oceanographic conditions change, long-beaked common dolphins may move between Mexican and U.S. waters, and therefore a multi-year average abundance estimate is the most appropriate for management within the U.S. waters. The geometric mean abundance estimate for California, Oregon and Washington waters based on two ship surveys conducted in 2005 and 2008 and 2009 is 27,046 (CV=0.59) 107,016 (0.42) long-beaked common dolphins (Forney 2007; Barlow 2010; Carretta *et al*. 2011).

Minimum Population Estimate

The log-normal 20th percentile of the weighted average abundance estimate is 17,127 76,224 long-beaked common dolphins.

Current Population Trend

California waters represent the northern limit for this stock and animals likely move between U.S. and Mexican waters. No information on trends in abundance are available for this stock because of high inter-annual variability in line-transect abundance estimates. Heyning and Perrin (1994) detected changes in the proportion of short-beaked to long-beaked common dolphins stranding along the California coast, with the short-beaked common dolphin stranding more frequently prior to the 1982-83 El Niño (which increased water temperatures off California), and the long-beaked common dolphin more commonly observed for several years afterwards. While no formal statistical trend analysis exists for this stock of long-beaked common dolphin, abundance estimates for California waters from a 2009 vessel-based line-transect survey were the highest of any survey dating back to 1991 (Carretta *et al*. 2011). The ratio of strandings of long-beaked to short-beaked common dolphin in southern California increased following a strong 1982-1983 El Niño (Heyning and Perrin 1994). Within San Diego County, dramatic increases in the ratio of long-beaked to short-beaked common dolphin strandings were observed between 2006 and 2008 (Danil *et al*. 2010), with higher numbers of long-beaked strandings persisting through 2010 (NMFS unpublished stranding data). During a 2009 ship-based survey of California and Baja California waters, the ratio of long-beaked to short-beaked common dolphin sightings was nearly 1:1, whereas during previous surveys conducted from 1986 to 2008 in the same geographic strata, the ratio was approximately 1:3.5 (Carretta *et al*. 2011). There appears to be an increasing trend of long-beaked common dolphins in California waters over the last 30 years. Thus, it appears that both relative and absolute abundance of these species off California may change with varying oceanographic conditions.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (17,127 76,224) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.48 0.40 (for a species of unknown status with a mortality rate CV > 0.80 >0.30 and <0.60; Wade and Angliss 1997), resulting in a PBR of 164 610 long-beaked common dolphins per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

A summary of recent fishery mortality and injury for long-beaked common dolphins is shown in Table 1. More detailed information on these fisheries is provided in Appendix 1. Mortality estimates for the California drift gillnet fishery are included for the five most recent years of monitoring, 2004-2008 2006-2010 (Carretta et al. 2005, Carretta and Enriquez 2006, 2007, 2009a, 2009b, 2012). After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, common dolphin entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). However, because of interannual variability in entanglement rates additional years of data will be required to fully evaluate the long-term effectiveness of pingers for reducing mortality of this species.

Common dolphin mortality has also been reported in halibut set gillnets in California (Julian and Beeson 1998). This fishery has only been observed twice since 2004 (Table 1). Although no common dolphins were observed taken, fisherman self-reports in 2004 indicate that at least one common dolphin (type not specified) was killed (Marine Mammal Authorization Permit Program data). Although these

~~reports are considered unreliable (see Appendix 4 of Hill and DeMaster 1998) they represent a minimum mortality for this fishery.~~

~~Twenty-four~~ Thirty-six common dolphins (two unidentified common dolphin and ~~22~~ 34 long-beaked common dolphins) stranded with evidence of fishery interactions (NMFS, Southwest Region, unpublished data) between ~~2004-2008~~ 2006-2010. ~~All but six~~ Most ~~of these~~ strandings showed evidence of an interaction with an unknown entangling net fishery (severed flukes, knife cuts, net marks, or net fragments wrapped around the animal). ~~One animal showed evidence of an interaction with an unknown hook and line fishery and five animals had either bullets removed from the carcass (3) or evidence of gunshot wounds (2).~~ Mean annual takes in Table 1 are based on ~~2004-2008~~ 2006-2010 data, with the exception of the small-mesh drift gillnet fishery, for which the most recent observer data was collected in 2004.

~~Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed-fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).~~ 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 long-beaked common dolphins (California Stock) and prorated unidentified common dolphins in commercial fisheries that might take this species. All observed entanglements resulted in the death of the animal. Coefficients of variation for mortality estimates are provided in parentheses, when available. Mean annual takes are based on ~~2004-2008~~ 2006-2010 data unless noted otherwise. n/a = information not available.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed (or self-reported)	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer	~~2004~~ ~~2005~~ 2006 2007 2008 2009 2010	~~20.6%~~ ~~20.9%~~ 18.5% 16.4% 13.5% 13.3% 11.9%	~~0~~ ~~3~~ 1 0 1 0 1	~~0~~ ~~14 (0.57)~~ 5 (1.04) 0 7 (1.08) 0 8 (1.00)	~~5.2 (0.78)~~ 4.0 (1.01)
CA small mesh drift gillnet fishery for white seabass, yellowtail, barracuda, and tuna[1]	observer	2004 2005 2006 2007 2008 2009 2010	17.6% not observed not observed not observed not observed not observed not observed	1 n/a n/a n/a n/a n/a n/a	5 (1.18) n/a n/a n/a n/a n/a n/a	5 (1.18)
CA halibut /white seabass and other species set gillnet fishery	Self report & observer	~~2004~~ ~~2005~~ 2006 2007 2008 2009 2010	~~not observed~~ ~~not observed~~ ~1% 17% not observed not observed 12.5%	~~(1)~~ ~~0~~ 0 0 0 0 1	~~≥1~~ ~~0~~ 0 0 0 0 7 (1.07)	~~≥1 (n/a)~~ 1.4 (1.07)

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed (or self-reported)	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
Undetermined	strandings	~~2004-2008~~ 2006-2010	~~24~~ 36 common dolphins (two unidentified and ~~22~~ 34 longbeaked common dolphins) stranded with evidence of fishery interactions. Evidence of fishery interactions included severed flukes, net fragments, net marks, positive metal detector scans, and knife marks or cuts. Some strandings may have come from observed fisheries that already have bycatch estimates and these are not included in the annual average to prevent double-counting of fishery mortality. Mean annual takes are therefore based on stranded animals only if the stranding can be attributed to a fishery lacking an observer program or cases where stranded animals represent the only documented fishery-related deaths in a given year. This results in a minimum of ~~9~~ 13 long-beaked common dolphin strandings over the 5 year period, or ~~1.8~~ 2.6 animals annually.			~~1.8 (n/a)~~ ≥ 2.6 (n/a)
Minimum total annual takes						~~13.0 (0.51)~~ 13.0 (0.55)

[1] Observer coverage in the small mesh drift gillnet fishery was estimated from logbook records. Logbook effort totaled 192, 134, 191, 201, and 125 sets for 2000 through 2004, respectively. The fishery was not observed after 2004.

Other Mortality

In the eastern tropical Pacific, 'northern common dolphins' have been incidentally killed in international tuna purse seine fisheries since the late 1950's. Cooperative international management programs have dramatically reduced overall dolphin mortality in these fisheries during the last decade (Joseph 1994). Between ~~2000-2004~~ 2004-2008, annual fishing mortality of northern common dolphins (potentially including both short-beaked and long-beaked common dolphins) ranged between ~~54~~ 55 and ~~159~~ 156 animals, with an average of ~~102~~ 112 (IATTC ~~2006~~ 2010). Although it is unclear whether these animals are part of the same population as long-beaked common dolphins found off California, they are managed separately under a section of the MMPA written specifically for the management of dolphins involved in eastern tropical Pacific tuna fisheries.

'Unusual mortality events' of long-beaked common dolphins due to domoic acid toxicity have been documented by NMFS as recently as 2007 along the California coast.

Three long-beaked common dolphins died near San Diego in 2011 as the result of blast trauma associated with underwater detonations conducted by the U.S. Navy. Three days later, a fourth animal stranded approximately 70 km north of that location with similar injuries (Danil and St. Leger 2011).

STATUS OF STOCK

The status of long-beaked common dolphins in California waters relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance of this species of common dolphin. ~~No habitat issues are known to be of concern for this species.~~ Exposure to blast trauma resulting from underwater detonations is a habitat concern for this stock and the cumulative impacts of these detonations at the population level is unknown (Danil and St. Leger 2011). They are not listed as "threatened" or "endangered" under the Endangered Species Act nor as "depleted" under the MMPA. Including mortality from commercial fisheries between 2006 and 2010 (13.0 animals per year) and mortality resulting from blast trauma (0.8 animals per year for the 5-yr period 2007 to 2011), ~~The~~ the average annual human-caused mortality ~~from 2004-2008 (13.0 animals)~~ is 13.8 long-beaked common dolphins. This does not exceed the PBR ~~(164)~~ (610), and therefore they are not classified as a "strategic" stock under the MMPA. The average total fishery mortality and injury for long-beaked common dolphins ~~(13.0)~~ (13.0) is less than 10% of the PBR and therefore, is considered to be insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Barlow, J. 2010. Cetacean abundance in the California Current from a 2008 ship-based line-transect survey. NOAA Technical Memorandum, NMFS, NOAA-TM-NMFS-SWFSC-456.

Barlow, J. and G. A. Cameron. 2003. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Marine Mammal Science 19(2):265-283.

~~Barlow, J. 2003. Preliminary estimates of the abundance of cetaceans along the U.S. west coast: 1991_2001. Southwest Fisheries Science Center Administrative Report LJ_03_03. Available from SWFSC, 8604 La Jolla Shores Dr., La Jolla CA 92037. 31p.~~

~~Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105:509-526.~~

~~Berdegué, J. 2002. Depredación de las especies pelágicas reservadas a la pesca deportiva y especies en peligro de extinción con uso indiscriminado de artes de pesca no selectivas (palangres, FAD's, trampas para peces y redes de agallar fijas y a la deriva) por la flota palangrera Mexicana. Fundación para la conservación de los picudos. A.C. Mazatlán, Sinaloa, 21 de septiembre.~~

Carretta, J.V. and L. Enriquez. 2012. Marine mammal and seabird bycatch in California gillnet fisheries in 2010. Administrative Report LJ-12-01, available from Southwest Fisheries Science Center, 3333 N. Torrey Pines Court, La Jolla, CA, 92037. 14 p.

Carretta, J.V., S.J. Chivers, and W.L. Perryman. 2011. Abundance of the long-beaked common dolphin (*Delphinus capensis*) in California and western Baja California waters estimated from a 2009 ship-based line-transect survey. Bulletin Southern California Academy of Sciences 110(3):152-164.

Carretta, J.V. and L. Enriquez. 2010. Marine mammal and sea turtle bycatch in the California/Oregon swordfish and thresher shark drift gillnet fishery in 2009. Administrative Report LJ-10-03, available from Southwest Fisheries Science Center, 3333 N. Torrey Pines Court, La Jolla, CA 92037. 11 p.

Carretta, J.V. and L. Enriquez. 2009a. Marine mammal and seabird bycatch observed in California commercial fisheries in 2007. Administrative Report LJ-09-01, available from Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, CA 92037. 12 p.

Carretta, J.V. and L. Enriquez. 2009b. Marine mammal bycatch observed in the California/Oregon swordfish and thresher shark drift gillnet fishery in 2008. Administrative Report LJ-09-03, available from Southwest Fisheries Science Center, 3333 North Torrey Pines Rd., La Jolla, CA 92037. 10 p .

Carretta, J.V. and L. Enriquez. 2007. Marine mammal and sea turtle bycatch in the California/Oregon thresher shark and swordfish drift gillnet fishery in 2006. Administrative Report LJ-07-06, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037. 9p.

~~Carretta, J.V. and L. Enriquez. 2006. Marine mammal bycatch and estimated mortality in California commercial fisheries during 2005. Administrative Report LJ-06-07, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037. 14p.~~

~~Carretta, J.V., S.J. Chivers, and K. Danil. 2005. Preliminary estimates of marine mammal bycatch, mortality, and biological sampling of cetaceans in California gillnet fisheries for 2004. Administrative Report LJ-05-10, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, California, 92037. 17 p.~~

Danil, K., S.J. Chivers, M.D. Henshaw, J.L. Thieleking, R. Daniels, J.A. St. Leger. 2010. Cetacean strandings in San Diego County, California, USA: 1851-2008. Journal of Cetacean Research and Management 11(2):163-184.

Danil, K. and J.A. St. Leger. 2011. Seabird and dolphin mortality associated with underwater detonation exercises. Marine Technology Society Journal 45(6):89-95.

Forney, K.A. 2007. Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27p.

Gerrodette, T. and T. Eguchi. 2011. Precautionary design of a marine protected area based on a habitat model. Endangered Species Research 15:159-166.

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

~~Hill, P. S. and D. P. DeMaster. 1998. Alaska Marine Mammal Stock Assessments, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-97. 166 pp.~~

~~Holts, D. and O. Sosa-Nishizaki. 1998. Swordfish, *Xiphias gladius*, fisheries of the eastern North Pacific Ocean. *In*: I. Barrett, O. Sosa-Nishizaki and N. Bartoo (eds.). Biology and fisheries of swordfish, *Xiphias gladius*. Papers from the International Symposium on Pacific Swordfish, Ensenada Mexico, 11-14 December 1994. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 142, 276 pp.~~

IATTC. ~~2006~~ 2010. Annual Report of the Inter-American Tropical Tuna Commission, ~~2004~~ 2008, La Jolla, California. ~~96~~ 100p.

Joseph, J. 1994. The tuna-dolphin controversy in the eastern Pacific Ocean: biological, economic and political impacts. Ocean Dev. Int. Law 25:1-30.

~~Julian, F. 1997. Cetacean mortality in California gill net fisheries: Preliminary estimates for 1996. Paper SC/49/SM02 presented to the International Whaling Commission, 1997 (unpublished). 13 pp.~~

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

~~NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038-027.~~

NMFS, Southwest Region, 501 West Ocean Blvd, Long Beach, CA 90802_4213.

Perrin, W. F., M. D. Scott, G. J. Walker and V. L. Cass. 1985. Review of geographical stocks of tropical dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern Pacific. NOAA Technical Report NMFS 28. Available from NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, California, 92038. 28p.

Rosel, P. E., A. E. Dizon and J. E. Heyning. 1994. Population genetic analysis of two forms of the common dolphin (genus *Delphinus*) utilizing mitochondrial DNA control region sequences. Marine Biology 119:159-167.

Sosa-Nishizaki, O., R. De la Rosa-Pacheco, R. Castro-Longoria, M. Grijalva Chon, and J. De la Rosa Velez. 1993. Estudio biologico pesquero del pez (*Xiphias gladius*) y otras especies de picudos (marlins y pez vela). Rep. Int. CICESE, CTECT9306.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales prefer colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). Along the west coast of North America, killer whales occur along the entire Alaskan coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). 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 geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (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).

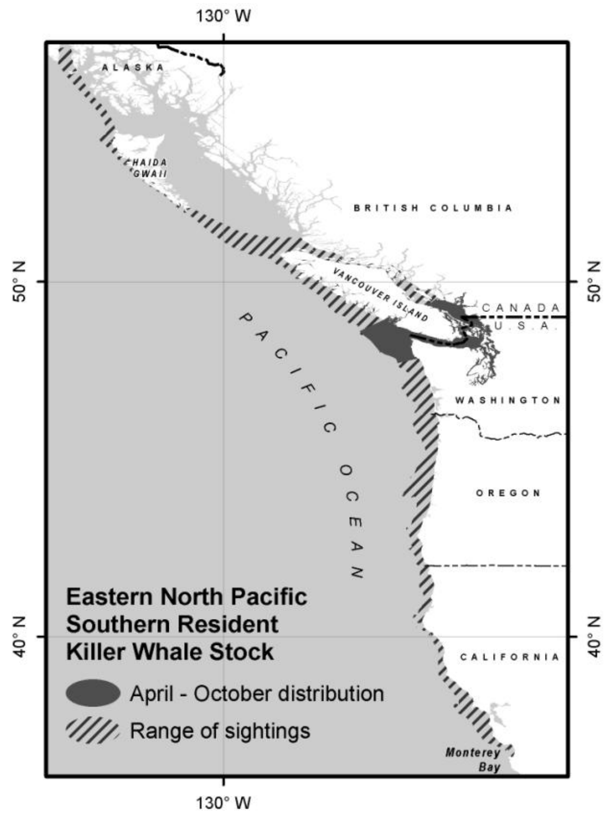

Figure 1. Approximate April - October distribution of the Eastern North Pacific Southern Resident killer whale stock (shaded area) and range of sightings (diagonal lines).

Studies on mtDNA restriction patterns provide evidence that the 'resident' and 'transient' types are genetically distinct (Stevens et al. 1989, Hoelzel 1991, Hoelzel and Dover 1991, Hoelzel et al. 1998). Analysis of 73 samples collected from eastern North Pacific killer whales from California to Alaska has demonstrated significant genetic differences among 'transient' whales from California through Alaska, 'resident' whales from the inland waters of Washington, and 'resident' whales ranging from British Columbia to the Aleutian Islands and Bering Sea (Hoelzel et al. 1998). However, low genetic diversity throughout this species world-wide distribution has hampered efforts to clarify its taxonomy. At an international symposium in cetacean systematics in May 2004, a workshop was held to review the taxonomy of killer whales. A majority of invited experts felt that the Resident- and Transient-type whales in the eastern North Pacific probably merited species or subspecies status (Reeves et al. 2004). Krahn et al. (2004) summarized additional lines of evidence supporting subspecies status of resident and transient killer whales in the North Pacific, including differences in 1) acoustic dialects; 2) skull features; 3) morphology; 4) feeding specializations; and 5) a lack of intermingling between the two sympatric ecotypes.

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 from the north–through Johnstone Strait–in the spring

(Ford et al. 2000), suggesting that they may spend time along the entire outer coast of Vancouver Island during the winter. In May 2003, these pods were sighted off the northern end of the Queen Charlotte Islands, the furthest north they had ever been documented (J. Ford, pers. comm.). In June 2007, whales from L-pod were sighted off Chatham Strait, Alaska, the furthest north they have ever been documented (J. Ford, pers. comm.).

Based on data regarding association patterns, acoustics, movements, genetic differences and potential fishery interactions, eight five 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, 2 3) the Eastern North Pacific Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia but extending for central California into southern Southeast Alaska (see Fig. 1), 3 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 I from southeast Alaska to the Bering Sea, 6) the AT1 Stock – found only in Prince William Sound, 4 7) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California, 5 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 resulted in a substantial understanding 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 86 87 whales in 2010 2011 (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 2009 2010 through 1 July 2011 includes four new calves and the deaths of a post-reproductive adult female, a subadult male, and an adult male since. It does not include a stillborn calf observed in September 2010 (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 86 87 animals.

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). The first complete census of this stock occurred in 1974. Between 1974 and 1993 the Southern Resident stock increased approximately 35%, from 71 to 96 individuals (Ford et al. 1994). This represents a net annual growth rate of 1.8% during those years. Since 1995, the population declined to 79 whales before increasing from 2002-2005 to a total of 91 whales. Since 2005 tThe population declined for three straight years to 85 whales but has increased only slightly remained almost unchanged in 2010 as of the 2011census (Ford et al.

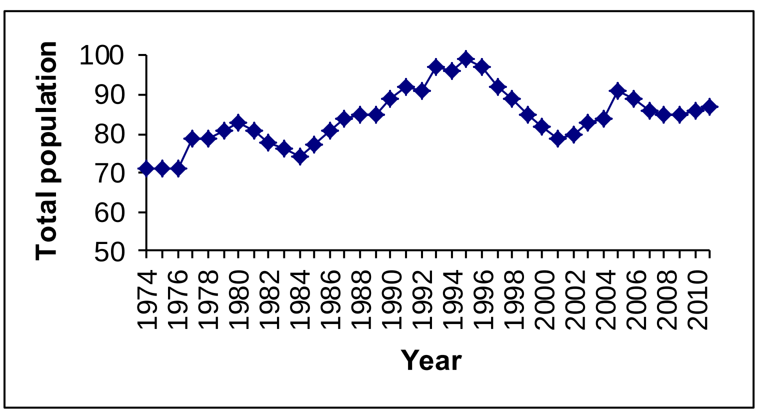

Figure 2. Population of Eastern North Pacific Southern Resident stock of killer whales, 1974-20102011. Each year's count includes animals first seen and first missed; a whale is considered first missed the year after it was last seen alive (Ford et al. 2000; Center for Whale Research, unpubl. data).

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. Studies of 'resident' killer whale pods in British Columbia and Washington waters resulted in estimated population growth rates of 2.92% and 2.54% over the period from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993). For southern resident killer whales, estimates of the population growth rate have been made during the three periods when the population has been documented increasing since monitoring began in 1974. From 1974 to 1980 the population increased at a rate of 2.6%/year, 2.3%/year from 1985 to 1996, and 3.6%/year from 2002 to 2005 (Center for Whale Research, unpubl. data). A recent analysis of the long-term trend of southern resident population growth (1979-2011) indicated that there was a 5% probability of the maximum growth (R_{max}) exceeding 2.8% and a 1% chance of it exceeding 3.2% (Ward 2012). ~~However, a population increases at the maximum growth rate only when the population is at extremely low levels; thus, any of these estimates may be an underestimate of R_{MAX}.~~ Hence, R_{max} is estimated to be 3.2% for southern resident killer whales and this value will be employed for this stock. ~~until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).~~

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (86 87) times one-half the default maximum net growth rate for cetaceans (½ of ~~4%~~ 3.2%) times a recovery factor of 0.1 (for an endangered stock, Wade and Angliss 1997), resulting in a PBR of ~~0.17~~ 0.14 whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

NMFS observers have monitored the northern Washington marine set gillnet fishery since 1988 (Gearin et al. 1994, 2000; P. Gearin, unpubl. data). Observer coverage ranged from approximately 40 to 83% in the entire fishery (coastal + inland waters) between 1998 and 2002. There was no observer coverage in this fishery from 1999-2003. However, the total fishing effort was 4, 46, 4.5 and 7 net days (respectively) in those years, it occurred only in inland waters, and no killer whale takes were reported. No killer whale mortality has been recorded in this fishery since the inception of the observer program.

In 1993, as a pilot for future observer programs, NMFS in conjunction with the Washington Department of Fish and Wildlife (WDFW) monitored all non-treaty components of the Washington Puget Sound Region salmon gillnet fishery (Pierce et al. 1994). Observer coverage was 1.3% overall, ranging from 0.9% to 7.3% for the various components of the fishery. Encounters (whales within 10 m of a net) with killer whales were reported, but not quantified, though no entanglements occurred.

In 1994, NMFS and WDFW conducted an observer program during the Puget Sound non-treaty chum salmon gillnet fishery (areas 10/11 and 12/12B). A total of 230 sets were observed during 54 boat trips, representing approximately 11% observer coverage of the 500 fishing boat trips comprising the total effort in this fishery, as estimated from fish ticket landings (Erstad et al. 1996). No interactions with killer whales were observed during this fishery. The Puget Sound treaty chum salmon gillnet fishery in Hood Canal (areas 12, 12B, and 12C) and the Puget Sound treaty sockeye/chum gillnet fishery in the Strait of Juan de Fuca (areas 4B, 5, and 6C) were also monitored in 1994 at 2.2% (based on % of total catch observed) and approximately 7.5% (based on % of observed trips to total landings) observer coverage, respectively (NWIFC 1995). No interactions resulting in killer whale mortality was reported in either treaty salmon gillnet fishery.

Also in 1994, NMFS, WDFW, and the Tribes conducted an observer program to examine seabird and marine mammal interactions with the Puget Sound treaty and non-treaty sockeye salmon gillnet fishery (areas 7 and 7A). During this fishery, observers monitored 2,205 sets, representing approximately 7% of the estimated number of sets in the fishery (Pierce et al. 1996). Killer whales were observed within 10 m of the gear during 10 observed sets (32 animals in all), though none were observed to have been entangled.

Killer whale takes in the Washington Puget Sound Region salmon drift gillnet fishery are unlikely to have increased since the fishery was last observed in 1994, due to reductions in the number of participating vessels and available fishing time (see details in Appendix 1). Fishing effort and catch have declined throughout all salmon fisheries in the region due to management efforts to recover ESA-listed salmonids.

An additional source of information on the number of killer whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1994 and 2004, there were no fisher self-reports of killer whale mortality from any fisheries operating within the range of this stock. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively-biased (Credle et al. 1994), these are considered to be minimum estimates. Logbook data are available for part of 1989-1994, after which incidental mortality reporting requirements were modified. Under the new system, logbooks are no longer required; instead, fishers provide self-reports. Data for the 1994-1995 phase-in period are fragmentary. After 1995, the level of reporting dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (see Appendix 7 in Angliss and Lodge 2002 for details).

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, though the mortality level is thought to be minimal.

During ~~this~~ the 1990's ~~decade~~ there ~~have been~~ were no reported takes from this stock incidental to commercial fishing operations (D. Ellifrit, pers. comm.), ~~no reports of interactions~~ between killer whales and longline operations (as occurs in Alaskan waters; see Yano and Dahlheim 1995), no reports of stranded animals with net marks, and no photographs of individual whales carrying fishing gear. The 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, no human-caused killer whale mortality or serious injuries were reported from non-fisheries sources in 1998-2004. 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 human-caused mortality for this stock over the past five years is 0.2 animals per year (reflecting the vessel strike mortality of animal L98 in 2006).

STATUS OF STOCK

On November 15, 2005 NMFS listed Southern Resident killer whales as endangered under the ESA. Total annual fishery mortality and serious injury for this stock (0) is not known to exceed 10% of the calculated PBR (~~0.17~~ 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 0.2 animals per year exceeds the PBR (~~0.17~~ 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 vessel 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). ~~and~~ T~~t~~here is some evidence that changes in coast–wide Chinook abundance has 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).

REFERENCES

Angliss, R. P., and K. L. Lodge. 2002. Alaska marine mammal stock assessments, 2002. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-133. 224 pp.

Baird, R. W., and P. J. Stacey. 1988. Variation in saddle patch pigmentation in populations of killer whales (*Orcinus orca*) from British Columbia, Alaska, and Washington State. Can. J. Zool. 66 (11):2582-2585.

Baird, R. W., P. A. Abrams, and L. M. Dill. 1992. Possible indirect interactions between transient and resident killer whales: implications for the evolution of foraging specializations in the genus *Orcinus*. Oecologia 89:125-132.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fish. Bull. 93:1_14.

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

Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford, and K. C. Balcomb III. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Pp. 386-406, *In:* Hammond, P. S., S. A. Mizroch, and G. P. Donovan (eds.), Individual Recognition of Cetaceans: Use of Photo-identification and Other Techniques to Estimate Population Parameters. Rep. Int. Whal. Commn. Special Issue 12.

Black, N. A. P.O. Box 52001, Pacific Grove, CA 93950.

Braham, H. W., and M. E. Dahlheim. 1982. Killer whales in Alaska documented in the Platforms of Opportunity Program. Rep. Int. Whal. Commn. 32:643-646.

Brault, S., and H. Caswell. 1993. Pod-specific demography of killer whales (*Orcinus orca*). Ecology 74(5):1444-1454.

Center for Whale Research, 1359 Smugglers Cove Rd., Friday Harbor, WA 98250.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2003. Species Listing. Available at URL: http://www.cosewic.gc.ca/eng/sct0/index_e.cfm (access date - October 2003).

Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1. 96 pp.

Dahlheim, M. E., D. K. Ellifrit, and J. D. Swenson. 1997. Killer whales of Southeast Alaska: a catalogue of photoidentified individuals. National Marine Mammal Laboratory, AFSC, NMFS, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115. 79 pp.

Ellifrit, D. Center for Whale Research, 1359 Smugglers Cove Rd., Friday Harbor, WA 98250.

Erstad, P., S. J. Jeffries, and D. J. Pierce. 1996. 1994 Report for the Puget Sound fishery observer program in management areas 10/11 & 12/12B: nontreaty chum gill net fishery. Final Report, Washington Dept. Fish and Wildlife, Olympia, WA. 14 pp.

Ford, J. K. B. Pacific Biological Station, Department of Fisheries and Oceans, Nanaimo, BC V9R 5K6.

Ford, J. K. B., and H. D. Fisher. 1982. Killer whale (*Orcinus orca*) dialects as an indicator of stocks in British Columbia. Rep. Int. Whal. Commn. 32:671-679.

Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 1994. Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington State. University of British Columbia Press, Vancouver, BC, and University of Washington Press, Seattle. 102 pp.

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

Ford, J.K.B., and G.M. Ellis. 2006. Selective foraging by fish-eating killer whales *Orcinus orca* in British Columbia. Marine Ecology Progress Series, 316: 185–199.

Ford, J.K.B., G.M. Ellis, P.F. Olesiuk, and K.C. Balcomb. 2009. Linking killer whale survival and prey abundance: food limitation in the oceans' apex predator? Biol. Lett. published online before print September 15, 2009, doi:10.1098/rsbl.2009.0468

Forney, K. A., J. Barlow, and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fish. Bull. 93:15_26.

Gearin, P. J. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

Gearin, P. J., S. R. Melin, R. L. DeLong, H. Kajimura, and M. A. Johnson. 1994. Harbor porpoise interactions with a chinook salmon set-net fishery in Washington State. Rep. Int. Whal. Commn. Special Issue 15:427-438.

Gearin, P. J., M. E. Gosho, J. L. Laake, L. Cooke, R. L. DeLong, and K. M. Hughes. 2000. Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, *Phocoena phocoena*, in the state of Washington. J. Cetacean Res. Manage. 2(1):1-9.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnel, and K. C. Balcomb. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Pp. 1-100, *In:* Brueggeman, J. J. (ed.), Oregon and Washington marine mammal and seabird surveys. Final Rep. OCS Study MMS 91-0093.

Guenther, T. J., R. W. Baird, R. L. Bates, P. M. Willis, R. L. Hahn, and S. G. Wischniowski. 1995. Strandings and fishing gear entanglements of cetaceans on the west coast of Canada in 1994. Paper SC/47/O6 presented to the International Whaling Commission, May 1995 (unpublished). 7 pp.

Hanson, M.B., R.W. Baird, J.K.B. Ford, J. Hempelmann-Halos, D. M.Van Doornik, J.R. Candy, C. K. Emmons, G. S. Schorr, B. Gisborne, K. L. Ayres, S. K. Wasser, K. C. Balcomb, K. Balcomb-Bartok, J. G. Sneva, and M. J. Ford. 2010. Species and stock identification of prey consumed by endangered "southern resident" killer whales in their summer range. Endangered Species Research 11: 69–82.

Hoelzel, A. R. 1991. Analysis of regional mitochondrial DNA variation in the killer whale; implications for cetacean conservation. Rep. Int. Whal. Commn. Special Issue 13:225-233.

Hoelzel, A. R., and G. A. Dover. 1991. Genetic differentiation between sympatric killer whale populations. Heredity 66:191-195.

Hoelzel, A. R., M. E. Dahlheim, and S. J. Stern. 1998. Low genetic variation among killer whales (*Orcinus orca*) in the Eastern North Pacific, and genetic differentiation between foraging specialists. J. Heredity 89:121-128.

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

Krahn,, M.M., M.B. Hanson, R.W. Baird, R.H. Boyer, D.G. Burrows, C.K. Emmons, J. K.B. Ford, L. L. Jones, D. P. Noren, P. S. Ross, G. S. Schorr, T.K. Collier. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. Mar. Poll. Bull. 54 (2007) 1903–1911.

Krahn, Margaret M, M. Bradley Hanson, Gregory S. Schorr, Candice K. Emmons, Douglas G. Burrows, Jennie L. Bolton, Robin W. Baird, Gina M. Ylitalo. 2009. Effects of age, sex and reproductive status on persistent organic pollutant concentrations in "Southern Resident" killer whales. Marine Pollution Bulletin 58: 1522–1529.

Leatherwood, J. S., and M. E. Dahlheim. 1978. Worldwide distribution of pilot whales and killer whales. Naval Ocean Systems Center, Tech. Rep. 443:1-39.

Leatherwood, S., C. O. Matkin, J. D. Hall, and G. M. Ellis. 1990. Killer whales, *Orcinus orca*, photo_identified in Prince William Sound, Alaska 1976 to 1987. Can. Field Nat. 104:362_371.

Matkin, C., G. Ellis, E. Saulitis, L. Barrett-Lennard, and D. Matkin. 1999. Killer Whales of Southern Alaska. North Gulf Oceanic Society. 96 pp.

Mitchell, E. D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. J. Fish. Res. Bd. Can. 32:914-916.

Northwest Indian Fisheries Commission (NWIFC). 1995. Monitoring of marbled murrelet and marine mammal interactions with 1994 tribal gillnet fisheries in northern Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Final Report to NMFS, Contract No. 52ABNF400087, and U.S. Fish and Wildlife Service. Unpubl. report. 41 pp. Available at NWIFC, 6730 Martin Way E, Olympia, WA 98516.

Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Rep. Int. Whal. Commn. Special Issue 12:209-242.

Pierce, D. J., W. P. Ritchie, and R. Kreuziger. 1994. Preliminary findings of seabird interactions with the non-treaty salmon gill net fishery: Puget Sound and Hood Canal Washington. Unpubl. report. Washington Dept. Fish and Wildlife, Olympia, WA. 39 pp. Available at WDFW, 600 Capitol Way N, Olympia, WA 98501.

Pierce, D. J., M. Alexandersdottir, S. J. Jeffries, P. Erstad, W. Beattie, and A. Chapman. 1996. Interactions of marbled murrelets and marine mammals with the 1994 Puget Sound sockeye gill net fishery. Final Report, Washington Dept. Fish and Wildlife, Olympia, WA. 21 pp.

Reeves, R.R., W.F. Perrin, B.L. Taylor, C.S. Baker, and S.L. Mesnick. 2004. Report of the workshop on shortcomings of cetacean taxonomy in relation to needs of conservation and management, April 30 – May 2, 2004, La Jolla, California. U.S. Department of Commerce NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-363. 94pp. Available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA. 92037.

Ross, P. S., G. M. Ellis, M. G. Ikonomou, L. G. Barrett-Lennard, and R. F. Addison. 2000. High PCB concentrations in free-ranging Pacific killer whales, *Orcinus orca*: effects of age, sex and dietary preference. Mar. Pollut. Bull. 40(6):504-515.

Stevens, T. A., D. Duffield, E. Asper, K. Hewlett, A. Bolz, L. Gage, and G. Bossart. 1989. Preliminary findings of restriction fragment differences in mitochondrial DNA among killer whales (*Orcinus orca*). Can. J. Zool. 67:2592-2595.

Wade, P. R., and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

Ward, E.J., E.E. Holmes, and K.C. Balcomb. 2009. Quantifying the effects of prey abundance on killer whale reproduction. Journal of Applied Ecology, 46(3):632-640.

Ward, E.J. 2012. Comparison of Southern Resident Killer Whale and Northern Resident Killer Whale population dynamics. Presentation made at the 2nd workshop on "The effects of salmon fisheries on Southern resident killer whales ", 13-15 March 2012, Vancouver, BC.

Yano, K., and M. E. Dahlheim. 1995. Killer whale, *Orcinus orca*, depredation on longline catches of bottomfish in the southeastern Bering Sea and adjacent waters. Fish. Bull. 93:355-372.

Ylitalo, G. M., C. O. Matkin, J. Buzitis, M. M. Krahn, L. L. Jones, T. Rowles, and J. E. Stein. 2001. Influence of life-history parameters on organochlorine concentrations in free-ranging killer whales (*Orcinus orca*) from Prince William Sound, AK. Sci. Total Environ. 281:183-203.

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SPERM WHALE (*Physeter macrocephalus*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Sperm whales are ~~widely~~ distributed across the entire North Pacific and into the southern Bering Sea in summer but the majority are thought to be south of 40°N in winter (Rice 1974; Rice 1989; Gosho et al. 1984; Miyashita et al. 1995). For management, the International Whaling Commission (IWC) had divided the North Pacific into two management regions (Donovan 1991) defined by a zig-zag line which starts at 150°W at the equator, is 160°W between 40-50°N, and ends up at 180°W north of 50°N; however, the IWC has not reviewed this stock boundary in many years (Donovan 1991). Sperm whales are found year-round in California waters (Dohl et al. 1983; Barlow 1995; Forney et al. 1995), but they reach peak abundance from April through mid-June and from the end of August through mid-November (Rice 1974). They were seen in every season except winter (Dec.-Feb.) in Washington and Oregon (Green et al. 1992). Of 176 sperm whales that were marked with Discovery tags off southern California in winter 1962-70, only three were recovered by whalers: one off northern California in June, one off Washington in June, and another far off British Columbia in April (Rice 1974). Recent summer/fall surveys in the eastern tropical Pacific (Wade and Gerrodette 1993) show that although sperm whales are widely distributed in the tropics, their relative abundance tapers off markedly westward towards the middle of the tropical Pacific (near the IWC stock boundary at 150°W) and tapers off northward towards the tip of Baja California. The structure of sperm whale populations in the eastern tropical Pacific is not known, but the only photographic matches of known individuals from this area have been between the Galapagos Islands and coastal waters of South America (Dufault and Whitehead 1995) and between the Galapagos Islands and the southern Gulf of California (Jaquet et al. 2003), suggesting that the eastern tropical Pacific animals constitute a distinct stock. A recent survey designed specifically to investigate stock structure and abundance of sperm whales in the northeastern temperate Pacific revealed no apparent hiatus in distribution between the U.S. EEZ off California and areas farther west, out to Hawaii (Barlow and Taylor 2005). ~~Recent analyses of genetic relationships of animals in the eastern Pacific found that mtDNA and microsatellite DNA of animals sampled in the California Current is significantly different from animals sampled further offshore and that genetic differences appeared larger in an east-west direction than in a north-south direction (Mesnick et al. 1999).~~ Sperm whales in the California Current have been identified as demographically independent from animals in Hawaii and the Eastern Tropical Pacific, based on genetic

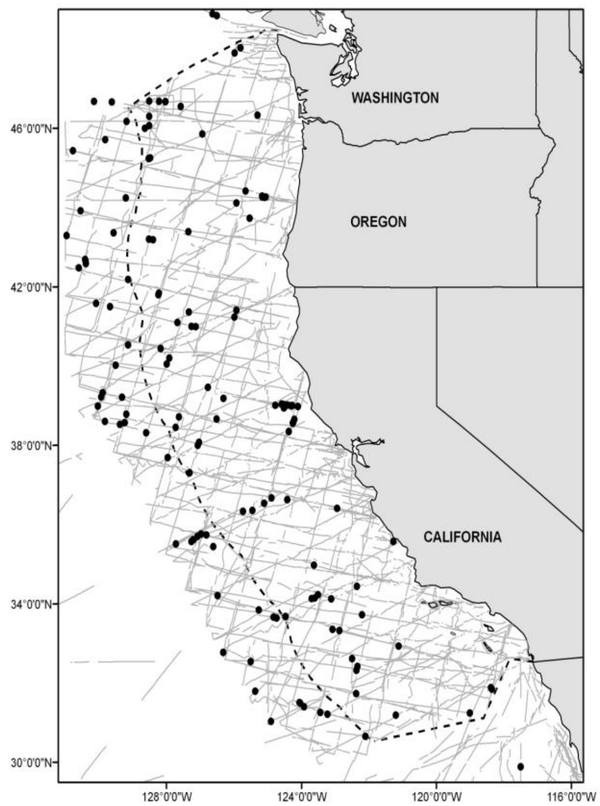

Figure 1. Sperm whale sighting locations based on shipboard surveys off California, Oregon, and Washington, 1991-2008. Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined. See Appendix 2 for data sources and information on timing and location of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

analyses of single-nucleotide polymorphisms (SNPs), microsatellites, and mtDNA (Mesnick *et al*. 2011). For the Marine Mammal Protection Act (MMPA) stock assessment reports, sperm whales within the Pacific U.S. EEZ are divided into three discrete, non-contiguous areas: 1) California, Oregon and Washington waters (this report), 2) waters around Hawaii, and 3) Alaska waters.

POPULATION SIZE

Barlow and Taylor (2001) estimated 1,407 (CV=0.39) sperm whales in California, Oregon, and Washington waters during summer/fall based on pooled 1993 and 1996 ship line transect surveys within 300 nmi of the coast and Barlow and Forney (2007) estimated 2,593 (CV= 0.30) sperm whales from a survey of the same area in 2001. A 2005 survey of this area resulted in an abundance estimate of 3,140 (CV=0.40) whales, which is corrected for diving animals not seen during surveys (Forney 2007). The most recent ship survey of the same area in 2008 resulted in an estimate of only 300 (CV = 0.51) sperm whales (Barlow 2010). The 2008 estimate is lower than all previous estimates within this region and may be due to interannual variability of sperm whale distribution ~~in this region~~. The most recent estimate of abundance for this stock is the geometric mean of the 2005 and 2008 summer/autumn ship survey estimates, or 971 (CV = 0.31) sperm whales. ~~A large 1982 abundance estimate for the entire eastern North Pacific (Gosho et al. 1984) was based on a CPUE method which is no longer accepted as valid by the International Whaling Commission.~~ A combined visual and acoustic line-transect survey conducted in the eastern temperate North Pacific in spring 1997 resulted in estimates of 26,300 (CV=0.81) sperm whales based on visual sightings, and 32,100 (CV=0.36) based on acoustic detections and visual group size estimates (Barlow and Taylor 2005). However, it is not known whether any or all of these animals routinely enter the U.S. EEZ. In the eastern tropical Pacific, the abundance of sperm whales has been estimated as 22,700 (95% C.I.=14,800-34,600; Wade and Gerrodette 1993), but this area does not include areas where sperm whales are taken by drift gillnet fisheries in the U.S. EEZ and there is no evidence of sperm whale movements from the eastern tropical Pacific to the U.S. EEZ. Barlow and Taylor (2001) also estimated 1,640 (CV=0.33) sperm whales off the west coast of Baja California, but again there is no evidence for interchange between these animals and those off California, Oregon and Washington.

Clearly, large populations of sperm whales exist in waters that are within several thousand miles west and south of the California, Oregon, and Washington region that is covered by this report; however, there is no evidence of sperm whale movements into this region from either the west or south and genetic data suggest that mixing to the west is extremely unlikely. There **is** limited evidence of sperm whale movement from California to northern areas off British Columbia, but there are no abundance estimates for this area. The most precise and recent estimate of sperm whale abundance for this stock is therefore 971 (CV = 0.31) animals from the ship surveys conducted in 2005 (Forney 2007) and 2008 (Barlow 2010). This estimate is corrected for diving animals not seen during surveys.

Minimum Population Estimate

The minimum population estimate for sperm whales is taken as the lower 20th percentile of the log-normal distribution of abundance estimated from the 2005-2008 summer/fall ship surveys off California, Oregon and Washington (Barlow and Forney 2007; Forney 2007) or approximately 751.

Current Population Trend

Sperm whale abundance appears to have been rather variable off California between 1979/80 and 1991 (Barlow 1994) and between 1991 and 2008 (Barlow and Forney 2007). The most recent estimate from 2008 is the lowest to date, in sharp contrast to the highest abundance estimates obtained from 2001 and 2005 surveys. There is no reason to believe that the population has declined; the most recent survey estimate likely reflects interannual variability within the study area. To date, there has not been a statistical analysis to detect trends in abundance. Although the population in the eastern North Pacific is expected to have grown since large-scale pelagic whaling stopped in 1980, the possible effects of large unreported catches are unknown (Yablokov 1994) and ~~the~~ ongoing incidental ship strikes and gillnet mortality make this uncertain.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no published estimates of the growth rate for any sperm whale population (Best 1993).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the California portion of this stock is calculated as the minimum population size (751) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (for an endangered stock with N_{min} <1,500; Taylor et al. 2003), resulting in a PBR of 1.5.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The ~~offshore~~ California drift gillnet swordfish fishery is the only fishery that is likely to directly take sperm whales from this stock. Detailed information on this fishery is provided in Appendix 1. A summary of known fishery mortality and injury for this stock of sperm whales from ~~2004-2008~~ 2006-2010 is given in Table 1. ~~After the 1997 implementation of a Take Reduction Plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). However, two sperm whales have been observed taken in nets with pingers (1996 and 1998). Because sperm whale entanglement is rare and because those nets which took sperm whales did not use the full mandated complement of pingers~~, Although acoustic pingers are known to reduce the entanglement of cetaceans in the California drift gillnet swordfish fishery (Barlow and Cameron 2003, Carretta et al. 2008, Carretta and Barlow 2011), it is difficult to evaluate whether pingers have any effect on sperm whale entanglement in drift gillnets. Sperm whales have only been entangled 10 times in over 8,000 observed drift gillnet sets since 1990. Six entanglements occurred prior to the use of pingers in this fishery. Two entanglements (1996 and 1998) occurred in sets that did not use a full complement of pingers, and two animals were entangled in 2010 in a single net where a full complement of 40 pingers was used (Carretta and Enriquez 2012). ~~One sperm whale stranded dead in 2004 with 5 to 6-inch mesh nylon netting found in its stomach (NMFS Southwest Regional Office, unpublished data). The fishery source of this netting is unknown.~~ Other fisheries may injure or kill sperm whales, in the form of entanglement or ingestion of marine debris. Three separate sperm whale strandings in 2008 showed evidence of fishery interactions (Jacobsen et al. 2011; NMFS, unpublished stranding data). Two whales died from gastric impaction as a result of ingesting multiple types of floating polyethylene netting (Jacobsen *et al*. 2010). The variability in size and age of the ingested net material suggests that it was ingested as surface debris and was not the result of fishery depredation (Jacobsen *et al*. 2010). Net types recovered from the whales' stomachs included portions of gillnet, bait nets, and fish/shrimp trawl nets. A third whale showed evidence of entanglement scars (NMFS, unpublished stranding data). Mean annual takes for ~~this fishery~~ all fisheries (Table 1) are based on ~~2004-2008~~ 2006-2010 observer and stranding data (~~Carretta et al. 2005;~~ Carretta and Enriquez ~~2006,~~ 2007, 2009a, 2009b, 2010, 2012, Jacobsen et al. 2010, NMFS unpublished stranding data). This results in an average estimate of ~~0.2 (CV = not available)~~ 3.8 (CV=0.95) sperm whale deaths per year.

Table 1. Summary of available information on the incidental mortality and injury of sperm whales (CA/OR/WA stock) for commercial fisheries that might take this species ~~(Carretta et al. 2005)~~. n/a indicates that data are not available. Mean annual takes are based on ~~2004-2008~~ 2006-2010 data unless noted otherwise.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed mortality (and serious injury in parentheses)	Estimated mortality (CV in parentheses)	Mean annual takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	~~2004~~ ~~2005~~ 2006 2007 2008 2009 2010	observer	~~20.6%~~ ~~20.9%~~ 18.5% 16.4% 13.5% 13.3% 11.9%	~~0~~ ~~0~~ 0 0 0 0 1 (1)	~~0~~ ~~0~~ 0 0 0 0 16 (0.95)	~~0 (n/a)~~ 3.2 (0.95)
Unknown fishery	~~2004-2008~~ 2006-2010	stranding	n/a	~~1~~ 3	~~≥1~~ ≥ 3	~~≥0.2~~ ≥ 0.6
Total annual takes						~~≥0.2 (n/a)~~ ≥ 3.8 (0.95)

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from this population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 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). 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.

Sperm whales from the North Pacific stock are known to depredate on longline sablefish catch in the Gulf of Alaska and sometimes incur serious injuries from becoming entangled in gear (Allen and Angliss 2011). An unknown number of whales from the CA/OR/WA stock probably venture into waters where Alaska longline fisheries operate, but the amount of temporal and spatial overlap is unknown. Thus, the risk of serious injury to CA/OR/WA stock sperm whales resulting from longline fisheries cannot be quantified.

Ship Strikes

One sperm whale died as the result of a ship strike in Oregon in 2007 (NMFS Northwest Regional Stranding data, unpublished). Sperm whale mortality and serious injuries attributed to ship strikes averaged 0.2 per year for 2004-2008 2006-2010.

STATUS OF STOCK

The only estimate of the status of North Pacific sperm whales in relation to carrying capacity (Gosho et al. 1984) is based on a CPUE method which is no longer accepted as valid. Whaling removed at least 436,000 sperm whales from the North Pacific between 1800 and the end of commercial whaling for this species in 1987 (Best 1976; Ohsumi 1980; Brownell 1998; Kasuya 1998). Of this total, an estimated 33,842 were taken by Soviet and Japanese pelagic whaling operations in the eastern North Pacific from the longitude of Hawaii to the U.S. West coast, between 1961 and 1976 (Allen 1980, IWC statistical Areas II and III), and approximately 1,000 were reported taken in land-based U.S. West coast whaling operations between 1919 and 1971 (Ohsumi 1980; Clapham et al. 1997). There has been a prohibition on taking sperm whales in the North Pacific since 1988, but large-scale pelagic whaling stopped earlier, in 1980. As a result of this whaling, sperm whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the California to Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. Including both fishery and ship-strike mortality, The the annual rate of kill and serious injury (0.4 4.0 per year) is less greater than the calculated PBR for this stock (1.5). Total human-caused mortality is greater than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and 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 deep-diving whales like sperm whales that feed in the ocean's "sound channel".

REFERENCES

Allison, C. International Whaling Commission. The Red House, 135 Station Road, Impington, Cambridge, UK CB4 9NP.

Allen, B. M. and R. P. Angliss. 2011. Alaska marine mammal stock assessments, 2010. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-223, 292 p.

Allen, K. R. 1980. Size distribution of male sperm whales in the pelagic catches. Rep. Int. Whal. Commn. Special Issue 2:51-56.

Barlow, J. 2010. Cetacean abundance in the California Current from a 2008 ship-based line-transect survey. NOAA Technical Memorandum, NMFS, NOAA-TM-NMFS-SWFSC-456.

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

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fish. Bull. 93:1-14.

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

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

Barlow, J. and G. A. Cameron. 2003. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Marine Mammal Science 19(2):265-283.

Barlow, J. and B.L. Taylor. 2005. Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey. Marine Mammal Science 21(3):429-445.

Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105:509-526.

~~Berdegué, J. 2002. Depredación de las especies pelágicas reservadas a la pesca deportiva y especies en peligro de extinción con uso indiscriminado de artes de pesca no selectivas (palangres, FAD's, trampas para peces y redes de agallar fijas y a la deriva) por la flota palangrera Mexicana. Fundación para la conservación de los picudos. A.C. Mazatlán, Sinaloa, 21 de septiembre.~~

Best, P. B. 1976. A review of world sperm whale stocks. Paper ACMRR/MM/SC/8 Rev. 1, FAO Scientific Consultation of Marine Mammals, Bergen, Norway.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

Brownell, R. L., Jr., A. V. Yablokov and V. A. Zemmsky. 1998. USSR pelagic catches of North Pacific sperm whales, 1949-1979: Conservation implications. Paper SC/50/CAWS27 presented to the International Whaling Commission, June 1998 (unpublished).

Carretta, J.V. and L. Enriquez. 2012. Marine mammal and seabird bycatch in California gillnet fisheries in 2010. Administrative Report LJ-12-01, available from Southwest Fisheries Science Center, 3333 N. Torrey Pines Court, La Jolla, CA 92037. 16 p.

Carretta, J.V. and J. Barlow. 2011. Long-term effectiveness, failure rates, and "dinner bell" properties of acoustic pingers in a gillnet fishery. Marine Technology Society Journal 45(5):7-19.

Carretta, J.V. and L. Enriquez. 2010. Marine mammal and sea turtle bycatch in the California/Oregon swordfish and thresher shark drift gillnet fishery in 2009. Administrative Report LJ-10-03, available from Southwest Fisheries Science Center, 3333 N. Torrey Pines Court, La Jolla, CA 92037. 11 p.

Carretta, J.V. and L. Enriquez. 2009a. Marine mammal and seabird bycatch observed in California commercial fisheries in 2007. Administrative Report LJ-09-01, available from Southwest Fisheries Science Center, 3333 North Torrey Pines Rd., La Jolla, CA 92037. 12 p.

Carretta, J.V. and L. Enriquez. 2009b. Marine mammal bycatch observed in the California/Oregon swordfish and thresher shark drift gillnet fishery in 2008. Administrative Report LJ-09-03, available from Southwest Fisheries Science Center, 3333 North Torrey Pines Rd., La Jolla, CA 92037. 10 p.

Carretta, J.V., J. Barlow, and L. Enriquez. 2008. Acoustic pingers eliminate beaked whale bycatch in a gill net fishery. Marine Mammal Science 24(4):956-961.

Carretta, J.V. and L. Enriquez. 2007. Marine mammal and sea turtle bycatch in the California/Oregon thresher shark and swordfish drift gillnet fishery in 2006. Administrative Report LJ-07-06, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037. 9p.

~~Carretta, J.V. and L. Enriquez. 2006. Marine mammal bycatch and estimated mortality in California commercial fisheries during 2005. Administrative Report LJ-06-07, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037. 14p.~~

~~Carretta, J.V., S.J. Chivers, and K. Danil. 2005. Preliminary estimates of marine mammal bycatch, mortality, and biological sampling of cetaceans in California gillnet fisheries for 2004.~~

Administrative Report LJ-05-10, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, California, 92037. 17 p.

Clapham, P. J., S. Leatherwood, I. Szczepaniak, and R. L. Brownell, Jr. 1997. Catches of humpback and other whales from shore stations at Moss Landing and Trinidad, California, 1919-1926. Marine Mammal Science 13(3):368-394.

Cordaro, J. Southwest Region, NMFS, 501 West Ocean Blvd, Long Beach, CA 90802_4213.

Dohl, T. P., R. C. Guess, M. L. Duman, and R. C. Helm. 1983. Cetaceans of central and northern California, 1980-83: Status, abundance, and distribution. Final Report to the Minerals Management Service, Contract No. 14-12-0001-29090. 284p.

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

Dufault, S. and H. Whitehead. 1995. The geographic stock structure of female and immature sperm whales in the South Pacific. Rep. Int. Whal. Commn. 45:401-405.

Forney, K. A., J. Barlow, and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fish. Bull. 93:15-26.

Forney, K.A., J. Barlow, M.M. Muto, M. Lowry, J. Baker, G. Cameron, J. Mobley, C. Stinchcomb, and J.V. Carretta. 2000. U.S. Pacific Marine Mammal Stock Assessments: 2000. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-300. 276p.

Forney, K.A. 2007. Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27p.

Gosho, M. E., D. W. Rice, and J. M. Breiwick. 1984. The sperm whale. Mar. Fish. Rev. 46(4):54-64.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Ch. 1 In: J. J. Brueggeman (ed.). Oregon and Washington Marine Mammal and Seabird Surveys. Minerals Management Service Contract Report 14-12-0001-30426.

Hanan, D. A. 1986. California Department of Fish and Game coastal marine mammal study, annual report for the period July 1, 1983 - June 30, 1984. Admin. Rept. LJ-86-16 available from Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA. 55pp.

Hanan, D. A., D. B. Holts, and A. L. Coan, Jr. 1993. The California drift gill net fishery for sharks and swordfish, 1981-82 through 1990-91. Calif. Dept. Fish and Game Fish. Bull. No. 175. 95pp.

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

Holts, D. and O. Sosa-Nishizaki. 1998. Swordfish, *Xiphias gladius*, fisheries of the eastern North Pacific Ocean. *In*: I. Barrett, O. Sosa-Nishizaki and N. Bartoo (eds.). Biology and fisheries of swordfish, *Xiphias gladius*. Papers from the International Symposium on Pacific Swordfish, Ensenada Mexico, 11-14 December 1994. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 142, 276 pp.

Jacobsen, J.K., L. Massey, and F. Gulland. 2010. Fatal ingestion of floating net debris by two sperm whales (*Physeter macrocephalus*). Marine Pollution Bulletin 60:765-767.

Jaquet, N., D. Gendron, and A. Coakes. 2003. Sperm whales in the Gulf of California: residency, movements, behavior, and the possible influence of variation in food supply. Marine Mammal Science 19 (3): 545–562

Julian, F. and M. Beeson. 1998. Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-95. Fishery Bulletin 96:271-284.

Kasuya, T. 1998. Evidence of statistical manipulations in Japanese coastal sperm whale fishery. Paper SC/50/CAWS10 presented to the International Whaling Commission, June 1998 (unpublished).

Leatherwood, S., K. Goodrich, A. L. Kinter, and R. M. Truppo. 1982. Respiration patterns and 'sightability' of whales. Rep. Int. Whal. Commn. 32:601-613.

Mesnick, S. L., B. L. Taylor, B. Nachenberg, A. Rosenberg, S. Peterson, J. Hyde, and A. E. Dizon. 1999. Genetic relatedness within groups and the definition of sperm whale stock boundaries from the coastal waters off California, Oregon and Washington. Admin. Rep. LJ-99-12. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA. 10 pp.

Mesnick, S.L., B.L. Taylor, F.I. Archer, K.K. Martien, S. Escorza Trevino, B.L. Hancock, S.C. Moreno Medina, V.L. Pease, K.M. Robertson, J.M. Straley, R.W. Baird, J. Calambokidis, G.S. Schorr, P. Wade, V. Burkanov, C.R. Lunsford, L. Rendell, and P.A. Morin. 2011. Sperm whale population structure in the eastern and central North Pacific inferred by the use of single-nucleotide polymorphisms, microsatellites and mitochondrial DNA. Molecular Ecology Resources 11:278-298.

Miyashita, T., H. Kato, and T. Kasuya (Eds.). 1995. Worldwide map of cetacean distribution based on Japanese sighting data. Volume 1. National Research Institute of Far Seas Fisheries, Shizuoka, Japan. 140pp.

Ohsumi, S. 1980. Catches of sperm whales by modern whaling in the North Pacific. Rep. Int. Whal. Commn. Special Issue 2: 11-18.

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167.

Rice, D.W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W.E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

Rice, D. W. 1989. Sperm whale Physeter macrocephalus, Linnaeus 1758. pp. 177-233 In: S. H. Ridgway and R. J. Harrison (eds.). Handbook of Marine Mammals, Vol. 4. Academic Press, London.

Sosa-Nishizaki, O., R. De la Rosa Pacheco, R. Castro Longoria, M. Grijalva Chon, and J. De la Rosa Velez. 1993. Estudio biologico pesquero del pez (*Xiphias gladius*) y otras especies de picudos (marlins y pez vela). Rep. Int. CICESE, CTECT9306.

Taylor, B.L., M. Scott, J. Heyning, and J. Barlow. 2003. Suggested guidelines for recovery factors for endangered marine mammals. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-354. 6p.

Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. Rept. Int. Whal. Commn. 43:477-493.

Revised ~~1/19/2011~~ 05/21/2012

GRAY WHALE (*Eschrichtius robustus*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

~~Gray whales formerly occurred in the North Atlantic Ocean (Fraser 1970, Mead and Mitchell 1984), but this species is currently found only in the North Pacific (Rice *et al*. 1984, Swartz *et al*. 2006). The following information was considered in classifying stock structure of gray whales based on the phylogeographic approach of Dizon*et al*. (1992): 1) Distributional data: two isolated geographic distributions in the North Pacific Ocean; 2) Population response data: the eastern North Pacific population has increased, and no evident increase in the western North Pacific; 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. Based on this limited information, two stocks have been recognized in the North Pacific: the Eastern North Pacific stock, which lives along the west coast of North America (Fig. 35), and the Western North Pacific or "Korean" stock, which lives along the coast of eastern Asia (Rice 1981, Rice *et al*. 1984, Swartz *et al*. 2006).~~

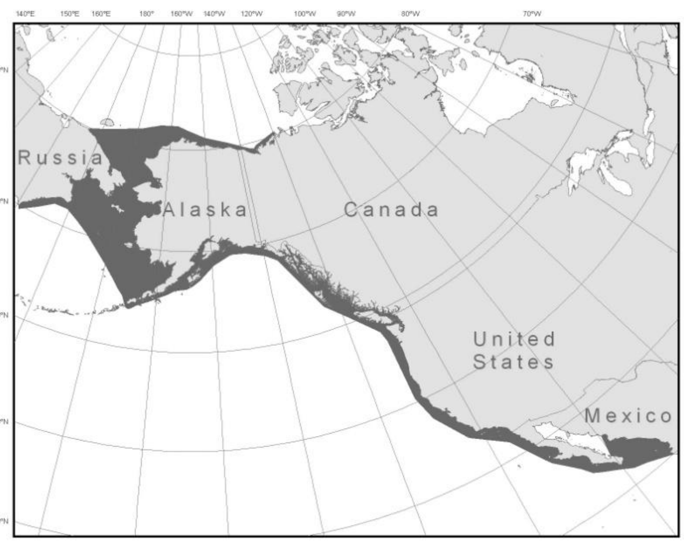

Figure 1. Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area).

~~Most of the Eastern North Pacific stock spends the summer feeding in the northern and western Bering and Chukchi Seas (Rice and Wolman 1971, Berzin 1984, Nerini 1984). However, gray whales have been reported feeding in the summer in waters near Kodiak Island, Southeast Alaska, British Columbia, Washington, Oregon, and California (Rice and Wolman 1971, Darling 1984, Nerini 1984, Rice *et al*. 1984, Moore *et al*. 2007). Photo-identification studies of these animals indicate that they move widely within and between areas on the Pacific coast, are not always observed in the same area each year, and may have several year gaps between resightings in studied areas (Calambokidis and Quan 1999, Quan 2000, Calambokidis *et al*. 2002, Calambokidis *et al*. 2004). The so-called "Pacific coast feeding aggregation" defines one of the areas where feeding groups occur. While some animals in this group demonstrate some site-fidelity, available information from sighting records (Calambokidis and Quan 1999, Quan 2000) and genetics (Ramakrishnan*et al*. 2001, Steeves 1998) indicates that this group is a component of the eastern North Pacific population and is not an isolated population unit. Each fall, the whales migrate south along the coast of North America from Alaska to Baja California, in Mexico (Rice and Wolman 1971), most of them starting in November or December (Rugh*et al*. 2001). The Eastern North Pacific stock winters mainly along the west coast of Baja California, using certain shallow, nearly landlocked lagoons and bays, and calves are born from early January to mid-February (Rice *et al*. 1981), often seen on the migration well north of Mexico (Sheldene*t al*. 2004). The northbound migration generally begins in mid-February and continues through May (Rice *et al*. 1981, 1984; Poole 1984a), with cows and newborn calves migrating northward primarily between March and June along the U.S. West Coast.~~

Once common throughout the Northern Hemisphere, the gray whale became extinct in the Atlantic by the early 1700s (Fraser 1970; Mead and Mitchell 1984), though one anomalous sighting occurred in the Mediterranean Sea in 2010 (Scheinin *et al.* 2011). Gray whales are now found in the North Pacific where two extant populations are currently recognized (Reilly *et al.* 2008). Recent genetic comparisons suggest that these two stocks, called the "Eastern North Pacific" (ENP) and "Western North Pacific" (WNP) populations, are distinct, with differentiation in both mtDNA haplotype and microsatellite allele frequencies (LeDuc *et al.* 2002; Lang *et al.* 2011a).

During summer and fall most whales in the ENP population feed in the Chukchi, Beaufort and northwestern Bering Seas (Fig. 1). An exception to this generality is the relatively small number (100s) of whales that summer and feed along the Pacific coast between Kodiak Island, Alaska and northern California (Darling 1984; Calambokidis *et al.* 2002; 2010; Gosho *et al.* 2011). By late November, the southbound migration is underway as whales begin to travel from summer feeding areas to winter calving areas off the west coast of Baja California, Mexico, and the southeastern Gulf of California (Rugh *et al*. 2001; Swartz *et al.* 2006). The southbound migration is segregated by age, sex and reproductive condition (Rice and Wolman 1971). The northbound migration begins about mid-February and is also segregated by age, sex and reproductive condition.

Gray whale breeding and calving are seasonal and closely synchronized with migratory timing. Sexual maturity is attained between 6 and 12 years of age (Rice 1990; Rice and Wolman 1971). Gestation is estimated to be 13 months, with calving beginning in late December and continuing to early February (Rice and Wolman 1971). Some calves are born during the southbound migration while others are born near or on the wintering grounds (Sheldon *et al*. 2004). Females produce a single calf, on average, every 2 years (Jones 1990). Calves are weaned and become independent by six to eight months of age while on the summer feeding ground (Rice and Wolman 1971). Three primary calving lagoons in the ENP are utilized during winter, and some females are known to make repeated returns to specific lagoons (Jones 1990). Genetic studies suggest that some substructuring may occur on the wintering grounds, with significant differences in mtDNA haplotype frequencies found between females (mothers with calves) utilizing two of the primary calving lagoons and females sampled in other areas (Goerlitz *et al*. 2003). Other research utilizing both mtDNA and microsatellites identified significant departure from panmixia between two of the lagoons using nuclear data, although no significant differences were identified using mtDNA (Alter *et al.* 2009).

The distribution and migration patterns of gray whales in the WNP are less clear. The main feeding ground is in the Okhotsk Sea off the northeastern coast of Sakhalin Island, Russia, but some animals occur off eastern Kamchatka and in other coastal waters of the northern Okhotsk Sea (Weller *et al*. 2002; Vertyankin *et al*. 2004; Tyurneva *et al*. 2010). Some WNP whales migrate south in autumn, but the migration route(s) and winter breeding ground(s) are poorly known. Information collected over the past century indicates that whales migrate along the coasts of Japan and South Korea (Andrews 1914; Mizue 1951; Omura 1984) to wintering areas somewhere in the South China Sea, possibly near Hainan Island (Wang 1984). No sightings off South Korea have been reported in over a decade, however. Results from photo-identification (Weller *et al.* 2011), genetic (Lang 2010; Lang *et al.* 2011a) and telemetry studies (Mate *et al.* 2011) have documented mixing between the WNP and ENP, including observations of six whales photographically matched from Sakhalin Island to southern Vancouver Island, and two whales genetically matched from Sakhalin to Santa Barbara, California. Combined results from photo-ID and genetics studies reveal that a total of 8 gray whales have been observed in both the WNP and ENP (Weller *et al.* 2011; International Whaling Commission (IWC) 2011a). Despite this level of mixing, significant mtDNA and nuclear genetic differences are found between whales in the WNP and those summering in the ENP.

Population structure within the ENP is less clear. Recent studies provide new information on gray whale stock structure within the ENP, with emphasis on whales that feed during summer off the Pacific coast between northern California and southeastern Alaska, occasionally as far north as Kodiak Island, Alaska (Gosho *et al*. 2011). These whales, collectively known as the “Pacific Coast Feeding Group” (PCFG), are a trans-boundary population with the U.S. and Canada and are defined by the IWC as follows: gray whales observed between 1 June to 30 November within the region between northern California and northern Vancouver Island (from 41°N to 52°N) and photo-identified within this area during two or more years (IWC 2011a; IWC 2011b; IWC 2011c). In 2005, the Makah Indian Tribe requested authorization from NOAA/NMFS, under the MMPA and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off the coast of Washington State (NMFS 2008). The spatial overlap of the Makah U&A and the summer distribution of PCFG whales have management implications. The proposal by the Makah Tribe includes time/area restrictions designed to reduce the probability of killing a PCFG whale and to focus the hunt on whales migrating to/from feeding areas to the north. Similarly, observations of gray whales moving between the western and eastern North Pacific highlights the need to estimate the probability of a WNP gray whale being taken during a hunt by the Makah Tribe (IWC 2011a; IWC 2011b). NMFS has published a notice of intent to prepare an environmental impact statement (EIS) on the proposed hunt (NMFS 2012) and the IWC is evaluating the potential impacts of a hunt on the PCFG (IWC 2011a; IWC 2011c; IWC 2011b).

Photo-identification studies from 1998 to 2008 between northern California and northern British Columbia provide data on the abundance and population structure of PCFG whales (Calambokidis *et al*. 2010). Gray whales using the Pacific Northwest during summer and autumn include two components: **1)** whales that frequently return to the area, display a high degree of intra-seasonal “residency” and account for a majority of the sightings between 1 June and 30 November. Despite movement and interchange among sub-regions of the study area, some whales are more likely to return to the same sub-region where they were observed in previous years. **2)**“visitors” from the northbound migration that are sighted only in one year, tend to be seen for shorter time periods in that year, and are encountered in more limited areas.

Satellite tagging studies between 3 September and 4 December 2009 off Oregon and California provide movement data for whales considered to be part of the PCFG (Mate *et al.* 2010). Duration of tag attachment differed between individuals, with some whales remaining in relatively small areas within the larger PCFG seasonal range and others traveling more widely. All six individuals whose tags continued to transmit through the southbound migration utilized the wintering area within and adjacent to Laguna Ojo de Liebre (Scammon´s lagoon). Three whales were tracked north from Ojo de Liebre: one traveled at least as far as Icy Bay, Alaska, while the other two were tracked to coastal waters off Washington (Olympic Peninsula) and California (Cape Mendocino). In addition to satellite tag data, photographic evidence has shown that some presumed PCFG whales move at least as far north as Kodiak Island, Alaska (Calambokidis *et al.* 2010; Gosho *et al.* 2011). The satellite tag and photo-ID data suggest that the range of the PCFG may, at least for some individuals, exceed the pre-defined 41°N to 52°N boundaries that have been used in PCFG-related analyses (e.g. abundance estimation).

Previous genetic studies of PCFG whales focused on evaluating recruitment patterns, with simulations indicating detectable mtDNA genetic differentiation would result if the PCFG originated from a single colonization event in the past 40 to 100 years, without subsequent external recruitment (Ramakrishnan and Taylor, 2001). Subsequent empirical analysis, however, failed to detect differences when 16 samples collected from known PCFG whales utilizing Clayoquot Sound, British Columbia, were compared with samples (n=41) collected from individuals presumably feeding farther north (Steeves *et al.* 2001). Additional genetic analysis with an extended set of samples (n=45) collected from whales within the PCFG range indicated that genetic diversity and the number of mtDNA haplotypes were greater than expected (based on simulations) if recruitment into the PCFG were exclusively internal (Ramakrishnan *et al.* 2001). However, both simulation-based studies focused on evaluating only the hypothesis of founding by a single and recent colonization event and did not evaluate alternative scenarios, such as recruitment of whales from other areas into the PCFG (Ramakrishnan and Taylor 2001; Ramakrishnan *et al.* 2001). More recently, Frasier *et al.* (2011) compared mtDNA sequence data from 40 individuals within the seasonal range of the PCFG with published sequences generated from 105 samples collected from ENP gray whales, most of which stranded along the migratory route (LeDuc *et al.*, 2002). The mtDNA haplotype diversity found among samples of the PCFG was high and similar to the larger ENP samples, but significant differences in mtDNA haplotype distribution and in estimates of long-term effective population size were found. Based on these results, Frasier *et al.* (2011) concluded that the PCFG qualifies as a separate management unit under the criteria of Moritz (1994) and Palsboll *et al.* (2007). The authors noted that the PCFG likely mates with the rest of the ENP population and that their findings were the result of maternally-directed site fidelity of whales to different feeding grounds.

A subsequent study by Lang *et al.* (2011b) assessed stock structure of whales utilizing feeding grounds in the ENP using both mtDNA and eight microsatellite markers. Significant mtDNA differentiation was found when samples from individuals (n=71) sighted over two or more years within the seasonal range of the PCFG were compared to samples from whales feeding north of the Aleutians (n=103) as well as when the PCFG samples were compared to the subset of samples collected off Chukotka, Russia (n=71). No significant differences were found when these same comparisons were made using microsatellite data. The authors concluded that (1) the significant differences in mtDNA haplotype frequencies between the PCFG and whales sampled in the northern areas indicates that the utilization of some feeding areas is being influenced by internal recruitment (e.g., matrilineal fidelity), and (2) the lack of significance in nuclear comparisons suggests that individuals from different feeding grounds may interbreed. The level of mtDNA differentiation identified, while significant, was low and the mtDNA haplotype diversity found within the PCFG was similar to that found in the northern strata. Lang *et al.* (2011b) suggested that these findings could be indicative of relatively recent colonization of the PCFG but could also be consistent with a scenario in which external recruitment into the PCFG is occurring.

After reviewing results from photo-identification, telemetry, and genetic studies available in 2010 (i.e. Calambokidis *et al.* 2010; Mate *et al.* 2010; Frasier *et al.* 2011), the IWC agreed that the hypothesis of the PCFG being a demographically distinct feeding group was plausible and warranted further investigation (IWC 2011a). Recent research by Lang *et al.* (2011b) provided further support for recognition of the PCFG as a distinct feeding aggregation. Because the PCFG appears to be a distinct feeding aggregation and may warrant consideration as a distinct stock in the future, separate PBRs are calculated for the PCFG within this report. Calculation of a PBR for this feeding aggregation allows NMFS to assess whether levels of human-caused mortality are likely to cause local depletion within this population.

POPULATION SIZE

Systematic counts of gray whales migrating south along the central California coast have been conducted by shore-based observers at Granite Canyon most years since 1967 (Fig. 2). The most recent southbound counts were made during the ~~2000/01, 2001/02, and 2006/07~~ 2007/2008, 2009/2010, and 2010/2011 surveys, from which abundance estimates are not yet available.

The most recent estimate of abundance is from the 2006/2007 southbound survey, or 19,126 (CV=7.1%) whales (Laake *et al.* 2009). Because of observed interannual differences in correction factors used to correct for bias in estimating pod size (Rugh *et al.* 2008), the time series of abundance estimates dating back to 1967 was reanalyzed. ~~Recently, Rugh *et al.* (2008b) evaluated the accuracy of various components of the shore-based survey method, with a focus on pod size estimation. They found that the correction factors that had been used to compensate for bias in pod size estimates have been calculated differently for different sets of years. In particular, the correction factors estimated by Laake *et al.* (1994) were substantially larger than those estimated by Reilly (1981). The pod size corrections of Reilly (1981) were used for the 1987/88 abundance estimate and the surveys prior to 1987 in the trend analysis were scaled based on the abundance estimate from 1987/88. The larger pod size correction factors of Laake (1992) were used for all of the surveys after 1987/88. This meant that the first 16 abundance estimates used one set of correction factors, and the more recent seven abundance estimates used different (and larger) correction factors which would influence the estimated trend and population trajectory. In addition, there have been other subtle differences in the analysis methods used for the sequence of abundance estimates. Thus, a re-evaluation of the analysis techniques and a reanalysis of the abundance estimates were warranted to apply a more uniform approach throughout the years.~~ Laake *et al.* (2009) developed a more consistent approach to abundance estimation that used a better model for pod size bias ~~with weaker assumptions.~~ and ~~They~~ applied their estimation approach to re-estimate abundance for all 23 surveys. ~~; therefore, the abundance estimates presented here are different from those presented in previous Stock Assessment Reports.~~

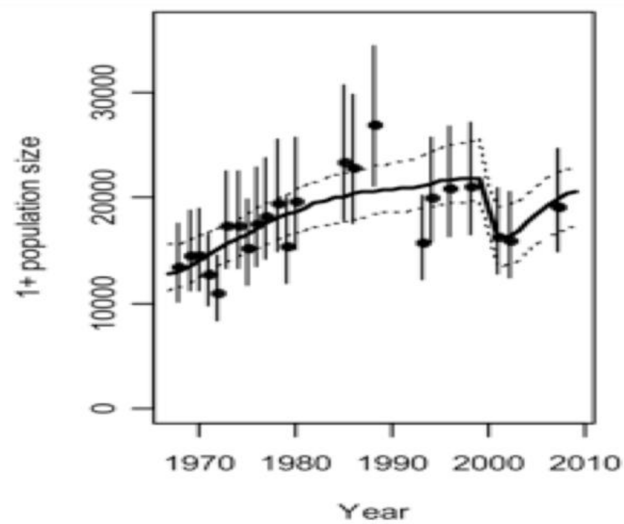

Figure 2. Estimated abundance of Eastern North Pacific gray whales from NMFS counts of migrating whales past Granite Canyon, California. Error bars indicated 90% probability intervals. The solid line represents the estimated trend of the population with 90% intervals as dashed lines (after Punt and Wade 2010).

The new abundance estimates between 1967 and 1987 were generally larger than previous abundance estimates; differences by year between the new abundance estimate and the old estimate range from -2.5% to 21%. However, the opposite was the case for survey years 1992 to 2006, with estimates smaller (-4.9% to -29%) than previous estimates. This ~~pattern~~ is largely explained by ~~the~~ differences in the correction for pod size bias, ~~which occurred~~ because the pod sizes in the calibration data were positively-biased. ~~over-represented pods of two or more whales and underrepresented~~ single whales ~~relative to the estimated true pod size distribution.~~ Re-evaluation of the correction for pod size bias and the other changes made to the estimation procedure yielded a somewhat different trajectory for population growth. The estimates still show the population increased steadily from the 1960s until the 1980s. Previously, the peak abundance estimate was in 1998 followed by a large drop in numbers (Rugh *et al.* 2008~~b~~). Now the peak estimate is a decade earlier in 1987/88. The revised estimates for the most recent years are 16,369 (CV=6.1%) in 2000/01, 16,033 (CV=6.9%) in 2001/02, and 19,126 (CV=7.1%) in 2006/07. Revised estimates from the three years prior are 20,103 (CV=5.6%) in 1993-94, 20,944 (CV=6.1%) in 1995-96, and 21,135 (CV=6.8%) in 1997-98 (Laake *et al.* 2009).

Gray whale counting methods were updated with a new counting technique during the 2006/2007 migration where two observers and a computer are used to log and track individual pods (Durban *et al.* 2010). This replaces a long-used method of a single observer recording sightings on paper forms. The two-observer method allows for a higher frequency of observations of each whale pod, because one observer is dedicated solely to observing pods, while a second observer's primary role is data recording and software tracking of pods. Evaluations of both counting techniques during simultaneous (2006/2007 and 2007/2008) and independent (2006/2007, 2007/2008, 2009/2010, and 2010/2011) trials have been completed (Durban *et al*. 2010, 2011) and correction factors for the new approach are presently being estimated (Durban *et al*. 2011).

Photographic mark-recapture abundance estimates for PCFG gray whales between 1998 and 2008, including estimates for a number of smaller geographic areas within the more broadly defined PCFG region, are reported in Calambokidis *et al*. (2010). These estimates were further refined during an inter-sessional workshop of the IWC (IWC 2011b). The 2008 abundance estimate for the defined range of the PCFG between 41°N to 52°N is 194 (SE = 17.0) whales.

~~The~~ Eastern North Pacific ~~population of~~ gray whales experienced an unusual mortality event in 1999 and 2000, ~~. An unusually high number of gray whales were~~ when large numbers stranded along the west coast of North America ~~in those years~~ (Moore *et al*., 2001; Gulland *et al*., 2005). Over 60% of the dead whales were adults, and more adults and subadults stranded in 1999 and 2000 relative to ~~the~~ years prior to the mortality event (1996-98), when calf strandings were more common. Many ~~of the~~ stranded whales were ~~in an~~ emaciated ~~condition,~~ and aerial photogrammetry documented that gray whales were ~~skinnier in girth~~ thinner in 1999 relative to previous years (Perryman and Lynn, 2002). ~~In addition, calf production in 1999 and 2000 was less than 1/3 of that in the previous years (1996-98).~~ Several factors ~~since this mortality event~~ suggest that the high mortality rate was a short-term, acute event and not a chronic situation or trend: 1) in 2001 and 2002, strandings of gray whales along the coast decreased to levels that were below their pre-1999 level (Gulland *et al*., 2005); 2) average calf production in 2002-2004 returned to levels seen before 1999; and 3) in 2001, living whales no longer appeared to be emaciated. A Working Group on Marine Mammal Unusual Mortality Events (Gulland *et al*., 2005) concluded that the emaciated condition of many ~~of the~~ stranded whales supported the idea that starvation could have been a significant contributing factor to the higher number of strandings in 1999 and 2000. ~~Perryman *et al*. (2002) found a significant positive correlation between an index of the amount of ice-free area in gray whale feeding areas in the Bering Sea and their estimates of calf production for the following spring; the suggested mechanism is that more open water for a longer period of time provides greater feeding opportunities for gray whales.~~ Unusual oceanographic conditions in 1997 may also have decreased productivity in the region (Minobe 2002). Regardless of the mechanism, visibly emaciated whales (LeBoeuf *et al*. 2000; Moore *et al*. 2001) suggest a decline in ~~the availabilityof~~ available food resources, and it is clear that ~~Eastern North Pacific~~ ENP gray whales were substantially affected in those years; whales were ~~on average~~ skinnier, they had a lower survival rate (particularly of adults), and calf production was dramatically lower. A modeling analysis estimates that 15.3% of the non-calf population died in each of the years of the mortality event, compared to about 2% in a normal year (Punt and Wade 2010). The most recent abundance estimate from 2006/07 suggests the population has nearly increased back ~~up~~ to ~~the~~ levels seen in the 1990s before the mortality event in 1999 and 2000 (Figure 2).

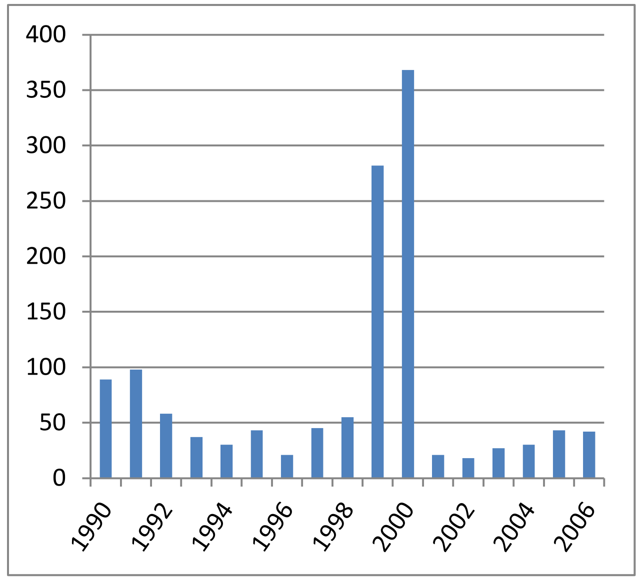

Figure 3. Number of stranded gray whales recorded along the west coast of North America between 1990 and 2006 (data from Brownell et al. 2007).

Gray whale calves were counted from Piedras Blancas, a shore site in central California, in 1980-81 (Poole 1984a) and each year since 1994 (Perryman *et al*. 2002, 2004, 2011). In 1980 and 1981, calves passing this site comprised 4.7% to 5.2% of the population (Poole 1984b). ~~From 1994-2000, calf production indices (calf estimate/total population estimate) were 4.2%, 2.7%, 4.8%, 5.8%, 5.5%, 1.7% and 1.1%, respectively (Perryman *et al*. 2002), and in 2004 the index was 9% (Perryman *et al*. 2004).~~ Estimates for the total number of northbound calves in 2001 to 2010 were 256, 842, 774, 1528, 945, 1020, 404, 553, 312 and 254, respectively (Perryman *et al*. 2011). These calf estimates were highly variable between years. Calf production indices, as calculated by dividing the estimates of northbound calves by estimates of abundance for the population (Laake *et al*. 2009), ranged between 1.3 - 8.8% with a mean of 4.1% during the 17-year time series (1994-2010). Annual indices of calf production include impacts of early postnatal mortality but may overestimate recruitment because they exclude possibly significant levels of killer whale predation on gray whale calves north of the survey site. The relatively low reproductive output is consistent with reports of little or no population growth over the same time period (Laake *et* *al*. 2009; Punt and Wade 2010). Comparisons of sea ice cover in the Bering Sea with estimates of northbound calves revealed that average ice cover in the Bering Sea explains roughly 70% of the inter-annual variability in estimates of northbound calves the following spring (Perryman *et al*. 2011). In other words, a late retreat of seasonal ice may impact access to prey for pregnant females and reduce the probability that existing pregnancies will be carried to term.

Gray whale calves have also been counted from shore stations along the California coast during the southbound migration (Shelden *et al*. 2004). Those results have indicated significant increases in average annual calf counts near San Diego in the mid- to late-1970s compared to the 1950s and 1960s, and near Carmel in the mid-1980s through 2002 compared to late-1960s through 1980 (Shelden *et al*. 2004). This increase may be related to a trend toward later migrations over the observation period (Rugh *et al*. 2001, Buckland and Breiwick 2002), or it may be due to an increase in spatial and temporal distribution of calving as the population increased (Shelden *et al*. 2004).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for ~~this~~ the ENP stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1 + [CV(N)]^2)]^{½})$. Using the 2006/07 abundance estimate of 19,126 and its associated CV of 0.071, N_{MIN} for this stock is 18,017.

The minimum population estimate for PCFG gray whales is calculated as the lower 20th percentile of the log-normal distribution of the 2008 mark-recapture estimate given above, or 180 animals.

Current Population Trend

The population size of the ~~Eastern North Pacific~~ ENP gray whale stock has been increasing over the past several decades despite an unusual mortality event in 1999 and 2000. The estimated annual rate of increase, based on the unrevised abundance estimates between 1967 and 1988, is 3.3% with a standard error of 0.44% (Buckland *et al*. 1993). Using the revised abundance time series from Laake *et al*. (2009) leads to an annual rate of increase for that same period of 3.2% with a standard error of 0.5% (Punt and Wade 2010).

Abundance estimates of PCFG gray whales reported by Calambokidis *et al*. (2010) from 1999 to 2008 indicates a stable population size over multiple spatial scales. No statistical analysis of trends in abundance is currently available for this population.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The abundance time-series has been revised (Laake *et al.* 2009), so estimates of productivity rates must be based on the revised time-series. Using abundance data through 2006/07, an analysis of the ~~Eastern North Pacific~~ ENP gray whale population led to an estimate of R_{max} of 0.062, with a 90% probability the value was between 0.032 and 0.088 (Punt and Wade 2010). This estimate came from the best fitting age- and sex-structured model, which was a density-dependent Leslie model including an additional variance term, with females and males modeled separately, that accounted for the mortality event in 1999-2000. ~~NMFS has decided to use the lower 10th percentile of that estimate of 0.040. This has the interpretation that there is a 90% probability that the true value of R_{max} is greater than 0.040. Therefore, the R_{max} for Eastern North Pacific gray whales is the same as the default value of 0.04. Therefore, NMFS will use an R_{max} of 0.040.~~ During review of a draft of this stock assessment report, the Pacific Scientific Review Group recommended using the R_{max} value of 0.062 reported by Punt and Wade (2010), instead of the lower 10th percentile of this estimate. This value of R_{max} is also applied to PCFG gray whales, as it is currently the best estimate of R_{max} available for gray whales in the eastern north Pacific.

POTENTIAL BIOLOGICAL REMOVAL

~~Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 1.0, the value for a stock estimated to be above MNPL and therefore not depleted. Thus, for the Eastern North Pacific stock of gray whales, PBR = 360 animals (18,017 × 0.02 × 1.0).~~ The potential biological removal (PBR) level for the ENP stock of gray whales is calculated as the minimum population size (18,017), <u>times</u> one-half of the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 1.0 for a stock above MNPL (Punt and Wade 2010), or 558 animals.

The potential biological removal (PBR) level for PCFG gray whales is calculated as the minimum population size (180 animals), <u>times</u> one half the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), <u>times</u> a recovery factor of 0.5 (for a population of unknown status), resulting in a PBR of 2.8 animals.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY
Fisheries Information

In previous stock assessments, there were six different observed federal commercial fisheries in Alaska that could have had incidental serious injuries or mortalities of gray whales. In 2004, the definitions of these commercial fisheries were changed to reflect target species: these new definitions have resulted in the identification of 22 observed fisheries in the Gulf of Alaska and Bering Sea that use trawl, longline, or pot gear (69 FR 70094, 2 December 2004). There were no observed serious injuries or mortalities of gray whales in any of those fisheries.

NMFS observers monitored the northern Washington marine set gillnet fishery (coastal + inland waters), otherwise known as the Makah tribal fishery for Chinook salmon, during 1990-98 and in 2000. There was no observer coverage in this fishery in 1999; however, the total fishing effort was only four net days (in inland waters), and no marine mammals were reported taken. One gray whale was observed taken in 1990 (Gearin*et al*. 1994) and one in 1995 (P. Gearin, unpubl. data). In July of 1996, one gray whale was entangled in the same tribal set gillnet fishery, but it was released unharmed (P. Gearin, AFSC-NMML, pers. comm.). Data from the most recent 5 years indicates that no gray whales were seriously injured or killed incidental to this fishery.

NMFS observers monitored the California/Oregon thresher shark/swordfish drift gillnet fishery from 2006 to 2010 and the California set gillnet halibut fishery in 2006, 2007, and 2010: no gray whales were observed entangled (Carretta and Enriquez 2007, 2009a, 2009b, 2010, 2012). 1993 to 2003 (Table 1; Julian 1997; Cameron 1998; Julian and Beeson 1998; Cameron and Forney 1999, 2000; Carretta 2001, 2002; Carretta and Chivers 2003, 2004).One gray whale mortality was observed in this fishery in both 1998 and 1999. Overall entanglement rates in the California/Oregon thresher shark/swordfish drift gillnet fishery dropped considerably 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 on buoy lines (Barlow and Cameron 1999). Data from the most recent 5 years indicates that no gray whales were seriously injured or killed incidental to this fishery.

It should be noted that no Observers have not been assigned to most Alaska gillnet fisheries, including those in Bristol Bay that are known to interact with this stock gray whales. , making the estimated mortality from U.S. fisheries a minimum figure.Further, due Due to a lack of observer programs,there are few data concerning the mortality of marine mammals data from incidental to Canadian commercial fisheries is not available. , which are analogous to U.S. fisheries that are known to interact with gray whales. Most data on human-caused mortality and serious injury of gray whales is from strandings (including at-sea reports of entangled animals alive or dead). Strandings represent only a fraction of actual gray whale deaths (natural or human-caused), as reported by Punt and Wade (2010), who estimated that only 3.9% to 13.0% of gray whales that die in a given year end up stranding and being reported. Data regarding the level of gray whale mortality related to commercial fisheries in Canadian waters, though thought to be small, are not readily available or reliable which results in an underestimate of the annual mortality for this stock. However, the large stock size and observed rate of increase over the past 20 years makes it unlikely that unreported mortalities from those fisheries would be a significant source of mortality for the stock. The estimated minimum annual mortality rate incidental to U. S. commercial fisheries (6.7 whales) is not known to exceed 10% of the PBR (44.2) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

A summary of human-caused mortality and serious injury resulting from unknown fishery sources (predominantly pot/trap or net fisheries) is given in Table 1 for the most recent 5-year period of 2006 to 2010. Total observed human-caused fishery mortality for ENP gray whales for the period 2006 to 2010 is 15 animals or 3.0 whales per year (Table 1). Total observed human-caused fishery mortality and serious injury for PCFG gray whales for the period 2006 to 2010 is one animal, or 0.2 whales per year (Table 1).

Table 1. Summary of incidental mortality of Eastern North Pacific gray whales due to commercial fisheries from 2003-2007 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from stranding data. Data from 2003-2007 (or the most recent 5 years of available data) are used in the mortality calculation. N/A indicates that data are not available.

Fishery name	Years	Data type	Observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Unknown west coast fisheries	2003-2007	strand data	N/A	N/A, 1, 1, 1, 0	N/A	[≥0.6]
AK salmon purse seine	1999-2003	strand data	N/A	1, N/A, N/A, N/A, N/A	N/A	[≥0.5]

~~Fishery name~~	~~Years~~	~~Data type~~	~~Observer coverage~~	~~Observed mortality (in given yrs.)~~	~~Estimated mortality (in given yrs.)~~	~~Mean annual mortality~~
~~Pot fisheries~~	~~2003-2007~~	~~strand data~~	~~N/A~~	~~3, 0, 0, 1, 0~~	~~N/A~~	~~[≥0.8]~~
~~CA yellowtail/ barracuda/white seabass gillnet fishery~~	~~1999-2003~~	~~strand data~~	~~N/A~~	~~N/A, 1, N/A, N/A, N/A~~	~~N/A~~	~~[≥0.2]~~
~~Other entanglements~~	~~1999-2003~~	~~strand data~~	~~N/A~~	~~1, 2, N/A, 2, 1~~	~~N/A~~	~~[≥1.2]~~
~~Minimum total annual mortality~~						~~≥3.3~~

Table 1. Human-caused deaths and serious injuries (SI) of gray whales from fishery-related sources for the period 2006 to 2010 as recorded by NMFS stranding networks.

Date of observation	Location	PCFG range N 41- N 52 AND season?	Description	Determination
11-May-10	Orange County CA	No	Free-swimming animal entangled in gillnet; animal first observed inside Dana Point Harbor on 5/11/10; animal successfully disentangled on 5/12/10 & swam out of harbor; animal observed alive in surf zone for several hours on 5/14/10 off Doheny State Beach before washing up dead on beach	Dead
7-May-10	Cape Foulweather OR	No	Entangled in 3 crab pots, whale not relocated	SI
16-Apr-10	Seaside OR	No	27-ft long gray whale stranded dead, entangled in crab pot gear	Dead
8-Apr-10	San Francisco CA	No	Rope wrapped around caudal peduncle; identified as gray whale from photo. Free-swimming, diving. No rescue effort, no resightings, final status unknown	SI
5-Mar-10	San Diego	No	Free-swimming entangled whale reported by member of the public; no rescue effort initiated; no resightings reported; final status unknown	SI
21-Jul-09	Trinidad Head CA	Yes	Free-swimming animal with green gillnet, rope & small black floats wrapped around caudal peduncle; report received via HSU researcher on scene during research cruise; animal resighted on 3 Aug; no rescue effort initiated; final status unknown	SI
25-Mar-09	Seal Beach CA	No	Free-swimming animal with pink gillnet wrapped around head, trailing 4 feet of visible netting; report received via naturalist on local whale watch vessel; no rescue effort initiated; final status unknown	SI
31-Jan-09	San Diego CA	No	Free-swimming animal towing unidentified pot/trap gear; report received via USCG on scene; USCG reported gear as 4 lobster pots; final status unknown	SI
16-Apr-08	Eel River CA	No	Observed 12 miles west of Eel River by Humboldt State University personnel. It was unknown sexwith an estimated length of 20 ft and in emaciated condition. The animal was described as towing 40-50 feet of line & 3 crab pot buoys from the caudal peduncle and moving very slowly. Vessel retrieved the buoys, pulled them and ~20 ft of line onto the deck and cut it loose from the whale. The whale swam away slowly with 20-30 feet of line still entangling the peduncle, outcome unknown. Identification numbers on buoy traced to crab pot fishery gear that was last fished in Bering Sea in December 2007.	SI
26-Jul-07	Seattle WA	No[1]	Some gear was removed from the animal, swam away with gear still attached, tribal fishing nets, animal was not sighted again to remove more gear.	SI
20-Apr-07	Newport OR	No	Entangled in crab gear. skipper of nearby vessel removed 8 pots before he had to return to port due to darkness whale still had 8 buoys and several wraps of line around mid-section, left pectoral flipper, and through mouth	SI

[1] For purposes of calculating annual human-caused mortality, this whale is counted as an ENP whale and not part of the PCFG. This determination is based on observations that PCFG whales are not known to enter Puget Sound and current estimates of PCFG population size exclude whales seen in this area (J. Calambokidis, Cascadia Research, personal communication).

13-Jul-06	Ekuk, AK	No	Stranded animal at Etolin Pt. Observed in commercial salmon set net.	Dead
3-Jul-06	Bristol Bay, AK	No	Animal trailing gear, able to swim but not dive. Ropes, buoys, and single line with buoys reported around mid-section.	SI
29-May-06	Gray's Harbor WA	No	Entangled in crab pot. Rope wrapped around fluke, tailstock, mid-body and through baleen. Rope scarring on head and left side (right side unseen).	Dead
14-May-06	Lakeside OR	No	Live entangled gray whale calf with crab pot and gear wrapped around tail stock and mouth, died on 5/15	Dead
23-Apr-06	Cape Lookout OR	No	Entangled whale close to shore, was behind two other larger whales; whale had netting over snout and long line (8-10 times its body length) and 2 bright orange floats	SI

Strandings and Entanglements

Reports of entangled gray whales found swimming, floating, or stranded with fishing gear attached occur along the U.S. west coast and British Columbia. Details of strandings that occurred in 1993-95 and 1996-98 in the United States and British Columbia are described in Hill and DeMaster (1999) and Angliss*et al*. (2002), respectively. Table 2 presents data on strandings that occurred on the U. S. west coast from 2005 to 2009. The strandings resulting from commercial fishing are listed as unknown west coast fisheries in Table 2, unless they could be attributed to particular fisheries. During the 5-year period from 2005 to 2009, stranding network data indicate a minimum annual mean of 2.4 gray whale mortalities resulting from interactions with commercial fishing gear.

Table 2. Human-related gray whale strandings and entanglements, 2005-2009. An asterisk in the "number" column indicates cases that were not considered serious injuries. Note: NMFS convened a workshop in 2007 to review and update the guidelines for what constitutes "serious injury". Changes to the agency's guidelines resulting from this workshop may affect whether injured animals identified are considered "seriously injured" in future SARs.

Year	Number	Area	Condition	Description
2005	1	Grayland, WA	Dead	Entanglement lines on head
2005	1	Horsefall Beach, OR	Dead	Entanglement; fishing line wrapped around animal
2006	1	Grays Harbor, WA	Dead	Entangled in crab pot; rope wrapped around fluke, tailstock, mid-body, and through baleen; rope scarring on head and left side
2006	1	San Francisco Bay, CA	Dead	Fresh floating carcass; propeller wounds evident
2006	1	Cape Lookout, OR	Live	Entangled whale observed from shore; netting over rostrum and trailing long line (8-10 times length of animal) and 2 bright orange floats
2006	1	Lakeside, OR	Live/ Dead	Calf initially sighted alive entangled with crab pot and gear wrapped around tail stock and mouth; found dead 1 month later
2006	1	Bristol Bay, AK	Alive	Trailing gear; able to swim but not dive; ropes, buoys, and single line with buoys around mid-section; possible Bristol Bay gillnet
2007	1	Newport, OR	Alive	Adult found entangled in crab gear; 8 pots removed, but unable to remove 8 other buoys and several wraps of line around mid-section, left pectoral flipper, and through mouth
2007	1	Bering Sea, AK	Alive	Emacited juvenile; "S"-shaped spinal deformity; trailing 40-50 ft of line w/3 buoys; line wrapped at insertion of flukes 1-2 times; partial disentanglement, but 20-30 ft. of trailing gear remained

~~2008~~	~~1~~	~~Huntington Beach, CA~~	~~Dead~~	~~Calf w/propeller wounds to left dorsum from mid-body to caudal peduncle; deep external bruising on right side of head; necropsy revealed multiple cranial fractures~~
~~2009~~	~~1~~	~~Offshore Seal Beach, Orange County, CA~~	~~Alive~~	~~Gillnet wrapped around head in front of blowholes; apparent wound near net on top of head; trailing 4 ft. of netting in water~~
~~2009~~	~~1~~	~~Off Trinidad Head, CA~~	~~Alive~~	~~Adult female (mom), free-swimming w/green net w/ black floats wrapped around peduncle; gear trailing 2-3 m~~

~~In 1999 and 2000, a large number of gray whale strandings occurred along the west coast of North America between Baja California, Mexico, and the Bering Sea (Norman *et al*. 2000, Pérez-Cortés *et al*. 2000, Brownell *et al*. 2001, Gulland*et al*. 2005). A total of 273 gray whale strandings was reported in 1999 and 355 in 2000, compared to an average of 38 per year during the previous four years (Fig. 2). Gray whale strandings occurred throughout the year in both 1999 and 2000, but regional peaks of strandings occurred where and when the whales were in their migration cycle. Since then, stranding rates have been low (21, 18, 27, 30, 43, and 42 whales in 2001-2006, respectively; Brownell *et al*. 2007). Hypothesized reasons for the high stranding rate in 1999 and 2000 include starvation, effects of chemical contaminants, natural toxins, disease, direct anthropogenic factors (fishery interactions and ship strikes), increased survey/reporting effort, and effects of wind and currents on carcass deposition (Norman *et al*. 2000). Since only 16 animals showed conclusive evidence of direct human interaction in 1999-2000, it seems unreasonable that direct anthropogenic factors were responsible for the increase in strandings. In addition, although survey effort has varied considerably in Mexico and Alaska, it has been relatively constant in Washington, Oregon, and California, so the high rates were not a function of increased observational effort. The other hypotheses have not yet been conclusively eliminated. However, assuming a 5% mortality rate for gray whales (Wade and DeMaster 1996), it would be reasonable to expect that approximately 1,300 gray whales would die annually of natural causes; therefore, the high rate of strandings does not seem to be an area of concern.~~

Subsistence/Native Harvest Information

Subsistence hunters in ~~Alaska and~~ Russia and the United States have traditionally harvested whales from ~~this~~ the ENP stock in the Bering Sea, although only the Russian hunt has persisted in recent years (Reeves 2002). The Makah Tribe of Washington State traditionally hunted gray whales for at least several hundred years until the early 20th century (Huelsbeck 1988) and has requested authorization from NOAA/NMFS, under the MMPA and the Whaling Convention Act, to resume limited hunting of gray whales (see details in Stock Definition and Geographic Range section of this report). ~~The only reported takes by subsistence hunters in Alaska during this decade occurred in 1995, with the take of two gray whales by Alaska Natives (IWC 1997). Russian subsistence hunters reported taking 43 whales from this stock in 1996 (IWC 1998a) and 79 in 1997 (IWC 1999).~~ In ~~1997~~ 2007, the IWC approved a 5-year quota ~~(1998-2002)~~ (2008-2012) of 620 gray whales, with an annual cap of 140, for Russian and U.S. (Makah Indian Tribe) aboriginals based on the aboriginal needs statements from each country ~~(IWC 1998b).~~ The U.S. and Russia have agreed that the quota will be shared with an average annual harvest of 120 whales by the Russian Chukotka people and 4 whales by the Makah Indian Tribe. Total takes by the Russian ~~aboriginal~~ hunt were ~~126 in 2003 (IWC 2005), 110 in 2004 (IWC 2006), 115 in 2005 (IWC 2007),~~ 129 in 2006 (IWC 2008),~~and~~126 in 2007 (IWC 2009), 127 in 2008 (IWC 2010), 115 in 2009 (IWC 2011c) and 118 in 2010 (IWC 2011a). Based on this information, the annual subsistence take averaged ~~121~~ 123 whales during the 5-year period from ~~2003~~ 2006 to ~~2007~~ 2010.

Other Mortality

~~The nearshore migration route used by gray whales makes ship~~ Ship strikes are a ~~nother potential~~ source of mortality for gray whales (Table 2). For the most recent five-year period, 2006-2010, the total serious injury and mortality of ENP gray whales attributed to ship strikes is 11 animals, or 2.2 whales per year (Table 2). The total serious injury and mortality of PCFG gray whales during this same period is one animal, or 0.2 whales per year (Table 2). ~~Between 1999 and 2003, the California stranding network reported 4 serious injuries or mortalities of gray whales caused by ship strikes: 1 each in 1999, 2000, 2001, and 2003 (J. Cordaro, NMFS-SWR, pers. comm.). One ship strike mortality was reported in Alaska in 1997 (B. Fadely, AFSC-NMML, pers. comm.).~~ Additional mortality from ship strikes probably goes unreported because the whales either do not strand or do not have obvious signs of trauma. ~~Therefore, it is not possible to quantify the actual mortality of gray whales from this source, and the annual mortality rate of 1.2 gray whales per year due to collisions with vessels represents a minimum estimate from this source of mortality.~~

~~In 1999 and 2000, the California stranding network reported gray whale strandings due to harpoon injuries (Table 35). A Russian harpoon tip was found in a dead whale that stranded in 1999 (R. Brownell, NMFS-SWFSC, pers. comm.), and an injured whale with a harpoon in its back was sighted in 2000.~~ In February 2010, a gray whale stranded dead near Humboldt, CA with parts of two harpoons embedded in the body. Since ~~these~~ this whale ~~swere~~ was likely harpooned during the aboriginal hunt in Russian waters, ~~they~~ it would have been counted as "struck and lost" ~~whales~~ in the harvest data.

One PCFG gray whale was illegally killed by hunters in Neah Bay in September 2007 (Calambokidis *et al*. 2009).

Table 2. Summary of gray whale serious injuries (SI) and deaths attributed to vessel strikes for the five-year period 2006-2010.

Date of observation	Location	PCFG range N 41 - N 52 AND season?	Description	Determination
12-Mar-10	Santa Barbara CA	No	21 meter sailboat underway at 13 kts collided with free-swimming animal; whale breached shortly after collision; no blood observed in water; minor damage to lower portion of boat's keel; final status unknown; dna analysis of skin sample confirmed species as gray whale	SI
16-Feb-10	San Diego CA	No	Free-swimming animal with propeller-like wounds to dorsum	SI
9-Sep-09	Quileute River WA	Yes	USCG vessel reported to be traveling at 10 knots when they hit the gray whale at noon on 9/9/2009. The animal was hit with the prop and was reported alive after being hit, blood observed in water.	SI
1-May-09	Los Angeles CA	No	Catalina island transport vessel collided with free-swimming calf accompanied by adult animal; calf was submerged at time of collision; pieces of flesh & blood observed in water; calf never surfaced; presumed mortality	SI
27-Apr-09	Whidbey Is. WA	No	Large amount of blood in body cavity, bruising in some areas of blubber layer and in some internal organs. Findings suggestive of blunt force trauma likely caused by collision with a large ship.	Dead
5-Apr-09	Sunset Beach CA	No	Dead stranding; 3 deep propeller-like cuts on right side, just anterior of genital opening; carcass towed out to sea	Dead
4-Apr-09	Ilwaco WA	No	Necropsied, broken bones in skull; extensive hemorrhage head and thorax; sub-adult male	Dead
1-Mar-08	Mexico	No	Carcass brought into port on bow of cruise ship; collision occurred betweeen ports of San diegoand CaboSan Lucas between 5:00 p.m. On 2/28 & 7:20 a.m. On 3/1	Dead
7-Feb-08	Orange County CA	No	Carcass; propeller-like wounds to left dorsum from mid-body to caudal peduncle; deep external bruising on right side of head; field necropsy revealed multiple cranial fractures	Dead
1-Jun-07	Marin, CA	No	Carcass; 4 propeller-like wounds to body	Dead
20-Apr-06	San Francisco CA	No	Floating carcass; propeller wounds; killer whale rake mark scars	Dead
24-Mar-06	San Diego CA	No	Free-swimming animal struck by 18 foot pleasure craft; blood observed in water; final status of animal unknown	SI

HABITAT CONCERNS

~~Eastern North Pacific gray whales range from subtropical lagoons in Baja Mexico to arctic seas around Alaska and eastern Russia (Braham 1984).~~ Evidence indicates that the Arctic climate is changing significantly, ~~and that one result of the change is a~~ resulting in a reduction in ~~the extent of~~ sea ice cover in ~~at least~~ some regions ~~of the Arctic~~ (~~ACIA 2004,~~ Johannessen *et al*. 2004). These changes are likely to affect ~~marine mammal species~~ gray whales ~~in the Arctic, including the gray whale,~~ due to the impacts ~~of a changing Arctic environment~~ on the species' benthic food supply. With the increase in numbers of gray whales (Rugh *et al*. 2005), in combination with changes in prey distribution (Grebmeier *et al*. 2006; Moore *et al*. 2007), some gray whales have moved into new feeding areas, spreading their summer range (Rugh *et al*. 2001). Moore and Huntington (2008) observed that gray whales ~~are perhaps the most adaptable and versatile of the mysticete species,~~ are opportunistic foragers, ~~and have recently been~~ with documented feeding year-round off Kodiak, Alaska. Bluhm and Gradinger (2008) examined ~~likely trends in~~ the availability of pelagic and benthic prey in the Arctic and concluded that pelagic prey is likely to increase while benthic prey is likely to decrease. They noted that marine mammal species that exhibit trophic plasticity ~~feed both pelagically and benthically~~ (such as gray whales which feed on both benthic and pelagic prey) will ~~fare~~ adapt better than trophic specialists ~~those that only feed benthically~~. ~~For gray whales, they observed that the composition of gray whale prey may be less important than the energy density at feeding sites.~~

Global climate change is also likely to ~~lead to~~ increase ~~d~~ human activity in the Arctic as sea ice decreases, including oil and gas ~~(O&G)~~ exploration and shipping (Hovelsrud *et al*. 2008). ~~This increased~~ Such activity ~~will~~ increases the chance of oil spills and ship strikes in this region ~~portion of the whales' range~~. ~~Shipping and some O&G activities have been occurring throughout the whales' range over the past several decades but have not prevented the species' recovery.~~ Gray whales have demonstrated avoidance behavior to anthropogenic sounds associated with oil and gas exploration (Malme *et al.* 1983, 1984) and low-frequency active sonar during acoustic playback experiments (Buck and Tyack 2000, Tyack 2009).

Ocean acidification ~~is another future development that~~could ~~affect gray whalesby affecting theirprey.Increased acidity in the ocean will~~ reduces the abundance of shell-forming organisms (Fabry *et al*. 2008, Hall-Spencer *et al*. 2008), many of which are important in the gray whales' diet (Nerini 1984, Moore and Huntington 2008).

STATUS OF STOCK

In 1994, ~~due to steady increases in population abundance,~~ the ~~eastern North Pacific~~ ENP stock of gray whales was removed from the List of Endangered and Threatened Wildlife (the List), as it was no longer considered endangered or threatened under the Endangered Species Act (ESA) (NMFS 1994). ~~As required by the ESA, NMFS monitored the status of this stock for 5 years following delisting. A workshop convened by NMFS on 16-17 March 1999 at the AFSC's National Marine Mammal Laboratory in Seattle, WA, reviewed the status of the stock based on research conducted during the 5-year period following delisting. Invited workshop participants determined that the stock was neither in danger of extinction, nor likely to become endangered within the foreseeable future, therefore there was no apparent reason to reverse the previous decision to remove this stock from the List (Rugh*et al*. 1999). This recommendation was subsequently adopted by NMFS.~~

~~Prior to the revised abundance estimates of Laake *et al*. (2009), Wade (2002) conducted an assessment of the Eastern North Pacific gray whale stock using survey data through 1995-96. Wade and Perryman (2002) updated the assessment in Wade (2002) to incorporate the abundance estimates from 1997-1998, 2000-2001, and 2001-2002, as well as calf production estimates from the northward migration (1994 to 2001), into a more complete analysis that further increased the precision of the results.All analyses concluded that the population was within the stock's optimum sustainable population (OSP) level (i.e., there was essentially zero probability that the population was below the stock's maximum net population level), and estimated the population in 2002 was between 71% and 102% of current carrying capacity. Similar results were found in a separate assessment (Punt *et al*. 2004). The Scientific Committee of the IWC reviewed both assessments and agreed that management advice could be formulated from the results. Both assessments indicated that the population was above MSYL, and was likely close to or above its unexploited equilibrium level (IWC 2003).~~

~~Using assessment methods similar to those of Wade (2002), Wade and Perryman (2002), and Punt *et al*. (2004);Punt and Wade (2010)conducted the first assessment of the Eastern North Pacific gray whale stock to use the revised abundance estimates from Laake*et al* (2009). From that assessment,~~ Punt and Wade (2010) estimated the ENP population ~~is estimated to be~~ was at 91% of carrying capacity (K), and at 129% of the maximum net productivity level (MNPL), with a probability of 0.884 that the population is above MNPL and therefore within the range of its optimum sustainable population (OSP).~~Those results were consistent across all the model runs. Therefore, the assessment using the revised abundance time series is consistent with previous assessments, and estimates the population is within OSP.~~

Even though the stock is within OSP, abundance will ~~rise and fall~~ fluctuate as the population adjusts to natural and ~~man~~ human-caused factors affecting ~~the~~ carrying capacity of the environment (Rugh *et al*. 2005). ~~In fact, it~~ It is expected that a population close to or at ~~the~~ carrying capacity ~~of the environment~~ will be more susceptible to environmental fluctuations ~~in the environment~~ (Moore *et al*. 2001). The ~~recent~~ correlation between gray whale calf production and environmental conditions in the Bering Sea (Perryman *et al*. 2002) may ~~be an example of~~ reflect this. ~~For this reason, it can be predicted that the population will undergo fluctuations in the future that may be similar to the 2-year event that occurred in 1999-2000 (Norman *et al*. 2000, Pérez-Cortés *et al*. 2000, Brownell *et al*. 2001, Gulland*et al*. 2005).~~ Overall, the population ~~increased (~~ nearly doubled in size ~~)~~ over ~~approximately~~ the first 20 years of monitoring, and ~~then~~ has fluctuated for the last 30 years around its average carrying capacity. This is ~~entirely~~ consistent with a population approaching K.

Alter *et al*. (2007) used estimates of genetic diversity to infer that North Pacific gray whales may have numbered ~96,000, including animals in both the western and eastern populations, 1,100-1,600 years ago. The authors recommend that because the current estimate of the eastern stock of gray whales is at most 28-56% of this historic abundance, the stock should be designated as "depleted" under the MMPA. NMFS does not accept the recommendation made by Alter *et al.* (2007) for the following reasons. First, their analysis examines the historic population of the entire historical Pacific population of gray whales, while MMPA management occurs at the level of a stock, which in this case is the eastern north Pacific ENP stock. It is speculative to try to determine what proportion of the estimated abundance may have been the eastern or western populations. It is also uncertain whether if Alter *et al.*'s estimates include the Atlantic population (Palsboll *et al*. 2007). Second, NMFS relies on current carrying capacity in making MMPA determinations. Ecosystems conditions change over time and with those changes, the carrying capacity of the ecosystem for different species will also changes. NMFS adopted the practice ofinterpreting interprets carrying capacity to mean "current" carrying capacity in part because it is not reasonable to expect ecosystems to remain static over a time span of thousands of years, even in the absence of human activity. Thus, an estimate of stock abundance 1,100-1,600 years ago is not relevant to MMPA decision-making, even if such an estimate were available.

At present, U.S. commercial fishery-related annual mortality levels less than 36.0 animals per year (i.e., 10% of PBR) can be considered insignificant and approaching zero mortality and serious injury rate. Based on currently available 2006-2010 data, the estimated annual level of human-caused mortality and serious injury for ENP gray whales includes Russian harvest (127.7 123), which includesmortalities mortality from commercial fisheries (3.3 3.0), Russian harvest (121), unlawful hunt (1), and ship strikes (2.2), totals 128 whales per year, which and entanglements (2.4), does not exceed the PBR (360 558). Therefore, the Eastern North Pacific ENP stock of gray whales is not classified as a strategic stock.

PCFG gray whales do not currently have a formal status under the MMPA, though the population size appears stable, based on photo-ID studies (IWC 2011a; IWC 2011b). Total annual human-caused mortality of PCFG gray whales during the period 2006 to 2010 includes deaths due to commercial fisheries (0.2/yr), ship strikes (0.2/yr), and illegal hunts (0.2/yr), or 0.6 whales annually. This does not exceed the PBR level of 2.8 whales for this population. Levels of human-caused mortality and serious injury resulting from commercial fisheries and ship strikes for both ENP and PCFG whales represent minimum estimates as recorded by stranding networks or at-sea sightings.

REFERENCES

Alter, S.E., S. Flores, J. Urban, L. Rojas-bracho, and S.R. Palumbi. 2009. Mitochondrial and nuclear genetic variation across calving lagoons in Eastern North Pacific gray whales (Eschrichtius robustus). Journal of Heredity 100:34-46.

Alter, S.E., E. Rynes, and S. R. Palumbi. 2007. DNA evidence for historic population size and past ecosystem impacts of gray whales. Proc. Nat. Acad. Sci. 104(38):15162-15167.

Andrews, R.C. 1914. Monographs of the Pacific Cetacea. I. The California gray whale (Rhachianectes glaucus Cope). Mem. Am. Mus. Nat. Hist. 1(5):227-87.

Angliss, R. P., D. P. DeMaster, and A. Lopez. 2002. Alaska marine mammal stock assessments, 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-124, 203 pp.

Barlow, J., and G. A. Cameron. 1999. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Unpubl. doc. submitted to Int. Whal. Comm. (SC/51/SM2). 20 pp.

Berzin, A. A. 1984. Soviet studies on the distribution and numbers of the gray whale in the Bering and Chukchi Seas from 1968 to 1982. Pp. 409-419 *In* M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), The Gray Whale, *Eschrichtius robustus.* Academic Press, Inc., Orlando. xxiv + 600 pp.

Bluhm, B. and Gradinger, R. 2008. Regional variability in food availability for Arctic marine mammals.*Ecol. Appl.* 18: S77-96.

Borodin, R. G. 2001. Aboriginal whaling in Chukotka waters in 2000. Unpubl. doc. submitted to Int. Whal. Comm. (SC/53/BRG23). 10 pp.

Borodin, R. G. 2003. Report on the aboriginal subsistence whale harvest of the Russian Federation in 2002. Unpubl. doc. submitted to Int. Whal. Comm. (SC/55/BRG22). 22 pp.

Borodin, R. G. 2004. Subsistence whale harvest of the Russian Federation in 2002. Unpubl. doc. submitted to Int. Whal. Comm. (SC/56/BRG49). 7 pp.

Borodin, R. G., Blokhin, and D. Litovka. 2002. Historical and present information about the aboriginal whale harvest of gray whales in Chukotka, Russia. Unpubl. doc. submitted to Int. Whal. Comm. (SC/54/BRG27). 10 pp.

Braham, H. W. 1984. Distribution and migration of gray whales in Alaska. In: *The Gray Whale* (Ed. by Jones, M. L., Swartz, S. L. & Leatherwood, S.), pp. 249-266. London: Academic Press.

Breiwick, J. W. 1999. Gray whale abundance estimates, 1967/68 - 1997/98: *ROI*, *RY*, and *K*. Pp. 62 *In* D. J. Rugh, M. M. Muto, S. E. Moore, and D. P. DeMaster, Status review of the Eastern North Pacific stock of gray whales. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-103, 96 pp.

Brownell, R. L., Jr., L. Rojas Bracho, S. L. Swartz, J. Urban R., M. L. Jones, H. Perez-Cortes, W. Perryman, and D. P. DeMaster. 2001. Status of the eastern gray whale population: past and future monitoring. Unpubl. doc. submitted to Int. Whal. Comm. (SC/53/BRG21). 11 pp.

Brownell, R. L., Jr., C. A. F. Makeyev, and T. K. Rowles. 2007. Stranding trends for Eastern Gray Whales, Eschrichtius robustus: 1975-2006. Unpubl. doc. submitted to Int. Whal. Comm. (SC/59/BRG40). 7 pp.

Buck, J.R. and P.L. Tyack. 2000. Response of gray whales to low-frequency sounds. J. Acoust. Soc. Am. 107:2774.

Buckland, S. T., and J. M. Breiwick. 2002. Estimated trends in abundance of eastern Pacific gray whales from shore counts (1967/68 to 1995/96). J. Cetacean Res. Manage. 4(1):41-48.

Buckland, S. T., J. M. Breiwick, K. L. Cattanach, and J. L. Laake. 1993. Estimated population size of the California gray whale. Mar. Mammal Sci. 9(3):235-249.

Calambokidis, J., J.L. Laake and A. Klimek. 2010. Abundance and population structure of seasonal gray whales in the Pacific Northwest, 1998 - 2008. Paper IWC/62/BRG32 submitted to the International Whaling Commission Scientific Committee. 50 pp.

Calambokidis, J. A. Klimek, and L. Schlender. 2009. Summary of collaborative photographic identification of gray whales from California to Alaska for 2007. Final Report for Purchase OrderAB133F-05-SE-5570.Available from Cascadia Research (www.cascadiaresearch.org), 218½ W Fourth Ave., Olympia, WA 98501.

Calambokidis, J., J. D. Darling, V. Deeke, P. Gearin, M. Gosho, W. Megill, C. M. Tombach, D. Goley, C. Toropova and B. Gisbourne. 2002. Abundance, range and movements of a feeding aggregation of gray whales (*Eschrichtius robustus*) from California and southeastern Alaska in 1998. J. Cetacean Res. Manage. 4(3):267-276.

Calambokidis, J., R. Lumper, J. Laake, M. Gosho, and P. Gearin. 2004. Gray whale photographic identification in 1998-2003: Collaborative research in the Pacific Northwest. Final report to National Marine Mammal Laboratory, Seattle, WA.Available from Cascadia Research (www.cascadiaresearch.org), 218½ W Fourth Ave., Olympia, WA 98501. 48pp.

Calambokidis, J., and J. Quan. 1999. Photographic identification research on seasonal resident whales in Washington State. Unpubl.doc. submitted to the Workshop to Review the Status of the Eastern North Pacific Stock of Gray Whales, 16-17 March 1999, Seattle, WA.

Cameron, G. 1998. Cetacean mortality in California gillnet fisheries: preliminary estimates for 1997. Unpubl. doc. submitted to Int. Whal. Comm. (SC/50/SM2). 15 pp.

Cameron, G. A., and K. A. Forney. 1999. Preliminary estimates of cetacean mortality in the California gillnet fisheries for 1997 and 1998. Unpubl. doc. submitted to Int. Whal. Comm. (SC/51/O4). 14 pp.

Cameron, G. A., and K. A. Forney. 2000. Preliminary estimates of cetacean mortality in California/Oregon gillnet fisheries for 1999. Unpubl. doc. submitted to Int. Whal. Comm. (SC/52/O24). 12 pp.

Carretta, J. V. 2001. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2000. Unpubl. doc. submitted to Int. Whal. Comm. (SC/53/SM9). 21 pp.

Carretta, J. V. 2002. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2001. Unpubl. doc. submitted to Int. Whal. Comm. (SC/54/SM12). 22 pp.

Carretta, J. V., and S. J. Chivers. 2003. Preliminary estimates of marine mammal mortality and biological sampling of cetaceans in California gillnet fisheries for 2002. Unpubl. doc. submitted to Int. Whal. Comm. (SC/55/SM3). 21 pp.

Carretta J. V., and S. J. Chivers. 2004. Preliminary estimates of marine mammal mortality and biological sampling of cetaceans in California gillnet fisheries for 2003. Unpubl. doc. submitted to Int. Whal. Comm. (SC/56/SM1). 20 pp.

Clarke, J. T., Moore, S. E. &Ljungblad, D. K. 1989. Observations on gray whale (*Eschrichtiusrobustus*) utilization patterns in the northeastern Chukchi Sea, July- October 1982- 1987.*Canadian Journal of Zoology*, 67, 2646-2654.

Carretta, J.V. and L. Enriquez. 2012. Marine mammal and seabird bycatch in California gillnet fisheries in 2010. Administrative Report LJ-12-01.NOAA Fisheries, Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA 92037.14 p.

Carretta, J.V. and L. Enriquez. 2010. Marine mammal and sea turtle bycatch in the California/Oregon swordfish and thresher shark drift gillnet fishery in 2009. Administrative Report LJ-10-03.NOAA Fisheries, Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA 92037.11 p.

Carretta, J.V. and L. Enriquez. 2009a. Marine mammal bycatch in the California/Oregon swordfish and thresher shark drift gillnet fishery in 2008. Administrative Report LJ-09-03.NOAA Fisheries, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, CA 92037. 10p.

Carretta, J.V. and L. Enriquez. 2009b. Marine mammal and seabird bycatch observed in California commercial fisheries in 2007. Administrative Report LJ-09-01.NOAA Fisheries, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, CA 92037. 12p.

Carretta, J.V. and L. Enriquez. 2007. Marine mammal and sea turtle bycatch in the Calfornia/Oregon thresher shark and swordfish drift gillnet fishery in 2006. Administrative Report LJ-07-06. Southwest Fisheries Science Center, NOAA NMFS, 8604 La Jolla Shores Drive, La Jolla, CA 92037. 9p.

Darling, J. D. 1984. Gray whales off Vancouver Island, British Columbia. Pp. 267-287 *In* M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), The Gray Whale, *Eschrichtiusrobustus.* Academic Press, Inc., Orlando. xxiv + 600 pp.

~~Dizon, A. E., C. Lockyer, W. F. Perrin, D. P. DeMaster, and J. Sisson. 1992. Rethinking the stock concept: a phylogeographic approach. Conserv. Biol. 6:24-36.~~

Durban, J., Lang, A., Weller, D.W., Rugh, D., Hobbs, R., Perryman, W. 2010. Comparing shore-based counts of eastern North Pacific gray whales. Paper SC/62/BRG8 presented to the IWC Scientific Committee.

Durban, J., Weller, D.W., Lang, A. and Perryman, W. 2011. Abundance indices of eastern North Pacific gray whales from southbound migration counts, 2007-2011. Paper SC/62/BRG7 presented to the IWC Scientific Committee.

Fabry, V. J., B. A. Seibel, R. A. Feely, and J. C. Orr. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. – ICES Journal of Marine Science, 65(3): 414–432.

Fraser, F. C. 1970. An early 17th century record of the California gray whale in Icelandic waters. Invest. Cetacea 2:13-20.

Frasier, T.R., S.M. Koroscil, B.N. White, and J.D. Darling. 2011. Assessment of population substructure in relation to summer feeding ground use in the eastern North Pacific gray whale. Endangered Species Research 14:39-48.

~~Gardner, S. C. & Chavez Rosales, S. 2000. Changes in the relative abundance and distribution of gray whales (*Eschrichtiusrobustus*) in Magdalena Bay, Mexico during an El Nino event.*Marine Mammal Science*, 16, 728-738.~~

~~Gearin, P. J., S. R. Melin, R. L. DeLong, H. Kajimura, and M. A. Johnson. 1994. Harbor porpoise interactions with a Chinook salmon set-net fishery in Washington State. Rep. Int. Whal. Comm. (Special Issue 15):427-438.~~

~~Gill, R. E. & Hall, J. D. 1983. Use of nearshore and estuarine areas of the southeastern Bering Sea by gray whales (*Eschrichtius robustus*). Arctic 36: 275-281.~~

Goerlitz, D.S., J. Urban, L. Rojas-Bracho, M. Belson and C.M. Schaeff. 2003. Mitochondrial DNA variation among Eastern North Pacific gray whales (Eschrichtiusrobustus) on winter breeding grounds in Baja California. Canadian Journal of Zoology-Revue Canadienne De Zoologie 81:1965-1972.

Gosho, M., P. Gearin, R. Jenkinson, J. Laake, L. Mazzuca, D. Kubiak, J. Calambokidis, W. Megill, B. Gisborne, D. Goley, C. Tombach, J. Darling, and V. Deecke. 2011. Movements and diet of gray whales (Eschrichtiusrobustus) off Kodiak Island, Alaska, 2002 – 2005. Paper SC/M11/AWMP2 presented to the International Whaling Commission AWMP workshop 28 March-1 April 2011.

Grebmeier, J. M., Overland, J. E., Moore, S. E., Farley, E. V., Carmack, E. C., Cooper, L. W., Frey, K. E., Helle, J. H., McLaughlin, F. A. & McNutt, S. L. 2006. A major ecosystem shift in the northern Bering Sea.*Science*, 311, 1461-1464.

Gulland, F.M.D., H. Pérez-Cortés M., J. Urgán R., L. Rojas-Bracho, G. Ylitalo, J. Weir, S.A. Norman, M.M. Muto, D.J. Rugh, C. Kreuder, and T. Rowles. 2005. Eastern North Pacific gray whale (*Eschrichtiusrobustus*) unusual mortality event, 1999-2000. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-150, 33 pp.

Hall-Spencer, J. M., R. Rodolfo-Metalpa, S. Martin, E. Ransome, M. Fine, S. M. Turner, S. J. Rowley, D. Tedesco, and M. C. Buia. 2008. Volcanic carbon dioxide vents show ecosystem effects of ocean acidification. Nature 454: 96-99.

Hill, P. S., and D. P. DeMaster. 1999. Alaska marine mammal stock assessments, 1999. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-110, 166 pp.

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

Hobbs, R.C., D.J. Rugh, J.M. Waite, J.M. Breiwick and D.P. DeMaster. 2004. Abundance of eastern North Pacific gray whales in the 1995/96 southbound migration. J. Cetacean Res. Manage. 6(2):115-120.

Hovelsrud, G.K., McKenna, M. and Huntington, H.P. 2008. Marine mammal harvests and other interactions with humans. *Ecol. Appl.* 18(2 Supplement): S135-S47.

Huelsbeck, D.R. (1988) Whaling in the precontact economy of the central northwest coast. Arctic Anthropology, 25 (1), 1–15.

International Whaling Commission. 1995. Report of the Scientific Committee. Rep. Int. Whal. Comm. 45:53-95.

International Whaling Commission. 1997. Chairman's Report of the 48th Annual Meeting. Rep. Int. Whal. Comm. 47:17-55.

International Whaling Commission. 1998a. International Whaling Commission Report 1996-97. Rep. Int. Whal. Comm. 48:1-2.

International Whaling Commission. 1998b. Chairman's Report of the 49th Annual Meeting. Rep. Int. Whal. Comm. 48:17-51.

International Whaling Commission. 1999. International Whaling Commission Report 1997-98. Annual Report of the International Whaling Commission 1998:1-2.

International Whaling Commission. 2001. International Whaling Commission Report 1999-2000. Annual Report of the International Whaling Commission 2000:1-3.

International Whaling Commission. 2003. Report of the Scientific Committee of the International Whaling Commission. J. Cetacean Res. Manage. 5(Suppl.):30-31.

International Whaling Commission. 2005. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. J. Cetacean Res. Manage. (Suppl.) 7:204-205.

International Whaling Commission. 2006. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. J. Cetacean Res. Manage. (Suppl.) 8:118-119.

International Whaling Commission. 2007. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. J. Cetacean Res. Manage. (Suppl.) 9:142-155.

International Whaling Commission. 2008. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. J. Cetacean Res. Manage. (Suppl.) 10:162-163.

International Whaling Commission. 2009. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. J. Cetacean Res. Manage. (Suppl.) 11:169-175.

International Whaling Commission. 2010. Report of the Scientific Committee. Annex F. Report of the sub-Committee on bowhead, right and gray whales. J. Cetacean Res. Manage. (Suppl.) 2:154-179.

International Whaling Commission. 2011a. Report of the Scientific Committee. Annex E and F. Report of the sub-Committee on bowhead, right and gray whales. Tromso, Norway 30 May-11 June 2011. [Available at http;//www.iwcoffice.org]

International Whaling Commission. 2011b. Report of the 2011 AWMP workshop with a focus on eastern gray whales. Report SC/63/Rep.2 presented to the International Whaling Commission Scientific Committee. [Available at http;//www.iwcoffice.org]

International Whaling Commission. 2011c. Report of the Scientific Committee. Annex E. Report of the standing working group on the aboriginal whaling management procedure (AWMP). J. Cetacean Res. Manage. (Suppl.):143-167.

Johannessen, O. M., L. Bengtsson, M. W. Miles, S. I. Kuzmina, V. A. Semenov, G. V. Alexseev, A. P. Nagurnyi, V. F. Zakharov, L. P. Bobylev, L. H. Pettersson, K. Hasselmann, and H. P. Cattle. 2004. Arctic climate change: observed and modeled temperature and sea-ice variability. Tellus. 56A:328-341.

Jones, M.L. 1990. Reproductive cycle in gray whales based on photographic resightings of females on the breeding grounds from 1977 – 1982. Report to the International Whaling Commission (Special Issue 12): SC/A88/ID38.

Julian, F. 1997. Cetacean mortality in California gillnet fisheries: preliminary estimates for 1996. Unpubl.doc. submitted to Int. Whal. Comm. (SC/49/SM2).13 pp.

Julian, F., and M. Beeson. 1998. Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-1995. Fish. Bull., U.S. 96(2):271-284.

Kochnev, A. A. 1998. Death of whales (Cetacea) in the Chukchi Sea and the Long Strait: Species composition, distribution and causes of death. *ZoologicheskyZhurnal*, 77, 601-605.

Laake, J., Punt, A., Hobbs, R., Ferguson, M., Rugh, D. and J. Breiwick. 2009. Re-analysis of gray whale southbound migration surveys 1967-2006. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-203, 55 p.

Laake, J. L., D. J. Rugh, J. A. Lerczak, and S. T. Buckland. 1994. Preliminary estimates of population size of gray whales from the 1992/93 and 1993/94 shore-based surveys. Unpubl. doc. submitted to Int. Whal. Comm. (SC/46/AS7). 13 pp.

Lang, A.R., Weller, D.W., LeDuc, R., Burdin, A.M., Pease, V.L., Litovka, D., Burkanov, V. and Brownell, R.L., Jr. 2011a.Genetic analysis of stock structure and movements of gray whales in the eastern and western North Pacific. Paper SC/63/BRG10 presented to the IWC Scientific Committee.

Lang, A.R., Taylor, B.L., Calambokidis, J., Pease, V.L., Klimik, A., Scordino, J., Robertson, K.M., Litovka, D., Burkanov, V., Gearin, P., George, J.C. and Mate, B. 2011b. Assessment of stock structure among gray whales utilizing feeding grounds in the Eastern North Pacific. Paper SC/M11/AWMP4 presented to the International Whaling Commission Scientific Committee.

Lang, A.R. 2010. The population genetics of gray whales (Eschrichtius robustus) in the North Pacific.Ph.D. dissertation, University of California San Diego, 222 pp.

LeDuc, R.G., Weller, D.W., Hyde, J., Burdin, A.M., Rosel, P.E., Brownell, R.L., Würsig, B. and Dizon, A.E. 2002. Genetic differences between western and eastern gray whales (Eschrichtius robustus). Journal of Cetacean Research and Management 4:1-5.

LeBoeuf, B. J., M. H. Perez Cortes, R. J. Urban, B. R. Mate, and U. F. Ollervides. 2000. High gray whale mortality and low recruitment in 1999: Potential causes and implications. J. Cetacean Res. Manage. 2(2): 85-99.

Malme C.I., Miles P.R., Clark C.W., Tyack P, Bird J.E. 1983. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Bolt Beranek and Newman Report No. 5366 submitted to Minerals Management Service, US Dept of the Interior, Anchorage, AK. Available at: www.mms.gov/alaska/reports/1980rpts/akpubs80s.htm

Malme C.I., Miles P.R., Clark C.W., Tyack P, Bird J.E. 1984.Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Phase II: January 1984 migration. Bolt Beranek and Newman Report No. 5586 submitted to Minerals Management Service, US Dept of the Interior, Anchorage, AK. Available at: www.mms.gov/alaska/reports/1980rpts/akpubs80s.htm

Mate, B., Lagerquist, B. and Irvine, L. 2010. Feeding habitats, migration, and winter reproductive range movements derived from satellite-monitored radio tags on eastern North Pacific gray whales. Paper SC/62/BRG21 presented to the International Whaling Commission Scientific Committee. 22 pp.

Mate, B., Bradford, A.L., Tsidulko, G., Vertyankin, V. and Ilyashenko, V. 2011.Late-feeding season movements of a western North Pacific gray whale off Sakhalin Island, Russia and subsequent migration into the Eastern North Pacific. Paper SC/63/BRG23 presented to the IWC Scientific Committee.

Mead, J.G., and E.D. Mitchell. 1984. Atlantic gray whales. Pp. 33-53 In M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), The Gray Whale, *Eschrichtius robustus*. Academic Press, Inc., Orlando. Xxiv + 600 pp.

Miller, R. V., Johnson, J. H. &Doroshenko, N. V. 1985.Gray whales (*Eschrichtiusrobustus*) in the western Chukchi and East Siberian seas.*Arctic*, 38, 58-60.

Minobe, S. 2002. Interannual to interdecadal changes in the Bering Sea and concurrent 1998/99 changes over the North Pacific. Progr. Oceanogr. 55(1-2):45-64.

Mizue, K. 1951. Gray whales in the east sea area of Korea. Sci. Rep. Whales, Res. Inst., Tokyo 5:71-9.

Moore, S. E. &DeMaster, D. P. 1997. Cetacean habitats in the Alaskan arctic.*Journal of Northwest Atlantic Fishery Science*, 22, 55-69.

Moore, S. E., DeMaster, D. P. & Dayton, P. K. 2000. Cetacean habitat selection in the Alaskan Arctic during summer and autumn.*Arctic*, 53, 432-447.

Moore, S. E. and H. P. Huntington. 2008. Arctic marine mammals and climate change: impacts and resilience. Ecological Applications 18(Suppl.):157–165.

Moore, S. E. & Ljungblad, D. K. 1984. Gray whales in the Beaufort, Chukchi, and Bering seas: Distribution and sound production. In: *The Gray Whale* (Ed. by Jones, M. L., Swartz, S. L. & Leatherwood, S.), pp. 543-559. London: Academic Press.

Moore, S.E., J. Urbán R., W.L. Perryman, F. Gulland, H. Pérez-Cortés M., P.R. Wade, L. Rojas-Bracho and T. Rowles. 2001. Are gray whales hitting 'K' hard? Mar. Mammal Sci. 17(4):954-958.

Moore, S.E., K.M. Wynne, J.C. Kinney, J.M. Grebmeier. 2007. Gray whale occurrence and forage southeast of Kodiak, Island, Alaska. Mar. Mammal Sci. 23 (2):419–428.

Moritz, C. 1994. Defining 'evolutionarily significant units' for conservation. Trends in Ecology and Evolution 9:373-375.

Nerini, M. 1984. A review of gray whale feeding ecology. Pp. 423-450 *In* M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), The Gray Whale, *Eschrichtiusrobustus.* Academic Press, Inc., Orlando. xxiv + 600 pp.

~~Norman, S. A., M. M. Muto, D. J. Rugh, and S. E. Moore. 2000. Gray whale strandings in 1999 and a review of stranding records in 1995-1998. Final Draft, Unusual Mortality Event Report to the National Marine Fisheries Service. Unpubl. doc. submitted to Int. Whal. Comm. (SC/52/AS5).36 pp.~~

NMFS 1994. Federal Register Volume 59, Number 115 (Thursday, June 16, 1994).

NMFS 2008. Draft environmental impact statement for proposed authorization of the Makah whale hunt. National Marine Fisheries Service, Northwest Region. May 2008.

NMFS 2012. Federal Register 77:29967-29969. Notice of Intent to Prepare an Environmental Impact Statement related to the Makah Indian Tribe's (Tribe) request for authorization of treaty right hunting of eastern North Pacific gray whales in usual and accustomed fishing grounds off the coast of Washington State.

Omura, H. 1984. History of gray whales in Japan. pp. 57-77. In: M.L. Jones, S.L. Swartz and S. Leatherwood (eds.) The Gray Whale, Eschrichtius robustus. Academic Press Inc., Orlando Florida. xxiv+600pp.

Palsboll, P.J., M. Berube, and F.W. Allendorf. 2007. Identification of management units using population genetic data. Trends in Ecology and Evolution 22: 11-16.

~~Pérez-Cortés, H., J. Urbán R., F. Ollervides, A. Gómez-Gallardo, J. I. Solis, and A. Eslimán. 2000. Report of the high gray whale mortality in the Baja California Peninsula during the 2000 season. Unpubl. doc. submitted to Int. Whal. Comm. (SC/52/AS16). 7 pp.~~

Perryman, W.L. and M.S. Lynn. 2002. Evaluation of nutritive condition and reproductive status of migrating gray whales (Eschrichtius robustus) based on analysis of photogrammetric data. Journal of Cetacean Research and Management 4(2):155-164.

Perryman, W. L., M. A. Donahue, P. C. Perkins, and S. B. Reilly. 2002. Gray whale calf production 1994-2000: are observed fluctuations related to changes in seasonal ice cover? Mar. Mammal Sci. 18(l):121-144.

Perryman, W.L., G.M. Watters, L.K. Swartz and R.A. Rowlett. 2004. Preliminary results from shore-based surveys of northbound gray whale calves in 2003 and 2004, with a comparison to predicted numbers based on the distribution of seasonal ice. Paper SC/56/BRG43 presented to the IWC Scientific Committee, June 2004 (unpublished). 7pp.

Perryman, W.L., Reilly, S.B. and Rowlett, R.A. 2011. Results of surveys of northbound gray whale calves 2001-2010 and examination of the full seventeen year series of estimates from PiedrasBlancas Light Station. Paper SC/M11/AWMP3 presented to the IWC Scientific Committee.

Poole, M. M. 1984a. Migration corridors of gray whales along the central California coast, 1980-1982. Pp. 389-407 *In* M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), The Gray Whale, *Eschrichtiusrobustus.* Academic Press, Inc., Orlando. xxiv + 600 pp.

Poole, M. M. 1984b. Preliminary assessment of annual calf production in the gray whale, *Eschrichtiusrobustus*, from Pt. PiedrasBlancas, California. Rep. Int. Whal. Comm. (Special Issue 6):223-231.

~~Punt, A. E., C. Allison and G. Fay. 2004. An examination of assessment models for the eastern North Pacific gray whale based on inertial dynamics. J. Cetacean Res. Manage. 6(2):121-132.~~

Punt, A. E., and P. R. Wade. 2010. Population status of the eastern North Pacific stock of gray whales in 2009. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-207, 43 p.

~~Quan, J. 2000. Summer resident gray whales of Washington State: Policy, biological and management implications of Makah whaling. MS. Thesis. School of Marine Affairs, University of Washington. Seattle, WA.~~

Ramakrishnan, U. and Taylor, B.L. 2001. Can gray whale management units be assessed using mitochondrial DNA? Journal of Cetacean Research and Management 3:13-18.

Ramakrishnan, U., R. G. LeDuc, J. Darling, B. L. Taylor, P. Gearin, M. Gosho, J. Calambokidis, R. L. Brownell, J. Hyde, and T. E. Steeves. 2001. Are the southern feeding group of Eastern Pacific gray whales a maternal genetic isolate? Rep. Int. Whal. Comm. SC53/SD8 5pp.

Reeves, R. 2002. The origins and character of 'aboriginal subsistence' whaling: a global review. Mammal Rev. 32(2):71-106.

~~Rice, D.W. 1981. Status of the eastern Pacific (California) stock of the gray whale. Pp. 181-187InFood and Agriculture Organization. 1981. Mammals in the Seas. Vol. III. General Papers and Large Cetaceans. Food and Agriculture Organization, Rome, Italy.~~

Rice, D.W. 1990. Life history parameters of the gray whale: a review of published estimates. Paper SC/A90/G22 presented to the IWC Scientific Committee Special Meeting on the Assessment of Gray Whales, April 1990.

Rice, D. W., and A. A. Wolman. 1971. The life history and ecology of the gray whale, *Eschrichtius robustus*. Am. Soc. Mammal. Special Publication 3. 142 pp.

~~Rice, D. W., A. A. Wolman, D. E. Withrow, and L. A. Fleischer. 1981. Gray whales on the winter grounds in Baja California. Rep. Int. Whal. Comm. 31:477-493.~~

~~Rice, D. W., A. A. Wolman, and H. W. Braham. 1984. The gray whale, *Eschrichtius robustus*. Mar. Fish. Rev. 46(4):7-14.~~

Reilly S.B., Bannister JL, Best PB, Brown M, Brownell RL, Butterworth DS, Clapham PJ, Cooke J, Donovan GP, Urbán J, Zerbini AN (2008) Eschrichtius robustus (western subpopulation). In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. [Available from http:// www.iucnredlist.org/].

~~Rugh, D., J. Breiwick, M. M. Muto, R. Hobbs, K. Shelden, C. D'vincent, I. M. Laursen, S. Reif, S. Maher, and S. Nilson. 2008a. Report of the 2006-2007 census of the eastern north Pacific stock of gray whales. AFSC Processed Rep. 2008-03, 157 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115.~~

~~Rugh, D. J. & Fraker, M. A. 1981. Gray whale (*Eschrichtius robustus*) sightings in eastern Beaufort Sea.*Arctic*, 34, 186-187.~~

Rugh, D.J., R.C. Hobbs, J.A. Lerczak and J.M. Breiwick. 2005. Estimates of abundance of the eastern North Pacific stock of gray whales 1997-2002. J. Cetacean Res. Manage. 7(1):1-12.

Rugh, D.J., Muto, M.M., Hobbs, R.C. and J.A. Lerczak. 2008~~b~~. An assessment of shore-based counts of gray whales. Mar. Mammal Sci. 24: 864-880.

~~Rugh, D. J., M. M. Muto, S. E. Moore, and D. P. DeMaster. 1999. Status review of the Eastern North Pacific stock of gray whales. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-103, 96 pp.~~

Rugh, D. J., K. E. W. Shelden, and A. Schulman-Janiger. 2001. Timing of the southbound migration of gray whales. J. Cetacean Res. Manage. 3(1):31-39.

Scheinen, A.P., D. Kerem, C.D. Macleod, M. Gazo, C.A. Chicote, and M. Castellote. 2011. Gray whale (*Eschrichtius robustus*) in the Mediterranean Sea: anomalous event or early sign of climate-driven distribution change? Marine Biodiversity Records, 4, e28 doi:10.1017/S1755267211000042.

Shelden, K.E.W., A. Schulman-Janiger, and D.J. Rugh. 2004. Gray whales born north of Mexico: indicator of recovery or consequence of regime shift? Ecological Applications 14(6):1789-1805.

~~Stafford, K. M., Moore, S. E., Spillane, M. & Wiggins, S. 2007. Gray whale calls recorded near Barrow, Alaska, throughout the winter of 2003-04. *Arctic*, 60, 167-172.~~

~~Steeves, T. E. 1998.Genetic population structure of gray whales (*Eschrichtius robustus*) that summer in Clayoquot Sound, British Columbia. M.S. Diss. American University, Washington, D.C.~~

Steeves, T.E., J.D. Darling, P.E. Rosel, C.M. Schaeff and R.C. Fleischer. 2001. Preliminary analysis of mitochondrial DNA variation in a southern feeding group of eastern North Pacific gray whales. Conservation Genetics 2:379-384.

~~Swartz, S.L. 1986. Gray whale migratory, social and breeding behavior. *Report of the International Whaling Commission* (special issue), 8, 207–229.~~

Swartz, S.L., B.L. Taylor, and D.J. Rugh. 2006. Gray whale *Eschrichtius robustus* population and stock identity. Mammal Review. 36(1):66-84.

Tyack, P. 2009. Acoustic playback experiments to study behavioral responses of free-ranging marine animals to anthropogenic sound. Marine Ecology Progress Series 395:187-200.

Tyurneva O. Yu., Yakovlev Yu. M., Vertyankin V. V. and Selin N. I. 2010. The peculiarities of foraging migrations of the Korean-Okhotsk gray whale (*Eschrichtius robustus*) population in Russian waters of the Far Eastern seas. Rus. Jour. of Marine Biol. 36(2):117-124.

Vertyankin, V.V., Nikulin, V.C., Bednykh A.M. and Kononov, A.P. 2004. Sighting of gray whales (*Eschrichtius robustus*) near southern Kamchatka. Pp 126-128 in: Marine Mammals of the Holarctic. Collection of scientific papers of International Conference.Koktebel, Crimea, Ukraine, October 11-17, 2004.

~~Wade, P. R. 2002. A Bayesian stock assessment of the eastern North Pacific gray whale using abundance and harvest data from 1967 to 1996. J. Cetacean Res. Manage. 4(1):85-98.~~

Wade, P. R., and R. Angliss. 1997. Guidelines for assessing marine mammal stocks: report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

~~Wade, P. R., and D. P. DeMaster. 1996. A Bayesian analysis of eastern Pacific gray whale population dynamics. Unpubl.doc. submitted to Int. Whal. Comm. (SC/48/AS3).21 pp.~~

~~Wade, P. R., and W. Perryman. 2002. An assessment of the eastern gray whale population in 2002. Unpubl.doc. submitted to Int. Whal. Comm. (SC/54/BRG7).16 pp.~~

Wang, P. 1984. Distribution of the gray whale (Eschrichtius gibbosus) off the coast of China. Acta Ther. Sinica 4(1):21-6. [In Chinese with English summary].

Weller, D.W., Burdin, A.M., Würsig, B., Taylor, B.L. and Brownell, R.L., Jr. 2002.The western Pacific gray whale: a review of past exploitation, current status and potential threats. J. Cetacean Res. Manage. 4(1):7-12.

Weller, D.W., Klimek, A., Bradford, A. L., Calambokidis, J., Lang, A.R., Gisborne, B., Burdin, A.M., Szaniszlo, W. and Brownell, R.L., Jr. 2011. Movements of western gray whales from the Okhotsk Sea to the eastern North Pacific. Paper SC/63/BRG6 presented to the IWC Scientific Committee.

Revised ~~01/15/2011~~ 05/10/2012

SPINNER DOLPHIN (*Stenella longirostris longirostris*): Hawaiian Islands Stock Complex- Hawaii Island, Oahu/4-islands, Kauai/Niihau, Pearl & Hermes Reef, Midway Atoll/Kure, Hawaii Pelagic

STOCK DEFINITION AND GEOGRAPHIC RANGE

Six morphotypes within four subspecies of spinner dolphins have been described worldwide in tropical and warm-temperate waters (Perrin et al. 2009). The Gray's (or pantropical) spinner dolphin (*Stenella longirostris longirostris*) is the most widely distributed subspecies and is found in the Atlantic, Indian, central and western Pacific Oceans (Perrin *et al.* 1991). Within the central and western Pacific, spinner dolphins are island-associated and use shallow protected bays to rest and socialize during the day then move offshore at night to feed (Norris and Dohl 1980; Norris *et al.* 1994). They are common and abundant throughout the entire Hawaiian archipelago (Shallenberger 1981; Norris and Dohl 1980; Norris et al. 1994), and 26 strandings have been reported (Maldini et al. 2005). ~~Recent s~~ Sighting locations from a 2002 shipboard survey of waters within the U.S. Exclusive Economic Zone (EEZ) of the main Hawaiian Islands (Barlow 2006) are shown in Figure 1. There were no on-effort sightings of spinner dolphins during the 2010 survey of the Hawaiian Islands (NMFS unpublished data).

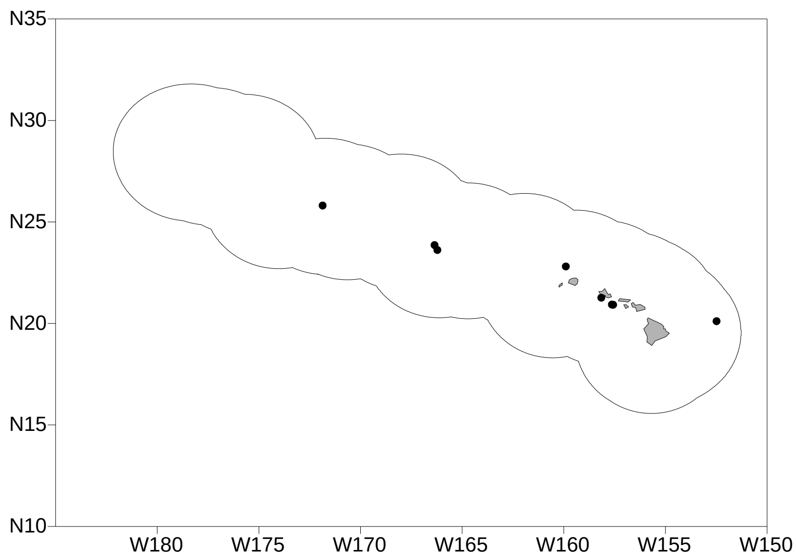

Figure 1. Spinner dolphin sighting locations during the 2002 shipboard cetacean survey of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2006; see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area and U.S. EEZ.

Hawaiian spinner dolphins belong to a stock that is separate from ~~those involved in the tuna purse seine fishery~~ animals in the eastern tropical Pacific (Perrin 1975; Dizon et al. 1994). The Hawaiian form is referable to the subspecies *S. longirostris longirostris*, which occurs pantropically (Perrin 1990). ~~Recent studies on the genetic~~ Genetic structure of spinner dolphins in the Hawaiian archipelago ~~found significant genetic distinctions~~ is evident between spinner dolphins sampled at five different islands/atolls: Hawaii, Oahu/4-islands, Kauai/Niihau, Pearl and Hermes Reef, Midway Atoll/Kure (Andrews 2009, Andrews et al. 2010). These distinctions are supported by available photo-ID and animal movement data (Karczmarski et al. 2005). In particular, mitochondrial and microsatellite DNA data from individuals sampled along the Kona Coast of Hawaii

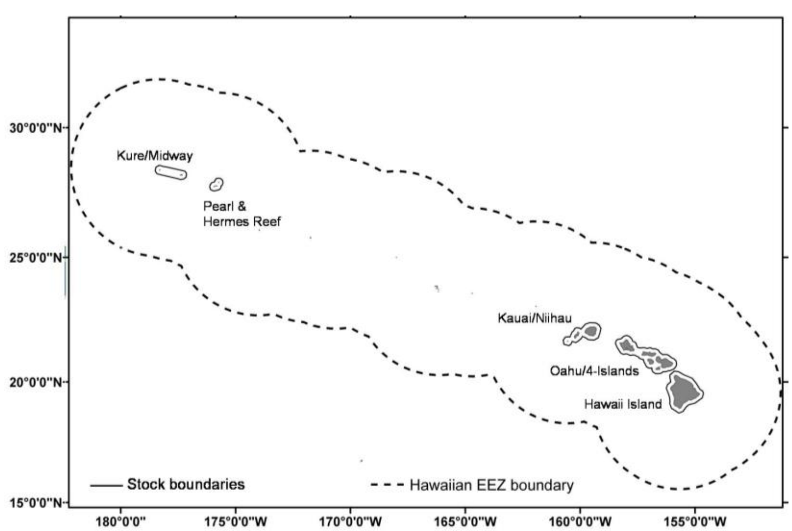

Figure 2. Spinner dolphin stock boundaries. Animals outside of the defined island areas represent the pelagic stock range

Island show marked distinctions from individuals sampled at all other Hawaiian Islands including Maui (Andrews 2009, Andrews et al. 2010). Hill et al. (2010) ~~(2009)~~ suggest an offshore boundary for each island-associated stock at 10 nmi from shore based on anecdotal accounts of spinner dolphin distribution. Analysis of individual spinner dolphin movements suggest that few individuals move long distances (from one main Hawaiian Island to another) and no dolphins have been seen farther than 10 nmi from shore (Hill et al. 2011). Norris et al. (1994) suggested that spinner dolphins may move between leeward and windward shores of the main Hawaiian Islands seasonally, and this does appear to be supported by recent analyses of abundance at Hawaii Island (Hill et al 2011). ~~This offshore boundary is likely to be revised as new information on the movements of island-associated spinner dolphins becomes available.~~ For the Marine Mammal Protection Act (MMPA) stock assessment reports, there are six stocks found within the U.S. EEZ of the Hawaiian Islands: 1) Hawaii Island, 2) Oahu/4-Islands, 3) Kauai/Niihau, 4) Pearl & Hermes Reef, 5) Kure/Midway, and 6) Hawaii Pelagic, including animals found both within the Hawaiian Islands EEZ (outside of island-associated boundaries) and in adjacent international waters. ~~Because data on abundance, distribution, and human-caused impacts are largely lacking for international waters, the status of all stocks combined is evaluated based on data from U.S. EEZ waters of the Hawaiian Islands (NMFS 2005).~~ Spinner dolphins ~~involved~~ in the eastern tropical Pacific that may interact with tuna purse-seine fisheries are managed separately under the MMPA.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Information on fishery-related mortality of cetaceans in Hawaiian waters is limited, but the gear types used in Hawaii-based fisheries cause marine mammal mortality and serious injury in other U.S. fisheries. Gillnets appear to entangle marine mammals wherever they are used, and float lines from lobster or fish traps and longlines occasionally entangle cetaceans (Perrin et al. 1994). In Hawaii, some entanglements of spinner dolphins have been observed (Nitta and Henderson 1993; NMFS/PIR, unpublished data), but no estimate of annual human-caused mortality and serious injury is available because the nearshore fisheries are not observed or monitored.

Interactions with cetaceans have been reported for all Hawaii pelagic fisheries (Nitta and Henderson 1993). There are currently 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. However, there are fishery closures within 25-75 miles from shore in the MHI and 50 miles from shore in the NWHI where insular or island-associated species occur. Between 2006 and 2010, no spinner dolphins were observed hooked or entangled in the SSLL fishery (100% observer coverage) or the DSLL fishery (20-28% observer coverage) (McCracken 2011).

Interaction rates between dolphins and the former NWHI bottomfish fishery were estimated based on studies conducted in 1990-1993, indicating an average of 2.67 dolphin interactions occurred for every 1000 fish brought on board, most likely involving bottlenose and rough-toothed dolphins (Kobayashi and Kawamoto 1995).

HAWAII ISLAND STOCK

POPULATION SIZE

Over the past few decades abundance estimates have been produced from studies along the Kona coast of Hawaii Island. Norris et al. (1994) photo-identified 192 individuals along the west coast of Hawaii and estimated 960 animals for this area in 1979-1980. Östman (1994) photo-identified 677 individual spinner dolphins in the same area from 1989 to 1992. Using the same estimation procedures as Norris et al. (1994), Östman (1994) estimated a population size of 2,334 for his study area along the Kona coast of Hawaii. As part of the Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) study, a total of twelve aerial surveys were conducted within 25 nmi of the main Hawaiian Islands in 1993, 1995 and 1998. An abundance estimate of 3,184 (CV=0.37) spinner dolphins was calculated from the combined survey data (Mobley et al. 2000), now representing the Kauai/Niihau, Oahu/4-Islands, and Hawaii Island stocks. Those data are well over 8 years old and abundance estimates are out of date. New mark-recapture estimates based on collaborative photo-identification studies have resulted in new seasonal abundance estimates for the Hawaii Island stock. Closed capture models provide three seasonal estimates for the leeward coast of Hawaii Island for different time periods: 790 (CV = 0.17) for May to July, 2003; 280 (CV = 0.21) for January to March, 2005; and 205 (CV = 0.16) for January to March, 2006 (Hill et al. 2011). Considerable seasonal variation in spinner dolphin occurrence on the leeward versus south and east sides of the island is thought to occur, with lower abundance off the leeward Kona coast in the winter, potentially due to increased wind and swell in that region (Norris et al. 1994). Because the estimates are confined to a small geographic region along the leeward coast, the summer estimate (May to July 2003) is likely to provide the best representation of the number of animals resident to Hawaii Island, though it is likely still an underestimate.

Minimum Population Estimate

The log-normal 20th percentile of the 2003 abundance estimate for the summertime leeward coast of Hawaii Island is 685 spinner dolphins. This minimum estimate is several years old so may not represent the current population. Moreover, it is likely negatively-biased, as it represents a minimum estimate of the number of dolphins, accounting only for those along the leeward coast in 2003; no data were included from the rest of Hawaii Island.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters. A default level of 4% is assumed for maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Hawaii Island stock is calculated as the minimum estimate of population size (685) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality or serious injury within the U.S. EEZ of the Hawaiian Islands; Wade and Angliss 1997) resulting in a PBR of 6.9 spinner dolphins per year.

STATUS OF STOCK

The status of Hawaii Island spinner dolphins relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance for this stock. A habitat issue of increasing concern is the potential effect of swim-with-dolphin programs and other tourism activities on spinner dolphins around the main Hawaiian Islands (Danil et al. 2005, Courbis & Timmel 2009). Spinner dolphins are not listed as "threatened" or "endangered" under the Endangered Species Act (1973) nor as "depleted" under the MMPA. The Hawaii Island stock of spinner dolphins is not considered a strategic stock under the 1994 amendments to the MMPA, because the estimated rate of mortality and serious injury within the Hawaiian Islands EEZ is zero, although coastal fisheries that are most likely to interact with this stock are unmonitored. Insufficient information is available to determine whether the total fishery mortality and serious injury for this Hawaii Island spinner dolphin stock is insignificant and approaching zero mortality and serious injury rate.

OAHU/4-ISLANDS STOCK

POPULATION SIZE

As part of the Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) study, a total of twelve aerial surveys were conducted within 25 nmi of the main Hawaiian Islands in 1993, 1995 and 1998. An abundance estimate of 3,184 (CV=0.37) spinner dolphins was calculated from the combined survey data (Mobley et al. 2000), now representing the Kauai/Niihau, Oahu/4-Islands, and Hawaii Island stocks. Those data are well over 8 years old and abundance estimates from these data are out of date. New mark-recapture estimates based on photo-identification studies have resulted in new seasonal abundance estimates for the Oahu/4-Islands stock. Closed capture models provide two separate estimates for the leeward coast of Oahu representing different time periods: 160 (CV = 0.14) for June to July, 2002; and 355 (CV = 0.09) for July to September 2007 (Hill et al. 2011). The 2002 estimate is now more than 8 years old and therefore will no longer be used based on NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005). The 2007 estimate is considered the best-available estimate of the population size of the Oahu/4-Islands stock. However, this estimate is likely an underestimate as it includes only dolphins found off the leeward coast of Oahu and does not account for individuals that may spend most of their time along other parts of Oahu or somewhere in the 4-Islands area.

Minimum Population Estimate

The log-normal 20th percentile of the 2007 abundance estimate for the summertime leeward coast of Oahu and the 4-Islands area is 329 spinner dolphins. This minimum estimate is several years old and may not represent the current population. Moreover, it is likely negatively-biased, as it represents a minimum estimate of the number of dolphins, accounting only for those along the leeward Oahu coast in 2007; no data were included from the rest of the stock range.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters. A default level of 4% is assumed for maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Oahu/4-Islands stock is calculated as the minimum estimate of population size (329) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality or serious injury within the U.S. EEZ of the Hawaiian Islands; Wade and Angliss 1997) resulting in a PBR of 3.3 spinner dolphins per year.

STATUS OF STOCK

The status of Oahu/4-Islands spinner dolphins relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance for this stock. A habitat issue of increasing concern is the potential effect of swim-with-dolphin programs and other tourism activities on spinner dolphins around the main Hawaiian Islands (Danil et al. 2005, Courbis & Timmel 2009). Spinner dolphins are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. The Oahu/4-Islands stock of spinner dolphins is not considered a strategic stock under the 1994 amendments to the MMPA, because the estimated rate of mortality and serious injury within the Hawaiian Islands EEZ is zero, although coastal fisheries that are most likely to interact with this stock are unmonitored. Insufficient data exist to determine whether the total fishery mortality and serious injury for this Oahu/4-Islands spinner dolphin stock is insignificant and approaching zero mortality and serious injury rate.

KAUAI/NIIHAU STOCK

POPULATION SIZE

As part of the Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) study, a total of twelve aerial surveys were conducted within 25 nmi of the main Hawaiian Islands in 1993, 1995 and 1998. An abundance estimate of 3,184 (CV=0.37) spinner dolphins was calculated from the combined survey data (Mobley et al. 2000), now representing the Kauai/Niihau, Oahu/4-Islands, and Hawaii Island stocks. Those data are well over 8 years old and abundance estimates from these data are out of date. New mark-recapture estimates based on photo-identification studies have resulted in a new seasonal abundance estimate for the Kauai/Niihau stock. Closed capture models provide an estimate of 601 (CV = 0.20) spinner dolphins for the leeward coast of Kauai for the period October to November 2005. This estimate is considered the best-available estimate of the population size of the Kauai/Niihau stock; however, it is likely an underestimate as it includes only dolphins found off the leeward coast of Kauai and does not account for individuals that may spend most of their time along other parts of Kauai, Niihau, or Kaula Rock.

Minimum Population Estimate

The log-normal 20th percentile of the leeward Kauai abundance estimate is 509 spinner dolphins. This minimum estimate is several years old so may not represent the current population. Moreover, it is likely negatively-biased, as it represents a minimum estimate of the number of dolphins, accounting only for those along the leeward Kauai coast in 2005; no data were included from the rest of the stock range near Niihau or Kaula Rock.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters. A default level of 4% is assumed for maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Kauai/Niihau stock is calculated as the minimum population size (509) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality or serious injury within the U.S. EEZ of the Hawaiian Islands; Wade and Angliss 1997 resulting in a PBR of 5.1 spinner dolphins per year.

STATUS OF STOCK

The status of Kauai/Niihau spinner dolphins relative to OSP is unknown, and there are insufficient data to evaluate abundance trends. A habitat issue of increasing concern is the potential effect of swim-with-dolphin programs and other tourism activities on spinner dolphins around the main Hawaiian Islands (Danil et al. 2005, Courbis & Timmel 2009). Spinner dolphins are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. The Kauai/Niihau stock of spinner dolphins is not considered a strategic stock under the 1994 amendments to the MMPA, because the estimated rate of mortality and serious injury within the Hawaiian Islands EEZ is zero, although coastal fisheries that are most likely to interact with this stock are unmonitored. Insufficient data are available to determine whether the total fishery mortality and serious injury for this Kauai/Niihau spinner dolphin stock is insignificant and approaching zero mortality and serious injury rate.

PEARL & HERMES REEF STOCK

POPULATION SIZE

There is no information on the abundance of the Pearl & Hermes Reef stock of spinner dolphins. A photo-identification catalog of individual spinner dolphins from this stock is available, though inadequate survey effort and low re-sighting rates prevent robust estimation of abundance.

Minimum Population Estimate

There is no information on the minimum abundance of the Pearl & Hermes Reef stock of spinner dolphins.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters. A default level of 4% is assumed for maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Pearl & Hermes Reef stock is calculated as the minimum population size times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality or serious injury within the U.S. EEZ of the Hawaiian Islands; Wade and Angliss 1997). Because there is no minimum population estimate available for this stock the PBR for Pearl & Hermes Reef stock of spinner dolphins is undetermined.

STATUS OF STOCK

The status of Pearl & Hermes Reef spinner dolphins relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance for this stock. Spinner dolphins are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor as "depleted" under the MMPA. The Pearl & Hermes Reef stock of spinner dolphins is not considered a strategic stock under the 1994 amendments to the MMPA, because the estimated rate of mortality and serious injury within the Hawaiian Islands EEZ is zero. Insufficient data are available to determine whether the total fishery mortality and serious injury for this stock is insignificant and approaching zero mortality and serious injury rate.

MIDWAY ATOLL/KURE STOCK

POPULATION SIZE

In the Northwestern Hawaiian Islands, a multi-year photo-identification study at Midway Atoll resulted in a population estimate of 260 spinner dolphins based on 139 identified individuals (Karczmarski et al. 1998). This abundance estimate for the Midway Atoll/Kure stock of spinner dolphins is now more than 8 years old and therefore will no longer be used based on NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005). A 2010 shipboard line-transect survey within the Hawaiian EEZ resulted in a single off-effort sighting of spinner dolphins at

Kure Atoll. This sighting cannot be used within a line-transect framework; however, photographs of individuals may be used in the future to estimate the abundance of spinner dolphin at Midway Atoll/Kure using mark-recapture methods.

Minimum Population Estimate

The minimum abundance estimate for the Midway Atoll/Kure stock is now more than 8 years old and therefore will no longer be used based on NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005). There is no current minimum population size available for this stock.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters. A default level of 4% is assumed for maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Midway Atoll/Kure stock is calculated as the minimum population size times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality or serious injury within the U.S. EEZ of the Hawaiian Islands; Wade and Angliss 1997). Because no minimum population estimate is available for this stock, the PBR for the Midway Atoll/Kure stock of spinner dolphins is undetermined.

STATUS OF STOCK

The status of Midway Atoll/Kure spinner dolphins relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Spinner dolphins are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor as “depleted” under the MMPA. The Midway Atoll/Kure stock of spinner dolphins is not considered strategic under the 1994 amendments to the MMPA, because the estimated rate of mortality and serious injury within the Hawaiian Islands EEZ is zero. Insufficient data are available to determine whether the total fishery mortality and serious injury for this Midway Atoll/Kure spinner dolphin stock is insignificant and approaching zero mortality and serious injury rate.

HAWAII PELAGIC STOCK

POPULATION SIZE

~~No data on current population sizes for any of the Hawaiian Island stocks are available.~~ A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 3,351 (CV=0.74) spinner dolphins (Barlow 2006); however, this estimate assumed a single Hawaiian Islands stock. This estimate for the Hawaiian EEZ is ≥ 8 years old and therefore will no longer be used based on NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005). A 2010 shipboard line-transect survey within the Hawaiian EEZ did not result in any sightings of pelagic spinner dolphins. ~~Over the past few decades abundance estimates have been produced from several studies along the Kona coast of the Island of Hawaii. Norris et al. (1994) photo-identified 192 individuals along the west coast of Hawaii and estimated 960 animals for this area in 1979-1980. Östman (1994) photo-identified 677 individual spinner dolphins in the same area from 1989 to 1992. Using the same estimation procedures as Norris et al. (1994), Östman (1994) estimated a population size of 2,334 for his study area along the Kona coast of Hawaii. In the Northwestern Hawaiian Islands, a multi-year photo-identification study at Midway Atoll resulted in a population estimate of 260 spinner dolphins based on 139 identified individuals (Karczmarski et al 1998). As part of the Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) study, a total of twelve aerial surveys were conducted within about 25 nmi of the main Hawaiian Islands in 1993, 1995 and 1998. An abundance estimate of 3,184 (CV=0.37) spinner dolphins was calculated from the combined survey data (Mobley et al. 2000). These data may be used to produce abundance estimates for each new stock area; however, the data are now more than 8 years old and abundance estimates from these data would be out of date.~~

Minimum Population Estimate

~~Abundance data for each new stock is not yet available, but estimates will be incorporated into this report as estimates based on photo-identification data become available.~~ The log-normal 20th percentile of the 2002 abundance estimate for all stocks combined (Barlow 2006) is 1,920 spinner dolphins; however the minimum abundance estimate for the entire Hawaiian EEZ is ≥ 8 years old and will no longer be used based on NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005). No minimum estimate of abundance is available for this stock, as there were no sightings of pelagic spinner dolphins during a 2010 shipboard line-transect survey of the Hawaiian EEZ.

Current Population Trend

No data on current population trend are available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters. A default level of 4% is assumed for maximum net productivity rate. ~~No information on current or maximum net productivity rate is currently available for any stock in the Hawaiian Islands stock complex.~~

POTENTIAL BIOLOGICAL REMOVAL

~~The potential biological removal (PBR) level for the combined Hawaiian Islands stock complex is calculated as the minimum population size within the U.S EEZ of the Hawaiian Islands (1,920) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no estimated fishery mortality or serious injury within the U.S. EEZ of the Hawaiian Islands; Wade and Angliss 1997) resulting in a total PBR of 19 spinner dolphins from all stocks per year.~~ Because there is no minimum population size estimate for Hawaii pelagic spinner dolphins, the potential biological removal (PBR) is undetermined.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

~~Information on fishery-related mortality of cetaceans in Hawaiian waters is limited, but the gear types used in Hawaiian fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Gillnets appear to capture marine mammals wherever they are used, and float lines from lobster traps and longlines can be expected to occasionally entangle cetaceans (Perrin et al. 1994). In Hawaii, some entanglements of spinner dolphins have been observed (Nitta and Henderson 1993; NMFS/PIR, unpublished data), but no estimate of annual human-caused mortality and serious injury is available, because the nearshore gillnet fisheries are not observed or monitored~~

~~Interactions with cetaceans have been reported for all Hawaiian pelagic fisheries (Nitta and Henderson 1993). There are currently 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. Between 2004 and 2008, no spinner dolphins were observed hooked or entangled in the SSLL fishery (100% observer coverage) or the DSLL fishery (20-28% observer coverage) (Forney 2009, McCracken & Forney 2010).~~

~~Interaction rates between dolphins and the NWHI bottomfish fishery have been estimated based on studies conducted in 1990-1993, indicating that an average of 2.67 dolphin interactions, most likely involving bottlenose and rough-toothed dolphins, occurred for every 1000 fish brought on board (Kobayashi and Kawamoto 1995). Fishermen claim interactions with dolphins that steal bait and catch are increasing. It is not known whether these interactions result in serious injury or mortality of dolphins, nor whether spinner dolphins are involved.~~

Interactions with cetaceans have been reported for all Hawaii pelagic fisheries (Nitta and Henderson 1993). There are currently 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. Between 2006 and 2010, no spinner dolphins were observed hooked or entangled in the SSLL fishery (100% observer coverage) or the DSLL fishery (20-28% observer coverage) (McCracken 2011).

STATUS OF STOCK

The status of Hawaii pelagic spinner dolphins ~~in Hawaiian waters~~ relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance for ~~any~~ this stock. ~~A habitat issue of increasing concern is the potential effect of swim-with-dolphin programs and other tourism activities on spinner dolphins around the main Hawaiian Islands (Danil et al. 2005, Courbis and Timmel 2009).~~ Spinner dolphins are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor as “depleted” under the MMPA. The Hawaiian pelagic stocks of spinner dolphins ~~are~~ is not considered a strategic stock under the 1994 amendments to the MMPA, because the estimated rate of mortality and serious injury within the Hawaiian Islands EEZ is zero. However, there is no systematic monitoring of nearshore fisheries that may take animals from the island-associated and pelagic stock regions of the stock complex. Insufficient information is available to determine whether the total fishery mortality and serious injury for this any Hawaiian pelagic spinner dolphin stock is insignificant and approaching zero mortality and serious injury rate.

REFERENCES

Andrews, K.R. 2009. Barriers to gene flow in the spinner dolphin (*Stenella longirostris*). PhD dissertation, University of Hawaii, Manoa. 99 pp.

Andrews, K.R., Karczmarski, L., Au, W.W.L., Rickards, S.H., Vanderlip, C.A., Bowen, B.W., Grau, E.G., and Toonen, R.J. 2010. Rolling stones and stable homes: social structure, habitat diversity and population genetics of the Hawaiian spinner dolphin (*Stenella longirostris*). Molecular Ecology 19:732-748.

Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Marine Mammal Science 22(2): 446-464.

Courbis, S. and G. Timmel. 2009. Effects of vessels and swimmers on behavior of Hawaiian spinner dolphins (*Stenella longirostris*) in Kealake'akua, Honaunau, and Kauhako bays, Hawai'i. Marine Mammal Science 25(2):430-440.

Danil, K., D. Maldini, and K. Marten. 2005. Patterns of use of Maku'a Beach, O'ahu, Hawai'i, by spinner dolphins (Stenella longirostris) and potential effects of swimmers on their behavior. Aquatic Mammals 31(4):403-412.

Dizon, A. E., W. F. Perrin, and P. A. Akin. 1994. Stocks of dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern tropical Pacific: a phylogeographic classification. NOAA Tech. Rep. NMFS 119, 20 pp.

Forney, K.A. 2009. Serious injury determinations for cetaceans caught in Hawaii longline fisheries during 1994-2008. Draft document PSRG-2009-09 presented to the Pacific Scientific Review Group, November 3-5, 2009, Del Mar, CA.

Hill, M.C., A.L. Bradford, K.R. Andrews, R.W. Baird, M.H. Deakos, S.D. Johnston, D.W., Mahaffy, A.J. Milette, E.M. Oleson, J. Östman-Lind, A.A. Pack, S.H. Rickards, and S. Yin. 2011. Abundance and movements of spinner dolphins off the main Hawaiian Islands. Pacific Islands Fisheries Science Center Working Paper WP-11-013.

Hill, M.C., E.M. Oleson, K.R. Andrews. 2009 2010. A proposal to introduce new stock boundaries for Hawaiian spinner dolphins. PSRG-2009-12. New island-associated stocks for Hawaiian spinner dolphins (*Stenella longirostris longirostris*): Rationale and new stock boundaries. Pacific Islands Fisheries Science Center Admin Report H-10-04, 12p.

Karczmarski, L., B. Würsig and B. Winning. 1998. Socio-ecology and population biology of spinner dolphins *Stenella longirostris* in Midway Atoll, Northwest Hawaiian Chain, Central Pacific. Unpublished report to U.S. Fish and Wildlife Service and National Marine Fisheries Service. 41 pp.

Karczmarski, L., B. Wursig, G. Gailey, K.W. Larson, and C. Vanderlip. 2005. Spinner dolphins in a remote Hawaiian atoll: Social grouping and population structure. Behavioral Ecology 16(4):675-685.

Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.

Maldini, D., L. Mazzuca, and S. Atkinson. 2005. Odontocete stranding patterns in the Main Hawaiian Islands (1937-2002): How do they compare with live animal surveys? Pacific Science 59(1):55-67.

McCracken M., and K.A. Forney. 2010. Preliminary assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries. NMFS, Pacific Islands Fisheries Science Center Working Paper WP-10-001. 27p.

McCracken, M. 2011. Assessment of Incidental Interactions with Marine Mammals in the Hawaii Longline Deep and Shallow Set Fisheries from 2006 through 2010. PIFSC Working Paper WP-11-012, 30 pp.

Mobley, J. R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

Norris, K. S., B. Würsig, R. S. Wells, and M. Würsig. 1994. The Hawaiian Spinner Dolphin. University of California Press, 408 pp.

Norris, K. S. and T. P. Dohl. 1980. Behavior of the Hawaiian spinner dolphin, *Stenella longirostris*. Fish. Bull. 77:821-849.

NMFS, Pacific Islands Region, Observer Program, 1602 Kapiolani Blvd, Suite 1110, Honolulu, HI 96814.

Östman, J. S. O. 1994. Social organization and social behavior of Hawaiian spinner dolphins *(Stenella longirostris)*. Ph.D. dissertation, University of California, Santa Cruz, 114 pp.

Perrin, W. F. 1975. Variation of spotted and spinner porpoise (genus *Stenella*) in the eastern tropical Pacific and Hawaii. Bull. Scripps Inst. Oceanogr. 21, 206 pp.

Perrin, W. F. 1990. Subspecies of *Stenella longirostris* (Mammalia: Cetacea: Delphinidae). Proc. Biol. Soc. Wash. 103:453-463.

Perrin, W.F., P.A. Akin, and J.V. Kashiwada. 1991. Geographic variation in external morphology of the spinner dolphin *Stenella longirostris* in the Eastern Pacific and implications for conservation. Fishery Bulletin 89:411-428

Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.

Perrin, W.F., B. Würsig and J.G.M. Thewissen. 2009. Encyclopedia of Marine Mammals. Second Edition. Academic Press, Amsterdam.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Wade, P.R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

FALSE KILLER WHALE (*Pseudorca crassidens*): Pacific Islands Region Hawaiian Islands Stock Complex - Hawaiian Insular, Northwestern Hawaiian Islands, and Hawaii Pelagic and Palmyra Atoll Stocks

STOCK DEFINITIONS AND GEOGRAPHIC RANGES

False killer whales are found worldwide mainly 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. There are six stranding records from Hawaiian waters (Nitta 1991; Maldini et al. 2005). 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, NMFS unpublished data Bradford et al. 2012). Group size ranged from 1 to 52 false killer whales during the 2010 survey. Smaller-scale surveys conducted around the main Hawaiian Islands (Figure 2) show that false killer whales are also encountered in nearshore waters there (Baird et al. 2005, Mobley et al. 2000, Mobley 2001, 2002, 2003, 2004), and a single on-effort and three off-effort sightings during a 2010 shipboard survey reveal that the species also occurs near shore in the Northwestern Hawaiian Islands (Baird et al 2012). This species also occurs in U.S. EEZ waters around Palmyra Atoll (Figure 1), Johnston Atoll (NMFS/PIR/PSD unpublished data), and American Samoa (Johnston et al. 2008, Oleson 2009).

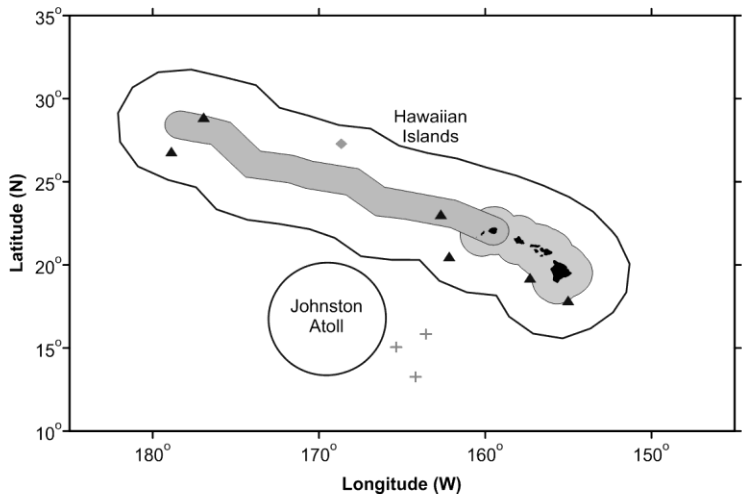

Figure 1. False killer whale on-effort sighting locations during standardized shipboard surveys of the Hawaiian U.S. EEZ (2002, gray diamond, Barlow 2006; 2010, black triangles, Bradford et al. 2012NMFS unpublished data), the Palmyra U.S. EEZ the Johnston Atoll EEZ and pelagic waters of the central Pacific south of the Hawaiian Islands (2005, gray crosses, Barlow and Rankin 2007). Outer lines represent approximate boundary of U.S. EEZs; light shaded gray area is the insular false killer whale stock area, including overlap zone between 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 insular false killer whale stock area.

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). Chivers et al. (2010) expanded previous analyses with additional samples and analysis of 8 nuclear DNA (nDNA) microsatellites, revealing strong phylogeographic patterns consistent with local evolution of haplotypes nearly unique to false killer whales occurring nearshore within the Hawaiian Archipelago. Analysis of 21 additional samples collected during a 2010 shipboard survey in Hawaiian waters 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 of individuals seen near the NWHI confirms that they do not associate with individuals near the MHI. 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 suggest the occurrence of three separate social clusters (Baird et al. 2012, Martien et al. 2011), where mating primarily occurs within clusters, though some mating is known to occur between males and females of different social clusters (Martien et al. 2011).

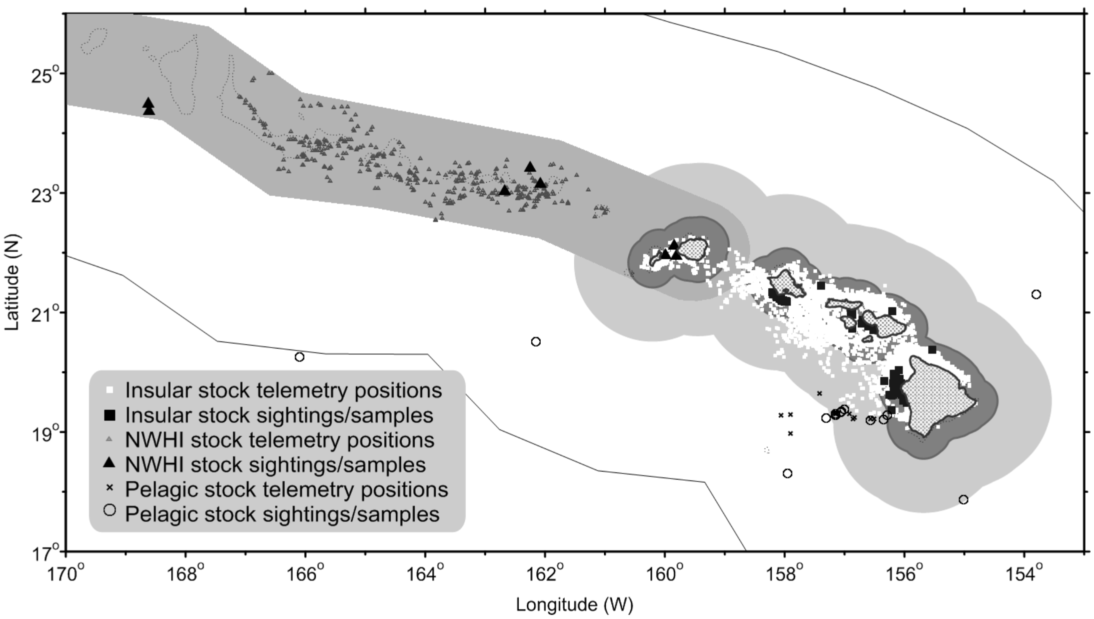

Figure 2. Sighting, biopsy, and telemetry records of false killer whale identified as being part of the insular (square ~~closed~~ symbols), NWHI (triangle symbols), or ~~versus~~ pelagic (open and cross symbols) stocks. The dark gray area is the 40-km insular core area; light gray area is the 40-km to 140-km insular-pelagic overlap zone (Baird et al. 2010, Baird unpublished data; 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 insular, pelagic, and NWHI stocks overlap in the vicinity of Kauai.

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 (see Figure 3), were determined to have Pacific pelagic haplotypes (Chivers et al. 2010). At the broadest scale, significant differences in both mtDNA and nDNA 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.

Genetic, photographic, and telemetry data collected from Hawaiian false killer whales demonstrates the existence of a previously unknown stock of island-associated false killer whales in the NHWI, and supports the current recognized boundaries of the insular and pelagic stocks. The three stocks have overlapping ranges. Insular false killer whales have been seen as far as 112 km from the main Hawaiian Islands, while pelagic stock animals have been seen within 42 km of the main Hawaiian Islands (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 Kauai (Baird et al. 2012, Bradford et al. 2012, Martien et al. 2011). Animals seen within 40 km of the main Hawaiian Islands between Hawaii Island and Oahu are considered to belong to the insular stock. Waters within 40 km of Kauai and Niihau are an overlap zone between the Hawaii insular and NWHI stock, as individuals from both populations have been seen here. 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 insular and pelagic stocks overlap between 40 km and 140 km from shore between Oahu and Hawaii Island. All three stocks overlap within 40 km and 93 km around Kauai and Niihau, and the insular and pelagic stocks overlap from 93 km to 140 km around these islands (Figure 2).

~~Genetic analyses of tissue samples collected within the Indo-Pacific indicate restricted gene flow between false killer whales sampled near the main Hawaiian Islands, and false killer whales sampled in all other regions (Chivers et al. 2007, 2010). The recent update from Chivers et al. (2010) included additional samples and analysis of 8 nuclear DNA (nDNA) microsatellites, revealing strong phylogeographic patterns that are consistent with local evolution of haplotypes that are nearly unique to false killer whales occurring the separate insular population around the main the Hawaiian Islands. Further, the recent analysis revealed significant differentiation, in both mitochondrial and nDNA, between pelagic false killer whales in the Eastern (ENP) and Central North Pacific (CNP) strata defined in 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 stock boundaries would be drawn.~~. ~~An additional 24 samples collected during the 2010 shipboard survey in pelagic Hawaiian waters are currently being analyzed and will be used to further evaluate stock identity and boundaries.~~

~~Since 2003, observers of the Hawaii-based longline fishery have also been collecting tissue samples of caught cetaceans for genetic analysis whenever possible. 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 (see Figure 3), were determined to have Pacific pelagic haplotypes (Chivers et al. 2010). Recent satellite telemetry studies, boat-based surveys, and photo-identification analyses of false killer whales around Hawaii have demonstrated that the insular and pelagic false killer whale stocks have overlapping ranges, rather than a clear separation in distribution. Insular false killer whales have been documented as far as 112 km from the main Hawaiian Islands, and pelagic stock animals have been documented as close as 42 km to the islands (Baird et al. 2008, Baird 2009, Baird et al. 2010, Forney et al 2010). Based on a review of new information (Forney et al. 2010), the 2010 stock assessment report recognized a new, overlapping stock structure for insular and pelagic stocks of false killer whales around Hawaii: animals within 40 km of the main Hawaiian Islands are considered to belong to the insular stock; animals beyond 140 km of the main Hawaiian Islands are considered to belong to the pelagic stock, and the two stocks overlap between 40 km and 140 km from shore (Figure 2).~~

The pelagic stock includes animals found ~~both~~ 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 remains a separate stock, because comparisons amongst false killer whales sampled at Palmyra Atoll and those sampled from the insular stock of Hawaii and the pelagic ENP reveal~~ed~~ restricted gene flow, although the sample size remains low for robust comparisons (Chivers et al. 2007, 2010). NMFS will ~~continue to~~ obtain and analyze additional ~~tissue~~ samples for genetic studies of 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 ~~four~~ Pacific Islands Region management stocks (Chivers et al. 2008, Martien et al. 2011): 1) the Hawaii insular stock, which includes animals inhabiting waters within 140 km (approx. 75 nmi) of the main Hawaiian Islands, ~~and~~ 2) the Northwestern Hawaiian Islands stock, which includes animals inhabiting waters within 93 km (50 nmi) of the NWHI and Kauai, ~~and~~ 3) the Hawaii pelagic stock, which includes false killer whales inhabiting waters greater than 40 km (22 nmi) from the main Hawaiian Islands, ~~3~~ 4) the Palmyra Atoll stock, which includes animals ~~false killer whales~~ found within the U.S. EEZ of Palmyra Atoll, and 4 5) the American Samoa stock, which includes animals ~~false killer whales~~ 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 ~~is~~ covered in ~~a~~ separate reports.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Interactions with ~~cetaceans have been reported for Hawaii-based pelagic fisheries and~~ false killer whales, including depredation of catch, have been identified in ~~fishermen's logs~~ logbooks and NMFS observer records ~~as taking catches~~ from Hawaii pelagic longlines (Nitta and Henderson 1993, NMFS/PIR unpublished data). False killer whales have ~~also~~ been observed feeding on mahi mahi, *Coryphaena hippurus*, and yellowfin tuna, *Thunnus albacares* (Baird 2009), and they have been reported to take large fish ~~(up to 70 pounds)~~ from the trolling lines of ~~both~~ commercial and recreational fishermen (Shallenberger 1981). There are anecdotal reports of marine mammal interactions in the commercial Hawaii shortline fishery which sets gear ~~, which was developed to target bigeye tuna , *Thunnus obesus*, and lustrous pomfret , *Eumegistus illustris*,~~ at Cross Seamount and ~~may also set gear~~ possibly around the main Hawaiian Islands. ~~Fishing~~ The shortline fishery is permitted through the State of Hawaii Commercial Marine License program, and until recently, ~~there were~~ no reporting systems ~~in place~~ existed to document marine mammal interactions. This fishery was added to the 2010 List of Fisheries as a Category II fishery (Federal Register Vol. 74, No. 219, p. 58859-58901, November 16, 2009), and efforts are underway to obtain ~~further information~~ data on ~~the extent of~~ interactions between shortlines and marine mammals ~~and to document the species involved~~. Baird and Gorgone (2005) documented ~~a~~ high rates of dorsal fin disfigurements ~~that were~~ consistent with injuries from unidentified fishing line for false killer whales belonging to the insular stock. ~~At the present time, however, it~~ It is unknown whether these injuries might have been caused by longline gear, shortline gear, or other hook-and-line gear used around the main Hawaiian Islands.

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, within the ranges of both insular and pelagic stocks. Between ~~2005~~ 2006 and ~~2009~~ 2010, two 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 24 false killer whales were observed taken in the DSLL fishery (≥20% observer coverage) within Hawaiian waters or adjacent high-seas waters (excluding Palmyra Atoll) (Forney 2011) ~~(Forney 2010a, b)~~. ~~Two~~ One false killer whale take~~s~~ in the DSLL fishery resulted in the death of the animal ~~, one within the Hawaiian EEZ and the other~~ in international waters. Based on an evaluation of the observer's description of each interaction and following the most recently developed criteria for assessing serious injury in marine mammals (Andersen et al. 2008), one animal taken in the SSLL fishery was considered not seriously injured and one was considered seriously injured, both within the Hawaii EEZ. In the DSLL fishery, one false killer whale taken within the overlap zone of the insular and pelagic stocks, two ~~one~~ taken in Hawaiian waters within the range of the pelagic stock, and one taken in international waters were considered not seriously injured. ~~For two~~ The level of injury could not be determined based on the observer descriptions for one false killer whale~~s~~ taken in the DSLL, ~~one within the overlap zone of the insular and pelagic stocks and one taken in Hawaiian waters~~ within the range of the pelagic stock. ~~, the level of injury could not be etermined based on the observer descriptions~~. The remaining ~~17~~ 18 false killer whales taken in the DSLL fishery (nine in international waters, ~~seven~~ nine in the Hawaiian Islands EEZ pelagic stock range ~~, and one in the EEZ of Palmyra Atoll~~) were considered seriously injured (Forney 2011 ~~2010a,b~~). ~~Nine~~ Seven additional unidentified "blackfish" (unidentified cetaceans known to be either false killer whales or short-finned pilot whales) ~~cetaceans~~ that may have been false killer whales were also seriously injured during 2006-2010 (Forney 2011). ~~2005-2009 (Forney 2010a,b)~~. ~~Eight~~ Six of these were taken in the DSLL fishery within U.S. EEZ waters, including ~~two~~ one animal~~s~~ within the insular stock range, and one was taken in the SSLL fishery in international waters (Figure 3).

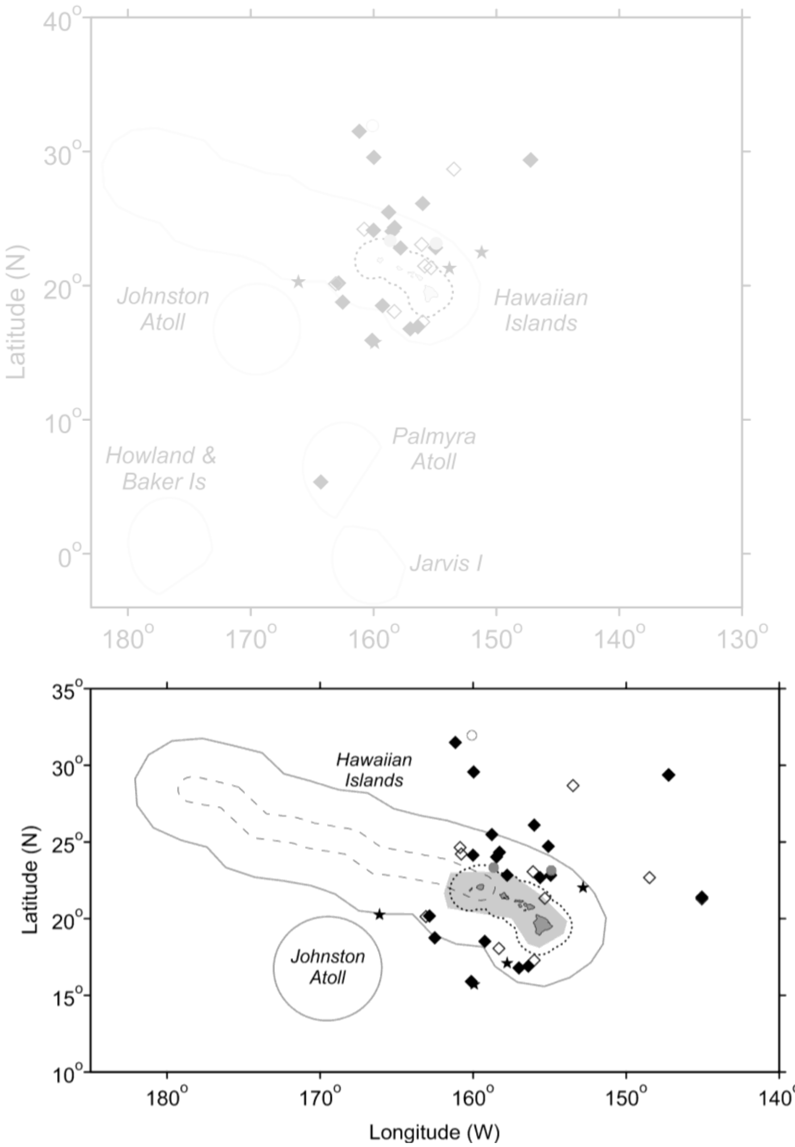

Figure 3. Locations of observed false killer whale takes (filled symbols) and possible takes of this species (open symbols) in the Hawaii-based longline fisheries, ~~2005-2009~~ 2006-2010. Deep-set fishery takes are shown in black; shallow-set fishery takes are shown in gray. Stars are locations of genetic samples from fishery-caught false killer whales. Solid gray lines represent the U.S. EEZ; the dotted line is the outer (140-km) boundary of the overlap zone between insular and pelagic false killer whale stocks; the dashed line is the 93-km boundary of the NWHI stock; the gray shaded area is the February-September longline exclusion zone. Fishery descriptions are provided in Appendix 1.

The total observed mortality and serious injury of cetaceans in the SSLL fishery (with 100% coverage), and the estimated annual and 5-yr average mortality and serious injury of cetaceans in the DSLL fishery (with approximately 20% coverage) are reported by McCracken (2011) ~~(2010a,b)~~. A number of recent changes are reflected in the methodology. Estimated takes of false killer whales and observed takes for which ~~an~~ injury severity is undetermined ~~determination could not be made~~, are prorated based on the proportions of observed interactions that resulted in death or serious injury (~~92%~~ 93%) or non-serious injury (~~8%~~ 7%), between the years 2000 and ~~2009~~ 2010. Further, takes of false killer whales of unknown stock ~~origin~~ ~~with~~in the insular/pelagic stock overlap zone are prorated assuming that ~~the density~~ densities of ~~the~~ insular stock animals declines and ~~the density of the~~ pelagic stock increase~~s~~ with ~~increasing~~ distance from shore (McCracken 2010~~b~~). No genetic samples are available to establish stock identity for these takes, but both stocks are considered at risk of interacting with longline gear ~~within this region~~. 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). Insular false killer whales have been documented via telemetry to move ~~sufficiently~~ far enough offshore (112km) to reach longline fishing areas, and animals from this stock have a high rate of dorsal fin disfigurements consistent with injuries from unidentified fishing line (Baird and Gorgone 2005). Based on these considerations, and as outlined in the NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005), bycatch within the overlap zone has been prorated based on the estimated densities of each stock (McCracken and Forney 2010).

Table 1. Summary of available information on incidental mortality and serious injury of false killer whales (Hawaiian Islands ~~Pacific Islands~~ Stock Complex) and unidentified blackfish in commercial fisheries, by stock and EEZ area, as applicable (McCracken 2010 ~~a,b~~). Mean annual takes are based on ~~2005-2009~~ 2006-2010 estimates unless otherwise indicated. Information on all observed takes (T) and combined mortality events & serious injuries (MSI) is included. Total takes were prorated to deaths, serious injuries, and non-serious injuries based on the observed proportions of each outcome ~~(see McCracken 2010a for details)~~. Unidentified blackfish are pro-rated as either false killer whales or short-finned pilot whales according to their distance from shore (see McCracken 2010~~b~~ for details). CVs are estimated based on the methods of McCracken & Forney (2010) and do not yet incorporate additional uncertainty introduced by prorating false killer whales in the overlap zone and prorating the unidentified blackfish.

Fishery Name	Year	Data Type	Percent Observer Coverage	Observed total interactions (T) and mortality events ~~(M)~~, and serious injuries (MSI) ~~and non-serious injuries (NSI)~~, and total estimated mortality and serious injury (M&SI) of false killer whales by stock / EEZ region							
				Hawaii Pelagic Stock				**Hawaii Insular Stock**		~~**Palmyra Atoll Stock**~~	
				Outside of U.S. EEZs		Hawaiian Islands EEZ					
				Obs. FKW T/MSI Obs. UB T/MSI	Estimated M&SI (CV)	Obs. FKW T/MSI Obs. UB T/MSI	Estimated M&SI (CV)	Obs. FKW T/MSI Obs. UB T/MSI	Estimated M&SI (CV)	~~Obs. FKW T/MSI~~ ~~Obs. UB T/MSI~~	~~Estimated M&SI (CV)~~
Hawaii-based deep-set longline fishery	~~2005~~	Observer data	~~28%~~	~~1/1~~ ~~0/0~~	~~3 (1.6)~~	~~1/1~~ ~~1/1*~~	~~3 (1.9)~~	~~0/0~~ ~~1/1*~~	~~0.5 (-)~~	~~0/0~~ ~~0/0~~	~~0 (-)~~
	2006		22%	2/2 0/0	8 (0.7)	2/1* 2/2*	13 (1.7)	1/0* 1/1*	2.2 (0.7)	~~0/0~~ ~~0/0~~	~~0 (-)~~
	2007		20%	1/0 0/0	2 (3.7)	2/1 0/0	8 (0.8)	0/0 0/0	0 (-)	~~1/1~~ ~~0/0~~	~~2 (0.7)~~
	2008		22%	0/0 0/0	0 (-)	4/3 3/3	17 (0.4)	0/0 0/0	0 (-)	~~0/0~~ ~~0/0~~	~~0 (-)~~
	2009		20%	7/7 0/0	39 (0.2)	2/2 0/0	12 (0.5)	0/0 0/0	0 (-)	~~0/0~~ ~~0/0~~	~~0 (-)~~
	2010		21%	1/1 0/0	6 (1.3)	2/3 1/1	14 (0.5)	0/0 0/0	0 (-)	~~0/0~~ ~~0/0~~	~~0 (-)~~
Mean Estimated Annual Takes (CV)					~~**10.4 (0.31)**~~ **11.2 (0.3)**		~~**10.6 (0.4)**~~ **13.6 (0.3)**		~~**0.6 (1.67)**~~ **0.5 (1.7)**		~~**0.3 (1.67)**~~
Hawaii-based shallow-set longline fishery	~~2005~~	Observer data	~~100%~~	~~0/0~~ ~~0/0~~	~~0~~	~~0/0~~ ~~0/0~~	~~0~~	~~0/0~~ ~~0/0~~	~~0~~	~~No fishing effort~~	
	2006		100%	0/0 0/0	0	0/0 0/0	0	0/0 0/0	0		
	2007		100%	0/0 0/0	0	0/0 0/0	0	0/0 0/0	0		
	2008		100%	0/0 1/1	0.5	1/0 0/0	0	0/0 0/0	0		
	2009		100%	0/0 0/0	0	1/1 0/0	1	0/0 0/0	0		
	2010		100%	0/0 0/0	0	0/0 0/0	0	0/0 0/0	0		
Mean Annual Takes (100% coverage)					**0.1**		**0.2**		**0**		
Minimum total annual takes within U.S. EEZs						~~**10.8 (0.4)**~~ **13.8 (0.3)**		~~**0.6 (1.67)**~~ **0.5 (1.7)**		~~**0.3 (1.67)**~~	

* False killer whale and unidentified blackfish takes within the insular/pelagic stock overlap zone are ~~is~~ shown once for each stock, but total estimates derived from these ~~is~~ takes are prorated among potentially affected stocks based on the distance from shore of the take location (see text above, and McCracken 2010a,b).

Finally, unidentified blackfish ~~cetaceans, known to be either false killer whales or short-finned pilot whales (together termed "blackfish")~~, are prorated to each stock based on ~~their~~ distance from shore (McCracken 2010~~b~~). The distance-from-shore model was chosen following consultation with the Pacific Scientific Review Group, based on the model's performance and simplicity relative to a number of other more complicated models with similar output (~~see~~ McCracken 2010~~b for more information~~). Proration of false killer whales takes within the insular-pelagic overlap zone and of unidentified blackfish takes introduces ~~additional, yet~~ 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), this approach ensures that potential impacts to all stocks are assessed.

Based on these bycatch analyses, 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. Estimates of mortality and serious injury (M&SI) include a pro-rated portion of the animals categorized as unidentified blackfish (UB). Although M&SI estimates are shown as whole numbers of animals, the 5-yr average M&SI is calculated based on the unrounded annual estimates.

Because of high rates of false killer whale mortality and serious injury in Hawaii-based longline fisheries, a Take-Reduction Team (TRT) was established in January 2010 (75 FR 2853, 19 January 2010). The scope of the TRT was to reduce mortality and serious injury in the Hawaii pelagic, Hawaii insular, and Palmyra stocks of false killer whales and across the DSLL and SSLL fisheries. The Team submitted a Draft Take-Reduction Plan to NMFS for consideration (Available at: http://www.nmfs.noaa.gov/pr/pdfs/interactions/fkwtrp_draft.pdf), and NMFS has proposed regulations based on this TRP (76 FR 42082, 18 July 2011).

HAWAII INSULAR STOCK

POPULATION SIZE

A photographic mark-recapture study ~~of photo-identification data obtained~~ during 2000-2004 around the main Hawaiian Islands produced an estimate of 123 (CV=0.72) 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 ~~for estimating~~ as a measure of current abundance (NMFS 2005). A Status Review for the insular stock (Oleson et al. 2010) used recent, unpublished estimates for two time periods, 2000-2004 and 2006-2009 in a Population Viability Analysis (PVA). The new estimates were based on more recent sighting histories and open population models, yielding more precise estimates for the two time periods. 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 ~~, as these animals have not been seen to associate with others in the insular population~~ (Baird unpublished data). The animals seen near Kauai included in the higher estimate have now been associated with the NWHI stock (Baird et al 2012), such that the ~~The~~ best estimate of population size is ~~taken as~~ the ~~larger~~ smaller estimate of 151 animals. ~~including those animals seen near Kauai given the geographic range currently defined for this stock~~. However, it should be noted that even this smaller estimate may be positively-biased, ~~this is an overestimate~~, because missed photo-ID matches were discovered after the ~~mark-recapture~~ analyses were complete (discussed in Oleson *et al.* 2010). The best estimate will be updated when a new mark-recapture estimate accounting for the missed matches is available.

Minimum Population Estimate

The minimum population estimate for the insular stock of false killer whales is the number of distinct individuals identified during ~~2005-2009~~ 2008-2011 photo-identification studies, or ~~110~~ 129 false killer whales (Baird, unpublished data). Recent mark-recapture estimates (Oleson et al. 2010) of abundance are known to have a positive bias of unknown magnitude, and therefore are not suitable for deriving a minimum abundance estimate.

Current Population Trend

~~A recent study (Reeves et al. 2009) summarized information on false killer whale sightings near Hawaii between 1989 and 2007, based on various survey methods, and suggested that the insular stock of false killer whales may have declined during the last two decades.~~ Reeves et al. (2009) suggested that the 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. ~~More recently,~~ 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, Mobley 2001, 2002, 2003, 2004). Sighting rates during these surveys showed a statistically significant decline that could not be attributed to any weather or methodological changes. The ~~recent~~ Status Review of Hawaiian 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 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. ~~A variety of alternative scenarios were evaluated, with all~~ All plausible models ~~indicating~~ indicated the probability of decline to fewer than 20 animals within 75 years is greater than 20%. Though causation was not evaluated, all plausible models indicated current declines at an average rate of -9% since 1989 (95% probability intervals -5% to -12.5%; 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. ~~Obtaining information on rates of productivity for marine mammals is difficult (Wade 1998), and no estimate is available for this stock.~~

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the insular false killer whale stock is calculated as the minimum population size (~~110~~ 129) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 resulting in a PBR of ~~0.2~~ 0.3 false killer whales per year. The recovery factor was chosen to be 0.1 because the stock has been proposed for listing as endangered under the U.S Endangered Species Act (see below) and because of the significant recent decline experienced by this stock (Oleson et al. 2010).

STATUS OF STOCK

The status of insular stock false killer whales relative to OSP ~~of false killer whales belonging to the insular stock~~ is unknown, although this stock appears to have declined during the past two decades (Oleson et al. 2010, Reeves et al. 2009; Baird 2009). ~~A recent study (~~Ylitalo et al. 2009~~)~~ documented elevated levels of polychlorinated biphenyls (PCBs) in three of nine insular false killer whales sampled, and biomass of some false killer whale prey species may have declined around the main Hawaiian Islands (Oleson et al. 2010, Boggs & Ito 1993, Reeves et al. 2009). Insular false killer whales have been proposed for listing as “endangered” under the Endangered Species Act (1973) (75 FR 70169, 17 November 2010). The proposed listing follows receipt of a petition from the Natural Resources Defense Council on October 1, 2009, requesting that Hawaiian insular false killer whales be listed as endangered under the ESA. NMFS determined that the petition presented substantial scientific information indicating that a listing may be warranted and thus was required to conduct an ESA status review of the stock (75 FR 316; January 5, 2010) and established a Biological Review Team (BRT) for this purpose. The Status Review report produced by the 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 based on behavioral, ecological, genetic, and cultural factors. The BRT evaluated risk to the population, including identification and ranking of threats to the population, quantitative assessment of extinction probability using a PVA, and an assessment of the overall risk of extinction to the population. The PVA analysis indicated the probability of near-extinction (less than 20 animals) within 75 years (3 generations) was greater than 20% for all biologically plausible models and given a wide range of input variables. Of the 29 indentified threats to the population, the BRT considered the effects of small population size, including inbreeding depression and Allee effects, exposure to environmental contaminants, competition for food with commercial fisheries, ~~and~~ hooking, entanglement, or intentional harm by fishers to be the most substantial threats to the population. The BRT concluded that Hawaiian insular false killer whales were at high risk of extinction. The final listing decision is not yet available. False killer whales are not listed as “depleted” under the MMPA.

Based on the best available scientific information (Oleson et al. 2010), Hawaiian insular false killer whales are declining, therefore the ~~insular false killer whale~~ stock is considered “strategic” under the 1994 amendments to the MMPA. The estimated average annual human-caused mortality and serious injury for this stock (~~0.60~~ 0.5 animals per year) is greater than the PBR (~~0.2~~ 0.3), providing further support for the “strategic” designation.

HAWAII PELAGIC STOCK

POPULATION SIZE

Analyses of a 2002 shipboard line-transect survey of the Hawaiian Islands EEZ ~~(HICEAS survey)~~ resulted in an abundance estimate of ~~236 (CV=1.13) false killer whales (Barlow 2006) outside of 75 nm of the main Hawaiian Islands. A recent 2007 re-analysis of the HICEAS 2002 data using improved methods and incorporating additional sighting information obtained on line-transect surveys south of the Hawaiian EEZ during 2005, resulted in a revised 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). This abundance estimate ~~for the pelagic stock of false killer whales~~ is now more than 8 years old and therefore will no longer be used based on NMFS Guidelines for

Assessing Marine Mammal Stocks (NMFS 2005). A new abundance survey was recently completed in 2010 within the Hawaiian Islands EEZ and resulted in five several acoustic and visual on-effort detections of false killer whales within the pelagic stock area. attributed to the Hawaii pelagic stock. Analysis of 2010 shipboard line-transect data resulted in an abundance estimate of 1,503 (CV=0.66) false killer whales outside of 40 km of the main Hawaiian Islands (Bradford et al. 2012). Behavioral observations and assessment of the line-transect detection function indicate that false killer whales are attracted to the survey vessel (Bradford et al. 2012). This abundance estimate has not been corrected for vessel attraction and is considered an over-estimate of population abundance. Vessel attraction can result in overestimation of abundance by as much as 4-times in some populations (Turnock and Quinn 1991). The acoustic data collected during the 2010 survey are still being analyzed and additional refinements to this estimate are expected. The detection process during the recent survey is different from that during the 2002 survey due to the inclusion of acoustic techniques; therefore a thorough analysis of the visual and acoustic detections will be required before a new abundance estimate will be available.

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 log-normal 20th percentile of the 2002 abundance estimate for the Hawaiian Islands EEZ outside of 75 nmi from the main Hawaiian Islands (Barlow & Rankin 2007) is 249 false killer whales. This minimum population estimate is more than 8 years old, and therefore would generally be considered outdated under NMFS Guidelines for Assessing Marine Mammal Stocks (2005). unless there were compelling evidence that the abundance has not dropped below the 2002 minimum level within the EEZ of the Hawaiian Islands. The 2010 survey had a significantly higher encounter rate than the 2002 survey (6 on-effort sightings versus one) for approximately the same level of effort and in the same study area. The log-normal 20th percentile of the 2010 abundance estimate for the Hawaiian Islands EEZ outside of 40 km from the main Hawaiian Islands (Bradford et al. 2012) is 906 false killer whales. The minimum abundance estimate has not been corrected for vessel attraction and may be an over-estimate of minimum population size. The acoustic data collected during the 2010 survey are still being analyzed and additional refinements to this estimate are expected. Although the detection process has been improved with the inclusion of acoustic methods designed to increase the probability of detection for false killer whales, NMFS considers the significant increase in encounter rate during the 2010 survey as evidence that the abundance in the EEZ has not dropped below the 2002 minimum estimate. Therefore, the minimum estimate will be retained at this time, particularly given that a new minimum estimate will be available following thorough analysis of data collected during the 2010 HICEAS survey.

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 specifically intended to increase encounter rates, 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, 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. Obtaining information on rates of productivity for marine mammals is difficult (Wade 1998), and no estimate is available for this stock.

POTENTIAL BIOLOGICAL REMOVAL

Following the NMFS Guidelines for Assessing Marine Mammal Stocks (NMFS 2005), the PBR is calculated only within the U.S. EEZ of the Hawaiian Islands, because estimates of human-caused mortality and serious injury are not available from all U.S. and non-U.S. sources in international waters where this stock may occur. The potential biological removal (PBR) level for the Hawaii pelagic stock of false killer whale is thus calculated as the minimum population size within the U.S. EEZ of the Hawaiian Islands (249 906) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.48 0.50 (for a stock of unknown status with a Hawaiian Islands EEZ mortality and serious injury rate CV = 0.30 between 0.30 and 0.60; Wade and Angliss 1997), resulting in a PBR of 2.4 9.1 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. They are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor 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 international waters are not available, and because the geographic range of this stock beyond the Hawaiian Islands EEZ is poorly known. Because the rate of mortality and serious injury to false killer whales within the Hawaiian Islands EEZ (~~10.8~~ 13.5 animals per year) exceeds the PBR (~~2.4~~ 9.1 animals per year), this stock is considered a "strategic stock" under the 1994 amendments to the MMPA. 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, because it has exceeded the PBR for more than 10 years.

~~The National Marine Fisheries Service~~ NMFS ~~recognizes that the assessment of this transboundary stock based only on abundance and human-caused mortality and serious injury within the U.S. EEZ of Hawaii introduces uncertainty, and~~ has considered whether the status assessment of this transboundary stock would change if animals outside the Hawaiian Islands EEZ are considered. Using all available peer-reviewed information on the abundance of false killer whales on the high-seas and within the EEZ of Johnston Atoll, a PBR can be calculated as the lower 20th percentile of the Barlow and Rankin (2007) abundance estimate (~~530~~ 539), times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of ~~0.48~~ 0.50 (for a stock of unknown status with a mortality and serious injury rate CV = 0.30 ~~between 0.30 and 0.60~~; Wade and Angliss 1997), resulting in ~~5.1~~ 5.4 false killer whales per year. This minimum abundance estimate may be based on a smaller geographic area than the (unknown) full range of the pelagic stock, because areas to the north of the Hawaiian Islands EEZ are not included; however, the estimate meets the definition of a 'minimum population estimate' under the MMPA. Bycatch information for the high seas is incomplete, because the levels of false killer whale takes in non-U.S. fisheries are not known. The average annual estimated mortality and serious injury by U.S. longline vessels operating on the high seas and within the EEZ of Johnston Atoll is ~~10.4~~ 11.3 ~~(CV=0.31;~~ McCracken 2011 ~~2010)~~. This value is greater than the PBR of ~~5.1~~ 5.4, and the combined U.S. and international mortality and serious injury is likely substantially higher, because fishing effort by foreign vessels may be up to six times greater than that of the U.S. fleet (NMFS, unpublished data). Better information on the full geographic range of this stock and quantitative estimates of bycatch in international fisheries are needed to reduce the uncertainties regarding impacts of false killer whale takes on the high seas, but these uncertainties do not change the current assessment that the pelagic false killer whale stock is strategic.

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) false killer whales attributed to the Northwestern Hawaiian Islands stock (Bradford et al. 2012). This is the best available abundance estimate for false killer whales within the Northwestern Hawaiian Islands. Behavioral observations and assessment of the line-transect detection function indicate that false killer whales are attracted to the survey vessel (Bradford et al. 2012). The abundance estimate has not been corrected for vessel attraction and is considered an over-estimate of population abundance. The acoustic data collected during the 2010 survey are still being analyzed and additional refinements to this estimate are expected.

Minimum Population Estimate

The log-normal 20th percentile of the 2010 abundance estimate for the Northwestern Hawaiian Islands stock (Bradford et al. 2012) is 262 false killer whales. This 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.

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 size (262) 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, Wade and Angliss 1997), resulting in a PBR of 2.6 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 elevated levels of polychlorinated biphenyls (PCBs) in three of nine Hawaii insular false killer whales sampled, and 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. 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 false killer whales within the Northwestern Hawaiian Islands is unknown but may be approaching zero if the stock remains entirely within Monument waters and the longline exclusion zone near Kauai. Mortality and serious injury does not exceed the PBR (2.6) for this stock and thus, this stock is not considered "strategic" under the 1994 amendments to the MMPA.

~~**PALMYRA STOCK**~~

~~**POPULATION SIZE**~~

~~Recent line transect surveys in the U.S. EEZ waters of Palmyra Atoll produced an estimate of 1,329 (CV = 0.65) false killer whales (Barlow & Rankin 2007). This is the best available abundance estimate for false killer whales within the Palmyra Atoll EEZ.~~

~~**Minimum Population Estimate**~~

~~The log-normal 20th percentile of the 2002 abundance estimate for the Palmyra Atoll EEZ (Barlow & Rankin 2007) is 806 false killer whales.~~

~~**Current Population Trend**~~

~~No data are available on current population trend.~~

~~**CURRENT AND MAXIMUM NET PRODUCTIVITY RATES**~~

~~No data are available on current or maximum net productivity rate for this species in Palmyra Atoll waters. Obtaining information on rates of productivity for marine mammals is difficult (Wade 1998), and no estimate is available for this stock.~~

~~**POTENTIAL BIOLOGICAL REMOVAL**~~

~~The potential biological removal (PBR) level for the Palmyra Atoll false killer whale stock is calculated as the minimum population size (806) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.40 (for a stock of unknown status with a mortality and serious injury rate CV >0.80; Wade and Angliss 1997), resulting in a PBR of 6.4 false killer whales per year.~~

~~**STATUS OF STOCK**~~

~~The status of false killer whales in Palmyra Atoll EEZ waters 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. They are 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 false killer whales within the Palmyra Atoll EEZ in the Hawaii-based longline fishery (0.3 animals per year) does not exceed the PBR (6.4) for this stock and thus, this stock is not considered "strategic" under the 1994 amendments to the MMPA. The total fishery mortality and serious injury for Palmyra Atoll false killer whales is less than 10% of the PBR and, therefore, can be considered to be insignificant and approaching zero. Additional injury and mortality of false killer whales is known to occur in U.S and international longline fishing operations in international waters, and the potential effect on the Palmyra stock is unknown.~~

REFERENCES

Andersen, M. S., K. A. Forney, T. V. N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. Van Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby. 2008. Differentiating Serious and Non-Serious Injury of Marine Mammals: Report of the Serious Injury Technical Workshop, 10-13 September 2007, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-39. 94p.

Baird, R.W. 2009. A review of false killer whales in Hawaiian waters: biology, status, and risk factors. Report prepared for the U.S. Marine Mammal Commission under Order No. E40475499, December 23, 2009. 40p.

Baird, R.W., A.M. Gorgone, D.J. McSweeney, D.L. Webster, D.R. Salden, M.H. Deakos, A.D. Ligon, G.S. Schorr, J. Barlow and S.D. Mahaffy. 2008e. False killer whales (*Pseudorca crassidens*) around the main Hawaiian Islands: long-term site fidelity, inter-island movements, and association patterns. Marine Mammal Science 24:591-612

Baird, R.W., A.M. Gorgone, D.L. Webster, D.J. McSweeney, J.W. Durban, A.D. Ligon, D.R. Salden, and M.H. Deakos. 2005. False killer whales around the main Hawaiian Islands: An assessment of inter-island movements and population size using individual photo-identification. Contract Report JJ133F04SE0120 prepared for the Pacific Islands Fisheries Science Center, National Marine Fisheries Service, 2570 Dole Street, Honolulu, Hawaii, 96822. 24pp.

Baird, R.W., and A.M. Gorgone. 2005. False killer whale dorsal fin disfigurements as a possible indicator of long-line fishery interactions in Hawaiian waters. Pacific Science 59:593-601.

Baird, R.W., E.M. Oleson, J. Barlow, A.D. Ligon, A.M. Gorgone, and S.D. Mahaffy. 2012. Photo-identification and satellite-tagging of false killer whales during HICEAS 2010: evidence of an island-associated population within the Papahanaumokuakea Marine National Monument. Pacific Science. *In review*.

Baird, R.W, G.S. Schorr, D.L. Webster, D.J. McSweeney, M.B. Hanson, and R.D. Andrews. 2010. Movements and habitat use of satellite-tagged false killer whales around the main Hawaiian Islands. Endangered Species Research 10:107-121.

Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Marine Mammal Science 22: 446–464.

Barlow, J. and S. Rankin. 2007. False killer whale abundance and density: Preliminary estimates for the PICEAS study area south of Hawaii and new estimates for the US EEZ around Hawaii. Administrative Report LJ-07-02. Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037.

Boggs, C.H. and R.Y. Ito. 1993. Hawaii's pelagic fisheries. In: Boehlert GW (ed.). The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2): 61-68.

Bradford, A.L., K.A. Forney, E.M. Oleson, and J. Barlow. 2012. Line-transect abundance estimates of false killer whales (Pseudorca crassidens) in the pelagic region of the Hawaiian Exclusive Economic Zone and in the insular waters of the Northwestern Hawaiian Islands. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822. Pacific Islands Fish. Sci. Cent. Admin. Rep. H-12-02, 23 p.

Chivers, S. J., R. W. Baird, D. J. McSweeney, D. L. Webster, N. M. Hedrick, and J. C. Salinas. 2007. Genetic variation and evidence for population structure in eastern North Pacific false killer whales (*Pseudorca crassidens*). Can. J. Zool. 85: 783-794.

Chivers S. J., K. A. Forney, and D. Johnston. 2008. Rationale for the 2008 revision to Hawaiian stock boundaries for false killer whales, Pseudorca crassidens. SWFSC Administrative Report LJ-08-04. Available from SWFSC, 8604 La Jolla Shores Drive, La Jolla, CA 92038. 5p.

Chivers, S. J., R. W. Baird, K. M. Martien, B. Taylor, L., E. Archer, A. M. Gorgone, B. L. Hancock, N. Hedrick, M., D. K. Mattila, D. J. McSweeney, E. M. Oleson, C. L. Palmer, V. Pease, K. M. Robertson, J. Robbins, J. C. Salinas, G. S. Schorr, M. Schultz, J. L. Theileking and D. L. Webster. 2010. Evidence of genetic differentiation for Hawai'i insular false killer whales (*Pseudorca crassidens*). 44p. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-458.

~~Chivers S. J., K. A. Forney, and D. Johnston. 2008. Rationale for the 2008 revision to Hawaiian stock boundaries for false killer whales, Pseudorca crassidens. SWFSC Administrative Report LJ-08-04. Available from SWFSC, 8604 La Jolla Shores Drive, La Jolla, CA 92038. 5p.~~

~~Forney, K.A. 2010a. Serious injury determinations for cetaceans caught in Hawaii longline fisheries during 1994-2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-462. 19p.~~

~~Forney, K.A. 2010b. Serious injury determinations for cetaceans caught in Hawaii-based longline fisheries, January 2009 through October 2010. Draft document PSRG-2010-15 presented to the Pacific Scientific Review Group, November16-18, 2010, Kona, HI.~~

Forney, K.A. 2011. Serious Injury Determinations for marine mammals caught in U.S. longline fisheries in Hawaii and American Samoa. Draft document PSRG-2011-11 presented to the Pacific Scientific Review Group, November 7-9, 2011, Seattle, WA.

Forney, K. A., R. W. Baird, and E. M. Oleson. 2010. Rationale for the 2010 revision of stock boundaries for the Hawai‘i insular and pelagic stocks of false killer whales, *Pseudorca crassidens*. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-471. 7p.

Johnston, D. W., J. Robbins, M. E. Chapla, D. K. Mattila & K. R. Andrews. 2008. Diversity, habitat associations and stock structure of odontocete cetaceans in the waters of American Samoa, 2003-2006. Journal of Cetacean Research and Management 10: 59-66.

Maldini, D., L. Mazzuca, and S. Atkinson. 2005. Odontocete stranding patterns in the main Hawaiian Islands (1937-2002): How do they compare with live animal surveys? Pacific Science 59(1):55-67.

Martien, K, R.W. Baird, B.L. Taylor, E.M. Oleson, S.J. Chivers. 2011. Population structure and mechanisms of gene flow within island-associated false killer whales (*Pseudorca crassidens*) around the Hawaiian Archipelago. PSRG-11-14, 19pp.

McCracken, M. L. and K.A. Forney. 2010. Preliminary assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries. NMFS, Pacific Islands Fisheries Science Center Working Paper WP-10-001. 27p.

~~McCracken, M.L. 2010a. Assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries from 2005 though 2009, NMFS, Pacific Islands Fisheries Science Center Working paper WP-10-006, 26p.~~

McCracken, M.L. 2010~~b~~. Adjustments to false killer whale and short-finned pilot whale bycatch estimates. NMFS, Pacific Islands Fisheries Science Center Working paper WP-10-007, 23p.

McCracken, M.L. 2011. Assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries from 2006 through 2010. Pacific Islands Fisheries Science Center Working paper WP-11-012, 30p.

~~Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep. Int. Whal. Commn. 43:417-437.~~

Mobley, J.R. , Jr, S. S. Spitz, K. A. Forney, R. A. Grotefendt, and P. H. Forestall. 2000. Distribution and abundance of odontocete species in Hawaiian waters: preliminary results of 1993-98 aerial surveys Admin. Rep. LJ-00-14C. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 26 pp.

Mobley, J.R. 2001. Results of 2001 aerial surveys north of Kauai. Report to North Pacific Acoustic Laboratory program. 20 pp. Available as downloadable pdf file at: http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/2001NPAL.pdf

Mobley, J.R. 2002. Results of 2002 aerial surveys north of Kauai. Report to North Pacific Acoustics Laboratory program. 20 pp. Available as downloadable pdf file at: http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/2002NPAL.pdf

Mobley, J.R. 2003. Results of 2003 aerial surveys north of Kauai. Report to North Pacific Acoustics Laboratory program. 20 pp. Available as downloadable pdf file at: http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/2003NPAL.pdf

Mobley, J.R. 2004. Results of 2004 aerial surveys north of Kauai. Report to North Pacific Acoustics Laboratory program. 25 pp. Available as downloadable pdf file at: http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/2004NPAL.pdf

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

NMFS. 2005. Revisions to Guidelines for Assessing Marine Mammal Stocks. 24 pp. Available at: http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf

Oleson, E.M. 2009. Assessment of American Samoa longline fishery and estimates of cetacean bycatch, 2006-2008. NMFS, Pacific Islands Fisheries Science Center Working Paper WP-09-006, 12p.

Oleson, E.M., C.H. Boggs, K.A. Forney, M.B. Hanson, D.R. Kobayashi, B.L. Taylor, P.R. Wade, and G.M. Ylitalo. 2010. Status Review of Hawaiian Insular False Killer Whales (*Pseudorca crassidens*) under the Endangered Species Act. U.S Dep. Commerc. NOAA Tech Memo., NOAA-TM-NMFS-PIFSC-22. 140 p. + Appendices.

~~Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.~~

Reeves, R.R., S. Leatherwood, and R.W. Baird. 2009. Evidence of a possible decline since 1989 in false killer whales (*Pseudorca crassidens*) around the main Hawaiian Islands. Pacific Science 63(2): 253–261.~~in press.~~

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.

Stacey, P. J., S. Leatherwood, and R. W. Baird. 1994. *Pseudorca crassidens*. Mamm. Spec. 456:1-6.

Turnock, B. J., and T. J. Quinn II. 1991. The effect of responsive movement on abundance estimation using line transect sampling. Biometrics 47:701-715.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

~~Wade, P.R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. Marine Mammal Science 14(1): 1-37.~~

Ylitalo, G. M., R. W. Baird, G. K. Yanagida, D. L. Webster, S. J. Chivers, J. L. Bolton, G. S. Schorr and D. J. McSweeney. 2009. High levels of persistent organic pollutants measured in blubber of island-associated false killer whales (*Pseudorca crassidens*) around the main Hawaiian Islands. *Marine Pollution Bulletin* 58: 1932-1937.

New 5/10/2012

FALSE KILLER WHALE (*Pseudorca crassidens*): Palmyra Atoll Stock

STOCK DEFINITIONS AND GEOGRAPHIC RANGE

False killer whales are found worldwide mainly 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. There are six stranding records from Hawaiian waters (Nitta 1991; Maldini et al. 2005). Four on-effort sightings of false killer whales were made during a 2005 shipboard survey of the U.S. Exclusive Economic Zone (EEZ) of Palmyra Atoll (Figure 1; Barlow & Rankin 2007). This species also occurs in U.S. EEZ waters around Hawaii (Barlow 2006, Bradford et al. 2011), Johnston Atoll (NMFS/PIR/PSD unpublished data), and American Samoa (Johnston et al. 2008, Oleson 2009).

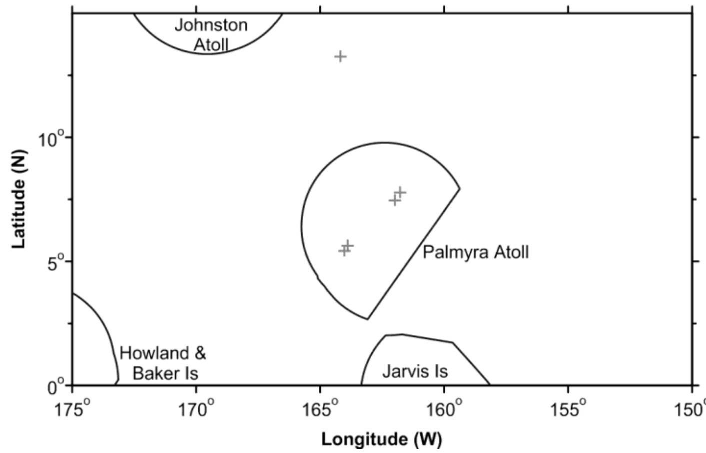

Figure 1. False killer whale on-effort sighting locations during a 2005 standardized shipboard surveys of the Palmyra U.S. EEZ and pelagic waters of the central Pacific south of the Hawaiian Islands (gray crosses, Barlow and Rankin 2007). Solid lines represent approximate boundary of U.S. EEZs.

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). The Palmyra Atoll stock of false killer whales remains a separate stock, because comparisons amongst false killer whales sampled at Palmyra Atoll and those sampled from the insular stock of Hawaii and the pelagic ENP revealed restricted gene flow, although the sample size remains low for robust comparisons (Chivers et al. 2007, 2010). NMFS will obtain and analyze additional tissue samples from Palmyra and the broader tropical Pacific for genetic studies of 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 (Chivers et al. 2008, Martien et al. 2011): 1) the Hawaii insular stock, which includes animals inhabiting waters within 140 km (approx. 75 nmi) of the main Hawaiian Islands, 2) the Northwestern Hawaiian Islands stock, which includes false killer whales inhabiting waters within 93 km (50 nmi) of the NWHI and Kauai, 3) the Hawaii pelagic stock, which includes false killer whales inhabiting waters greater than 40 km (22 nmi) from the main Hawaiian Islands, 4) the Palmyra Atoll stock, which includes false killer whales found within the U.S. EEZ of Palmyra Atoll, and 5) the American Samoa stock, which includes false killer whales found within the U.S. EEZ of American Samoa. Estimates of abundance, potential biological removal, and status determinations for the Palmyra Atoll stock is presented below; the Hawaii Stock Complex and American Samoa Stocks are presented in separate reports.

POPULATION SIZE

A 2005 line transect survey in the U.S. EEZ waters of Palmyra Atoll produced an estimate of 1,329 (CV = 0.65) false killer whales (Barlow & Rankin 2007). This is the best available abundance estimate for false killer whales within the Palmyra Atoll EEZ.

Minimum Population Estimate

The log-normal 20th percentile of the 2005 abundance estimate for the Palmyra Atoll EEZ (Barlow & Rankin 2007) is 806 false killer whales.

Current Population Trend

No data are available on current population trend.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Palmyra Atoll false killer whale stock is calculated as the minimum population size (806) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.40 (for a stock of unknown status with a mortality and serious injury rate CV >0.80; Wade and Angliss 1997), resulting in a PBR of 6.4 false killer whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Interactions with false killer whales, including depredation of catch, have been identified in logbooks and NMFS observer records from Hawaii pelagic longlines (Nitta and Henderson 1993, NMFS/PIR unpublished data). False killer whales have also been observed feeding on mahi mahi, *Coryphaena hippurus*, and yellowfin tuna, *Thunnus albacares*, and they have been reported to take large fish from the trolling lines of both commercial and recreational fishermen (Shallenberger 1981).

The Hawaii-based deep-set longline (DSLL) fishery targets primarily tunas and operate within U.S. waters and on the high seas near Palmyra Atoll. Between 2006 and 2010, one false killer whale was observed taken in the DSLL fishery within the Palmyra EEZ (≥20% observer coverage) (Forney 2011). Based on an evaluation of the observer's description of each interaction and following the most recently developed criteria for assessing serious injury in marine mammals (Andersen et al. 2008), the single false killer whale taken in the Palmyra EEZ was considered seriously injured (Forney 2011). The total estimated annual and 5-yr average mortality and serious injury of cetaceans in the DSLL fishery operating around Palmyra (with approximately 20% coverage) are reported by McCracken (2011) (Table 1). Although M&SI estimates are shown as whole numbers of animals, the 5-yr average M&SI is calculated based on the unrounded annual estimates.

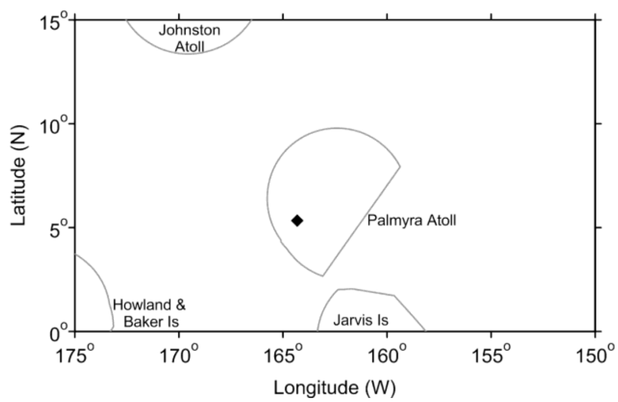

Figure 2. Locations of observed false killer whale takes in the Hawaii-based deep-set longline fishery, 2006-2010. Solid gray lines represent the U.S. EEZ. Fishery descriptions are provided in Appendix 1.

Because of high rates of false killer whale mortality and serious injury in Hawaii-based longline fisheries, a Take-Reduction Team (TRT) was established in January 2010 (75 FR 2853, 19 January 2010). The scope of the TRT was to reduce mortality and serious injury in the Hawaii pelagic, Hawaii insular, and Palmyra stocks of false killer whales and across the DSLL and SSLL fisheries. The Team submitted a Draft Take-Reduction Plan to NMFS for consideration (Available at: http://www.nmfs.noaa.gov/pr/pdfs/interactions/fkwtrp_draft.pdf), and NMFS has proposed regulations based on this TRP (76 FR 42082, 18 July 2011).

Table 1. Summary of available information on incidental mortality and serious injury of false killer whales (Palmyra Atoll stock) by fishery (McCracken 2011). Mean annual takes are based on 2006-2010 estimates unless otherwise indicated. Information on all observed takes (T) and combined mortality events & serious injuries (MSI) is included. Total takes were prorated to deaths, serious injuries, and non-serious injuries based on the observed proportions of each outcome. CVs are estimated based on the methods of

McCracken & Forney (2010) and do not yet incorporate additional uncertainty introduced by prorating false killer whales in the overlap zone and prorating the unidentified blackfish.

Fishery Name	Year	Data Type	Percent Observer Coverage	Observed total interactions (T) and mortality events and serious injuries (MSI), and total estimated mortality and serious injury (M&SI) of false killer whales in the Palmyra Atoll EEZ	
				Observed T/MSI	Estimated Mean Annual Takes (CV)
Hawaii-based deep-set longline fishery	2006	observer data	22%	0/0	0 (-)
	2007		20%	1/1	2 (0.7)
	2008		22%	0/0	0 (-)
	2009		20%	0/0	0 (-)
	2010		21%	0/0	0 (-)
Minimum total annual takes within U.S. EEZ					**0.3 (1.7)**

STATUS OF STOCK

The status of false killer whales in Palmyra Atoll EEZ waters 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. They are 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 false killer whales within the Palmyra Atoll EEZ in the Hawaii-based longline fishery (0.3 animals per year) does not exceed the PBR (6.4) for this stock and thus, this stock is not considered "strategic" under the 1994 amendments to the MMPA. The total fishery mortality and serious injury for Palmyra Atoll false killer whales is less than 10% of the PBR and, therefore, can be considered to be insignificant and approaching zero. Additional injury and mortality of false killer whales is known to occur in U.S and international longline fishing operations in international waters, and the potential effect on the Palmyra stock is unknown.

REFERENCES

Andersen, M. S., K. A. Forney, T. V. N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. Van Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby. 2008. Differentiating Serious and Non-Serious Injury of Marine Mammals: Report of the Serious Injury Technical Workshop, 10-13 September 2007, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-39. 94p.

Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Marine Mammal Science 22: 446–464.

Barlow, J. and S. Rankin. 2007. False killer whale abundance and density: Preliminary estimates for the PICEAS study area south of Hawaii and new estimates for the US EEZ around Hawaii. Administrative Report LJ-07-02. Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037.

Bradford, A.L., E.M. Oleson, K.A. Forney, and J. Barlow. 2011. False killer whales abundance in Hawaiian waters: Preliminary estimates from the 2010 abundance survey. PSRG-2011-19, XX pp..

Chivers, S. J., R. W. Baird, D. J. McSweeney, D. L. Webster, N. M. Hedrick, and J. C. Salinas. 2007. Genetic variation and evidence for population structure in eastern North Pacific false killer whales (*Pseudorca crassidens*). Can. J. Zool. 85: 783-794.

Chivers S. J., K. A. Forney, and D. Johnston. 2008. Rationale for the 2008 revision to Hawaiian stock boundaries for false killer whales, Pseudorca crassidens. SWFSC Administrative Report LJ-08-04. Available from SWFSC, 8604 La Jolla Shores Drive, La Jolla, CA 92038. 5p.

Chivers, S. J., R. W. Baird, K. M. Martien, B. Taylor, L., E. Archer, A. M. Gorgone, B. L. Hancock, N. Hedrick, M., D. K. Mattila, D. J. McSweeney, E. M. Oleson, C. L. Palmer, V. Pease, K. M. Robertson, J. Robbins, J. C. Salinas, G. S. Schorr, M. Schultz, J. L. Theileking and D. L. Webster. 2010. Evidence of genetic differentiation for Hawai'i insular false killer whales (*Pseudorca crassidens*). 44p.

Forney, K.A. 2011. Serious Injury Determinations for marine mammals caught in U.S. longline fisheries in Hawaii and American Samoa. Draft document PSRG-2011-11 presented to the Pacific Scientific Review Group, November 7-9, 2011, Seattle, WA.

Johnston, D. W., J. Robbins, M. E. Chapla, D. K. Mattila & K. R. Andrews. 2008. Diversity, habitat associations and stock structure of odontocete cetaceans in the waters of American Samoa, 2003-2006. Journal of Cetacean Research and Management 10: 59-66.

Maldini, D., L. Mazzuca, and S. Atkinson. 2005. Odontocete stranding patterns in the main Hawaiian Islands (1937-2002): How do they compare with live animal surveys? Pacific Science 59(1):55-67.

Martien, K, R.W. Baird, B.L. Taylor, E.M. Oleson, S.J. Chivers. 2011. Population structure and mechanisms of gene flow within island-associated false killer whales (*Pseudorca crassidens*) around the Hawaiian Archipelago. PSRG-11-14, 19pp.

McCracken, M. L. and K.A. Forney. 2010. Preliminary assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries. NMFS, Pacific Islands Fisheries Science Center Working Paper WP-10-001. 27p.

McCracken, M.L. 2011. Assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries from 2006 through 2010. Pacific Islands Fisheries Science Center Working paper WP-11-012, 30p.

Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.

Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.

NMFS. 2005. Revisions to Guidelines for Assessing Marine Mammal Stocks. 24 pp. Available at: http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf

Oleson, E.M. 2009. Assessment of American Samoa longline fishery and estimates of cetacean bycatch, 2006-2008. NMFS, Pacific Islands Fisheries Science Center Working Paper WP-09-006, 12p.

Stacey, P. J., S. Leatherwood, and R. W. Baird. 1994. *Pseudorca crassidens*. Mamm. Spec. 456:1-6.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

Appendix 3. 2012 Pacific Marine Mammal Stock Assessment Reports summary.
Shaded lines indicate reports revised in 2012. 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	≥431	≥337	N	2006	2007	2008	2011
Harbor seal	California	SWC	30,196	n/a	26,667	0.12	1	1,600	31	18	N	2002	2004	2009	2011
Harbor seal	Oregon/Washington Coast	AKC	unk	unk	unk	0.12	1	unk	≥3.8	≥1.8	N	1999			2010
Harbor seal	Washington Inland Waters	AKC	unk	unk	unk	0.12	1	unk	≥13.0	≥3.8	N	1999			2010
Northern Elephant Seal	California breeding	SWC	124,000	n/a	74,913	0.117	1	4,382	≥10.4	≥8.8	N	2001	2002	2005	2007
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	San Miguel Island	AKC	9,968	n/a	5,395	0.12	1	324	1.2	0	N	2004	2005	2007	2010
Monk Seal	Hawaii	PIC	~~1,125~~	n/a	~~1,093~~	0.07	0.1	undet	~~≥3.0~~	unk	S	~~2007~~	~~2008~~	~~2009~~	~~2011~~
			1,212		1,170				0.6			2008	2009	2010	2012
Harbor porpoise	Morro Bay	SWC	2,044	0.40	1,478	0.04	0.5	15	0	0	N	1999	2002	2007	2009
Harbor porpoise	Monterey Bay	SWC	1,492	0.4	1,079	0.04	0.45	10	≥1.0	≥1.0	N	1999	2002	2007	2009
Harbor porpoise	San Francisco – Russian River	SWC	9,189	0.38	6,745	0.04	0.5	67	0	0	N	1999	2002	2007	2009
Harbor porpoise	Northern CA/Southern OR	SWC	39,581	0.39	28,833	0.04	1	577	≥4	≥4	N	1999	2002	2007	2009
Harbor porpoise	Northern Oregon/Washington Coast	AKC	15,674	0.39	11,383	0.04	0.5	114	≥1.4	≥1.4	N	1991	1997	2002	2011
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	0.45	193	15.1	10.5	N	2001	2005	2008	2010
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	≥0.2	≥0.2	N	2001	2005	2008	2010
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	~~27,046~~	~~0.59~~	~~17,127~~	0.04	~~0.48~~	~~164~~	~~13~~	~~13~~	N	~~2001~~	~~2005~~	~~2008~~	~~2010~~
			107,016	0.42	76,224		0.4	610	13.8	13		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	AKC	~~86~~	n/a	~~86~~	~~0.04~~	0.1	~~0.17~~	~~0.2~~	~~0~~	S	~~2008~~	~~2009~~	~~2010~~	~~2011~~
			87		87	0.032		0.14	0	0		2009	2010	2011	2012
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	907	0.49	615	0.04	0.5	6.2	0	0	N	2001	2005	2008	2010
Mesoplodont beaked whales	California/Oregon/Washington	SWC	1,024	0.77	576	0.04	0.5	5.8	0	0	N	2001	2005	2008	2010
Cuvier's beaked whale	California/Oregon/Washington	SWC	2,143	0.65	1,298	0.04	0.5	13	0	0	N	2001	2005	2008	2010
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	971	0.31	751	0.04	0.1	1.5	~~0.4~~	~~0.2~~	S	2001	2005	2008	~~2010~~
									4.0	3.8					2012
Gray whale	Eastern North Pacific	SWC	19,126	0.07	18,017	~~0.04~~	1.0	~~360.0~~	~~127~~	~~3.3~~	N	2009	2010	2011	~~2011~~
						0.062		558	128	3					2012
Humpback whale	California/Oregon/Washington	SWC	2,043	0.10	1,878	0.08	0.3	11.3	≥ 3.6	≥ 3.2	S	2001	2005	2008	2010
Blue whale	Eastern North Pacific	SWC	2,497	0.24	2,046	0.04	0.3	3.1	1.0	0	S	2001	2005	2008	2010

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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	3,044	0.18	2,624	0.04	0.3	16	1.0	0	S	2001	2005	2008	2010
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
Rough-toothed dolphin	Hawaii	SWC	8,709	0.45	6,067	0.04	0.5	61	unk	unk	N			2002	2010
Rough-toothed dolphin	American Samoa	PIC	unk	unk	unk	0.04	0.5	unk	unk	unk	unk	n/a	n/a	n/a	2010
Risso's dolphin	Hawaii	SWC	2,372	0.97	1,195	0.04	0.5	12	0	0	N			2002	2010
Common Bottlenose dolphin	Hawaii Pelagic	SWC	3,178	0.59	2,006	0.04	0.45	18	≥0.4	≥0.4	N			2002	2010
Common Bottlenose dolphin	Kaua'I and Ni'ihau	SWC	147	0.11	134	0.04	0.5	1.3	unk	unk	N	2003	2004	2005	2010
Common Bottlenose dolphin	O'ahu	SWC	594	0.54	388	0.04	0.5	3.9	unk	unk	N	2002	2003	2006	2010
Common Bottlenose dolphin	4 Islands Region	SWC	153	0.24	125	0.04	0.5	1.3	unk	unk	N	2002	2003	2006	2010
Common Bottlenose dolphin	Hawaii Island	SWC	102	0.13	91	0.04	0.5	0.9	unk	unk	N	2002	2003	2006	2010
Pantropical Spotted dolphin	Hawaii	PIC	8,978	0.48	6,701	0.04	0.5	61.0	0	0	N			2002	2010
Spinner dolphin	Hawaii Pelagic	PIC	~~3,351~~	~~0.74~~	~~1,920~~	0.04	0.5	~~19~~	0	0	N		~~2002~~	~~2004~~	~~2010~~
			unk	unk	unk			undet				2002	2004	2010	2012
Spinner dolphin	Hawaii Island	PIC	~~unk~~	~~unk~~	~~unk~~	0.04	0.5	~~unk~~	unk	unk	N			~~1994~~	~~2010~~
			790	0.17	685			6.9					1994	2003	2012
Spinner dolphin	Oahu / 4 Islands	PIC	~~unk~~	~~unk~~	~~unk~~	0.04	0.5	~~unk~~	unk	unk	N	~~1993~~	~~1995~~	~~1998~~	~~2010~~
			355	0.09	329			3.3				1993	1998	2007	2012
Spinner dolphin	Kaua'I / Ni'ihau	PIC	~~unk~~	~~unk~~	~~unk~~	0.04	0.5	~~unk~~	unk	unk	N	~~1993~~	~~1995~~	~~1998~~	~~2010~~
			601	0	509			5.1				1995	1998	2005	2012
Spinner dolphin	Kure / Midway	PIC	unk	unk	unk	0.04	0.5	~~unk~~	unk	unk	N	~~n/a~~	~~n/a~~	~~1998~~	~~2010~~
								undet					1998	2010	2012
Spinner dolphin	Pearl and Hermes Reef	PIC	unk	unk	unk	0.04	0.5	~~unk~~	unk	unk	N	n/a	n/a	n/a	~~2010~~
								undet							2012
Spinner dolphin	American Samoa	PIC	unk	unk	unk	0.04	0.5	unk	unk	unk	unk	n/a	n/a	n/a	2010
Striped dolphin	Hawaii Pelagic	PIC	13,143	0.46	9,088	0.04	0.45	82	unk	unk	N			2002	2010
Fraser's dolphin	Hawaii	PIC	10,226	1.16	4,700	0.04	0.5	47	0	0	N			2002	2010
Melon-headed whale	Hawaii	PIC	2,950	1.17	1,350	0.04	0.5	14	0	0	N			2002	2010
Pygmy killer whale	Hawaii	PIC	956	0.83	520	0.04	0.5	5.2	0	0	N			2002	2010
False killer whale	Northwestern Hawaiian Islands	PIC	552	1.09	262	0.04	0.5	2.6	0	0	N			2010	2012
False killer whale	Hawaii Pelagic	PIC	~~484~~	~~0.93~~	~~249~~	0.04	~~0.48~~	~~2.4~~	~~10.8~~	~~10.8~~	S			~~2002~~	~~2011~~
			1,503	0.66	906		0.5	9.1	13.8	13.8			2002	2010	2012
False killer whale	Palmyra Atoll	PIC	1,329	0.65	806	0.04	0.4	6.4	0.3	0.3	N			2005	~~2011~~
															2012
False killer whale	Hawaii Insular	PIC	~~170~~	~~0.21~~	~~110~~	0.04	0.1	~~0.2~~	~~0.6~~	~~0.6~~	S	2007	2008	2009	~~2011~~
			151	0.20	129			0.3	0.5	0.5					2012
False killer whale	American Samoa	PIC	unk	unk	unk	0.04	0.5	unk	unk	unk	unk	n/a	n/a	n/a	2010

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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
Killer whale	Hawaii	PIC	349	0.98	175	0.04	0.5	1.8	0	0	N			2002	2010
Pilot whale, short-finned	Hawaii	PIC	8,846	0.49	5,986	0.04	0.4	48	0.7	0.7	N			2002	2010
Blainville's beaked whale	Hawaii	PIC	2,872	1.17	1,314	0.04	0.5	13.0	0	0	N			2002	2010
Longman's Beaked Whale	Hawaii	PIC	1,007	1.25	443	0.04	0.5	4.4	0	0	N			2002	2010
Cuvier's beaked whale	Hawaii	PIC	15,242	1.43	6,269	0.04	0.5	63	0	0	N			2002	2010
Pygmy sperm whale	Hawaii	PIC	7,138	1.12	3,341	0.04	0.5	33	0	0	N			2002	2010
Dwarf sperm whale	Hawaii	PIC	17,519	0.74	10,043	0.04	0.5	100	0	0	N			2002	2010
Sperm whale	Hawaii	PIC	6,919	0.81	3,805	0.04	0.1	7.6	0	0	S			2002	2010
Blue whale	Central North Pacific	PIC	unk	unk	unk	0.04	0.1	undet	0	0	S			2002	2010
Fin whale	Hawaii	PIC	174	0.72	101	0.04	0.1	0.2	0	0	S			2002	2010
Bryde's whale	Hawaii	PIC	469	0.45	327	0.04	0.5	3.3	0	0	N			2002	2010
Sei whale	Hawaii	PIC	77	1.06	37	0.04	0.1	0.1	0	0	S			2002	2010
Minke whale	Hawaii	PIC	unk	unk	unk	0.04	0.5	undet	0	0	N			2002	2010
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