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U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 2012

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

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).

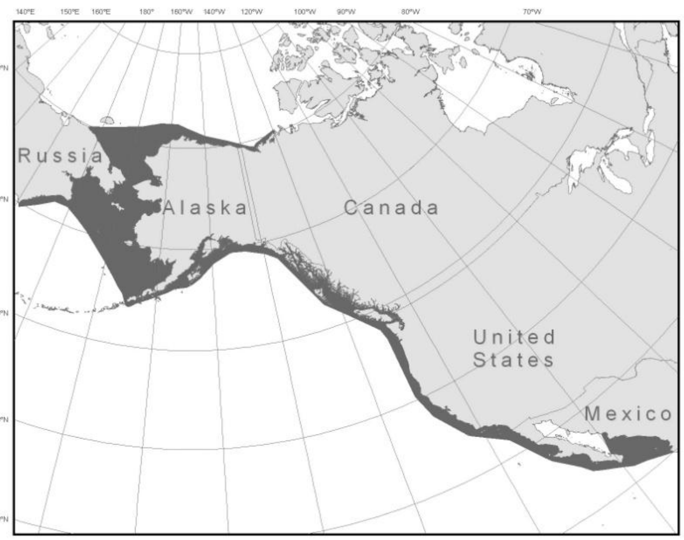

Figure 1. Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area).

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 theWNP 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 has 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 Palsbøll *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 statistically 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 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. Laake *et al.* (2009) developed a more consistent approach to abundance estimation that used a better model for pod size bias and applied their estimation approach to re-estimate abundance for all 23 surveys.

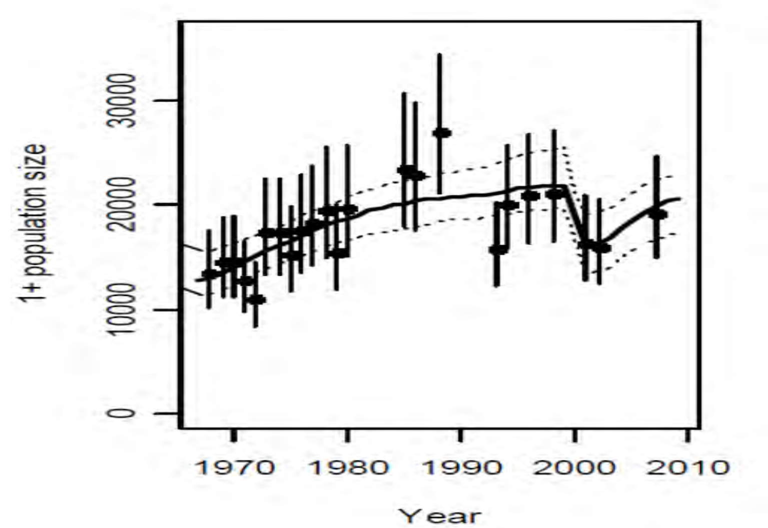

Figure 2. Estimated abundance of Eastern North Pacific gray whales from NMFS counts of migrating whales past Granite Canyon, California. Error bars indicated 90% probability intervals. The solid line represents the estimated trend of the population with 90% intervals as dashed lines (after Punt and Wade 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 is largely explained by differences in the correction for pod size bias, because the pod sizes in the calibration data were positively-biased. 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). 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.

Eastern North Pacific gray whales experienced an unusual mortality event in 1999 and 2000, when large numbers stranded along the west coast of North America (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 years prior to the mortality event (1996-98), when calf strandings were more common. Many stranded whales were emaciated and aerial photogrammetry documented that gray whales were thinner in 1999 relative to previous years (Perryman and Lynn, 2002). Several factors 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 stranded whales supported the idea that starvation could have been a significant contributing factor to the higher number of strandings in 1999 and 2000. Unusual oceanographic conditions in 1997 may also have decreased productivity in the Bering Sea (Minobe 2002). Regardless of the mechanism, visibly emaciated whales (LeBoeuf *et al*. 2000; Moore *et al*. 2001) suggest a decline in available food resources, and it is clear that ENP gray whales were substantially affected in those years; whales were 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 to levels seen in the 1990s before the mortality event in 1999 and 2000 (Figure 2).

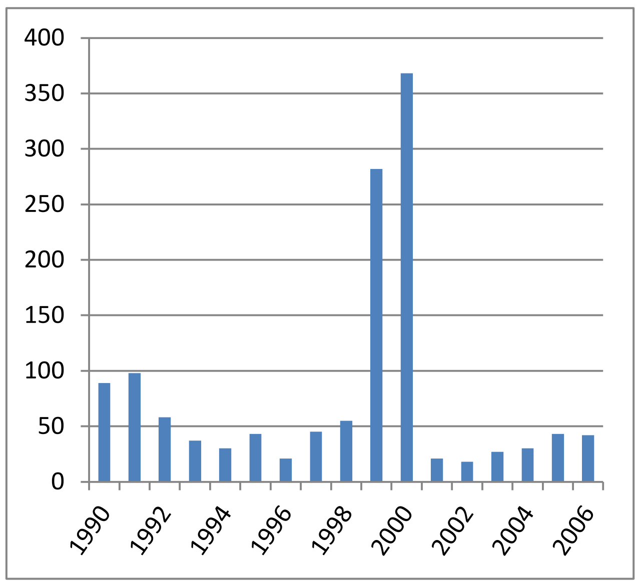

Figure 3. Number of stranded gray whales recorded along the west coast of North America between 1990 and 2006 (data from Brownell et al. 2007).

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). 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 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 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 indicate 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 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. 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

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

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). Observers have not been assigned to most Alaska gillnet fisheries, including those in Bristol Bay known to interact with gray whales. Due to a lack of observer programs, mortality data from Canadian commercial fisheries is not available. 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.

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. 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	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).

			more gear.	
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
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

Subsistence/Native Harvest Information

Subsistence hunters in Russia and the United States have traditionally harvested whales from 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). In2007, the IWC approved a 5-year quota (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. 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 hunt were 129 in 2006 (IWC 2008),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 123 whales during the 5-year period from 2006 to2010.

Other Mortality

Ship strikes are a 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). Additional mortality from ship strikes probably goes unreported because the whales either do not strand or do not have obvious signs of trauma.

In February 2010, a gray whale stranded dead near Humboldt, CA with parts of two harpoons embedded in the body. Since this whale was likely harpooned during the aboriginal hunt in Russian waters, it would have been counted as "struck and lost" 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 Diego and Cabo San 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

Evidence indicates that the Arctic climate is changing significantly, resulting in a reduction in the extent of sea ice cover in some regions (Johannessen et al. 2004). These changes are likely to affect gray whales due to the impacts 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 opportunistic foragers, with documented feeding year-round off Kodiak, Alaska. Bluhm and Gradinger (2008) examined 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 in response to climate change. They noted that marine mammal species that exhibit trophic plasticity (such as gray whales which feed on both benthic and pelagic prey) will adapt better than trophic specialists.

Global climate change is also likely to increase human activity in the Arctic as sea ice decreases, including oil and gas exploration and shipping (Hovelsrud et al. 2008). Such activity will increase the chance of oil spills and ship strikes in this region. 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 could reduce 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, the 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). Punt and Wade (2010) estimated the ENP population 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).

Even though the stock is within OSP, abundance will fluctuate as the population adjusts to natural and human-caused factors affecting carrying capacity of the environment (Rugh et al. 2005). It is expected that a population close to or at carrying capacity will be more susceptible to environmental fluctuations (Moore et al. 2001). The correlation between gray whale calf production and environmental conditions in the Bering Sea (Perryman et al. 2002) may reflect this. Overall, the population nearly doubled in size over the first 20 years of monitoring, and has fluctuated for the last 30 years around its average carrying capacity. This is 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 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 Pacific population of gray whales, while MMPA management occurs at the level of a stock, which in this case is the ENP stock. It is speculative to try to determine what proportion of the estimated abundance may have been in the eastern or western populations. It is also uncertain if Alter et al.'s estimates include the Atlantic population (Palsbøll et al. 2007). Second, NMFS relies on current carrying capacity in making MMPA determinations. Ecosystems change over time and with those changes, the carrying capacity of the ecosystem also changes. NMFS interprets carrying capacity to mean "current" carrying capacity in part because it is not reasonable to expect ecosystems to remain static over thousands of years. 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.

Based on 2006-2010 data, the estimated annual level of human-caused mortality and serious injury for ENP gray whales includes Russian harvest (123), mortality from commercial fisheries (3.0), and ship strikes (2.2), totals 128 whales per year, which does not exceed the PBR (558). Therefore, the 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.

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