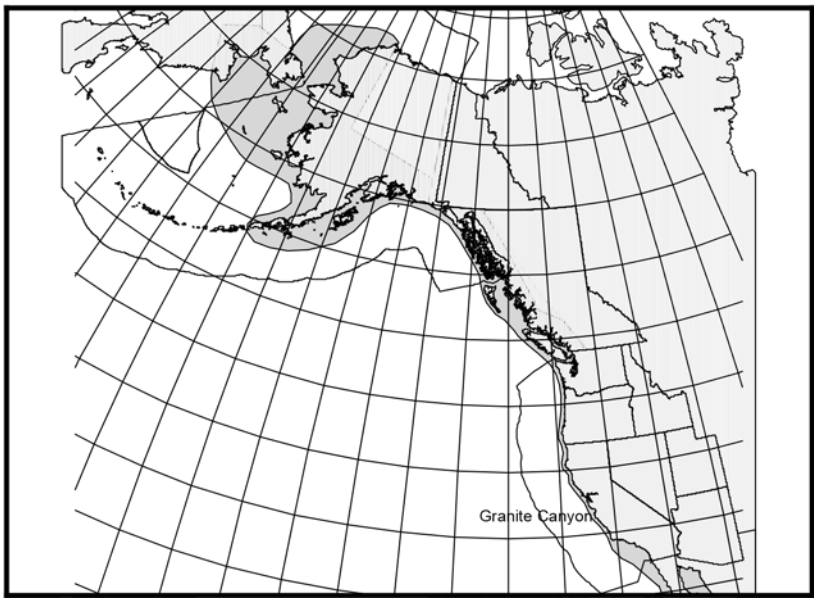
GRAY WHALE (*Eschrichtius robustus*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Gray whales formerly occurred in the North Atlantic Ocean (Fraser 1970), but this species is currently found only in the North Pacific (Rice et al. 1984). The following information was considered in classifying stock structure of gray whales based on the phylogeographic approach by Dizon et al. (1992) : 1) Distributional data: two isolated geographic distributions in the North Pacific Ocean; 2) Population response data: there is an increase in the eastern North Pacific, 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. 31), and the Western North Pacific or "Korean" stock, which lives along the coast of eastern Asia (Rice 1981, Rice et al. 1984). Most of the Eastern North Pacific stock spends the summer feeding in the northern Bering and Chukchi Seas (Rice and Wolman 1971, Berzin 1984, Nerini 1984). However, gray whales have been reported feeding in the summer in waters off of Southeast Alaska, British Columbia, Washington, Oregon, and California (Rice and Wolman 1971, Darling 1984, Nerini 1984, Rice et al. 1984). 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). 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.

Figure 31. Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area). Excluding some Mexican waters, the entire range of this stock is depicted in the figure.



There has been some speculation that discrete stocks of gray whales occur in coastal areas, such as Puget Sound. Although some localized, seasonal site fidelity has been confirmed, animals in Puget Sound have also been seen using coastal areas from northern California to Southeast Alaska in spring and fall (Calambokidis and Quan 1999, Gosho et al. 1999). At this time, available information indicates that the Eastern North Pacific stock of gray whales should be managed as a single stock (Swartz et al. 2000).

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. The latest abundance estimate (26,635; CV = 0.1006) is based on counts made during the 1997/98 southbound migration (Hobbs and Rugh 1999). This estimate is not significantly larger than the previous estimates of 22,263 (CV = 0.0925) whales in 1995/96 (Hobbs et al. in press); 23,109 (CV = 0.0542) whales in 1993/94 (Laake et al. 1994); and 21,296 (CV = 0.0605) whales in 1987/88 (Buckland et al. 1993); but it is significantly higher than the estimate of 17,674 (CV = 0.0587) whales in 1992/93 (Laake et al. 1994). Variations in estimates may be due in part to undocumented sampling variation or to differences in the proportion of the gray whale stock migrating as far as the central California coast each year (Hobbs and Rugh 1999). The 1997/98 abundance estimate is the most recent and is considered a reliable estimate of abundance for this stock. The most recent survey to determine abundance was carried out during the winter of 2000/01. An abundance estimate based on these data will be available in the 2003 SARs.

Gray whale calves have been counted from Piedras Blancas, a shore site in central California, in 1980-81 (Poole 1984a) and each year since 1994 (Perryman et al. 2002). In 1980 and 1981, calves passing this site comprised 4.7% to 5.2% of the population, respectively (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). Gray whale calves have also been counted from the shore station at Granite Canyon during the southbound migration (Shelden et al. 1995, Shelden and Rugh 2001). These results have indicated an apparent increase in the percentage of calf sightings from 0.0%-0.2% during 1952-74, 0.1%-0.9% during 1984-95 (Shelden et al. 1995), and 0.3%-1.5% during 1996-2001 (Shelden and Rugh 2001). This increase may be related to a trend toward later migrations over the observation period (Rugh et al. 2001, Buckland and Breiwick in press), or it may be due to an increase in spatial and temporal distribution of calving as the population increased.

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for this 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 1997/98 population estimate of 26,635 and its associated CV of 0.1006, N_{MIN} for this stock is 24,477.

Current Population Trend

The population size of the Eastern North Pacific gray whale stock has been increasing over the past several decades. The estimated annual rate of increase, based on shore counts of southward migrating gray whales between 1967 and 1988, is 3.29% with a standard error of 0.44% (Buckland et al. 1993). Taking account of the harvest, Wade and DeMaster (1996) estimated an underlying annual rate of increase of 4.4% (95% CI: 3.1%-5.6%) for this same time period. Incorporating the census data through the 1993/94 migration resulted in an annual rate of increase of 2.57% (SE = 0.4%: IWC 1995a). Most recently, Breiwick (1999) estimated the annual rate of increase from 1967/68 to 1997/98 at 2.52% (95% CI: 2.04%-3.12%), and Wade and DeMaster (1996) estimated the annual rate of increase from 1967/68 to 1995/96 at 2.4% (95% CI: 1.6%-3.2%).

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). 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 4 years (Fig. 32). Gray whale strandings occurred throughout the year in both 1999 and 2000, but regional peaks of strandings occurred where the whales were in their migration cycle. Hypothesized reasons for the increased stranding rate in recent years 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. The other hypotheses indicated 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. Thus, while the stranding rate was certainly much higher in 1999 and 2000 than in previous years, it may not indicate a higher mortality rate. Preliminary stranding data indicate that the stranding event in 1999 and 2000 is over, as only 21 gray whale strandings were reported in 2001 (T. Rowles, pers. comm.).

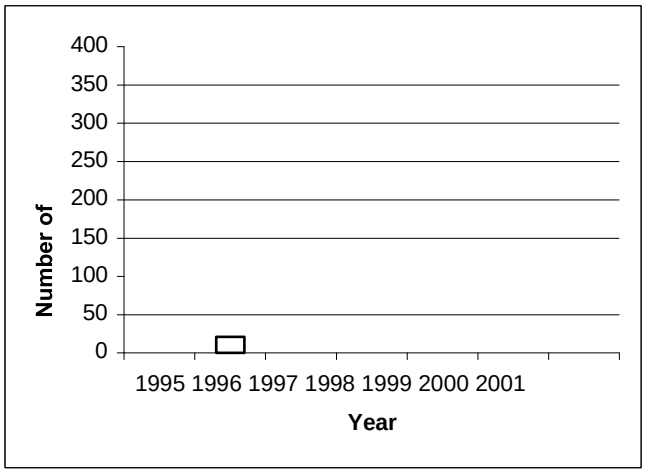


Figure 32. Number of strandings of gray whales along the west coast of North America, 1995-2001.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Using abundance data through 1996, an analysis of the Eastern North Pacific gray whale population led to an estimate of R_{max} of 0.072, with a 90% probability the value was between 0.039 and 0.126 (Wade 2002). 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. This estimate was higher than the estimate of R_{max} from a logistic model (0.053, 90% probability 0.031 to 0.113), which was not age- and sex-structured (Wade 2002). The Alaska Scientific Review Group recommended the use of the 0.053 point estimate for R_{max}. The difference in the two estimates of R_{max} is due to the bias in the harvest towards females, which is not accounted for in the logistic model. Therefore, NMFS has decided to use the estimate from the age- and sex-structured model, which had a lower 10th percentile of 0.047. This has the interpretation that there is a 90% probability that the true value of R_{max} is greater than 0.047. This is sufficient evidence that R_{max} for Eastern North Pacific gray whales is greater than the default value of 0.04. Therefore, NMFS will use a R_{max} of 0.047.

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 re-authorized 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 upper limit of the range (0.5-1.0) of values for non-listed stocks which are increasing while undergoing removals due to subsistence hunters (Wade and Angliss 1997). Thus, for the Eastern North Pacific stock of gray whales, PBR = 575 animals (24,477 × 0.0235 × 1.0).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY Fisheries Information

Six different commercial fisheries operating in Alaska waters within the range of the Eastern North Pacific gray whale stock were monitored for incidental take by NMFS observers during 1990-00: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries and Gulf of Alaska groundfish trawl, longline, and pot fisheries. No gray whale mortalities were observed for any of these Alaska 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 4 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, pers. comm.). Data from 1990-00 are included in Table 25a, although the mean estimated annual mortality is calculated using only the most recent 5 years of available data.

NMFS observers also monitored the California/Oregon thresher shark/swordfish drift gillnet fishery from 1993 to 2000 (Table 25a; Julian 1997; Cameron 1998; Julian and Beeson 1998; Cameron and Forney 1999, 2000; Carretta 2001). 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 (Barlow and Cameron 1999). Because of the changes in this fishery after implementation of the Take Reduction Plan, mean annual takes in Table 25a are based only on 1997-2000 data.

The mean annual mortality was 0.2 (CV = 1.0) for the northern Washington marine set gillnet fishery and 2.5 (CV = 0.58) for the California/Oregon thresher shark/swordfish drift gillnet fishery, resulting in a mean annual mortality rate of 2.7 (CV = 0.54) gray whales per year from observed fisheries.

An additional source of information on the number of gray whales killed or injured incidental to commercial fishery operations is the logbook/self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 2000, logbook/fisher self-reports indicated 2 gray whale mortalities related to the Bristol Bay gillnet fisheries in 1990, resulting in an annual mean of 0.5 gray whale mortalities from interactions with commercial fishing gear. In 1990, logbook records from the Bristol Bay set and drift gillnet fisheries were combined. As it is not possible to determine which fishery was responsible for the gray whale mortalities reported in 1990, both fisheries have been included in Table 25a. However, because logbook records are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Logbook data are available for part of 1989-94, 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 1994-95 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 for details).

Table 25a. Summary of incidental mortality of Eastern North Pacific gray whales due to commercial and tribal fisheries from 1990-2000 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from logbook/self-reports or stranding data. Data from 1996-2000 (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	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Northern Washington marine set gillnet (tribal: coastal + inland waters)	90-00	obs data	33-98%	1, 0, 0, 0, 0, 1, 0, 0, 0, n/a, 0	1, 0, 0, 0, 0, 1, 0, 0, 0, n/a, 0	0.2 (CV = 1.0)
CA/OR thresher shark/swordfish drift gillnet	93-00	obs data	12-25%	0, 0, 0, 0, 0, 1, 1, 0	0, 0, 0, 0, 0, 5, 5, 0	2.5* (CV = 0.58)
Observer program total						2.7 (CV = 0.54)

				Reported mortalities		
Bristol Bay salmon drift and set gillnet fisheries	90-00	logbook /selfreports	n/a	2, 0, 0, 0, n/a, n/a, n/a, n/a, n/a, n/a, n/a	n/a	[0.5]
Unknown west coast fisheries	93-00	strand data	n/a	0, 5, 3, 3, 6, 4, 5, 8	n/a	[5.2]
AK salmon purse seine	99-00	strand data	n/a	1, 0	n/a	[0.5]
Minimum total annual mortality						8.9

* Only 1997-2000 mortality estimates are included in the average because of gear modifications implemented within the fishery as part of a 1997 Take Reduction Plan. Gear modifications included the use of net extenders and acoustic warning devices (pingers).

Reports of entangled gray whales found swimming, floating, or stranded with fishing gear attached occurs 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; while Table 25b presents data on strandings that occurred on the U. S. west coast from 1999-2000. The strandings resulting from commercial fishing are listed as unknown west coast fisheries in Table 25a, unless they could be attributed to a particular fisheries. During the 5-year period from 1996-2000, stranding network data indicate a minimum annual mean of 5.7 gray whale mortalities resulting from interactions with commercial fishing gear.

Table 25b. Human-related gray whale strandings and entanglements, 1999-2000. An asterisk in the "number" column indicates cases that were not considered serious injuries.

Year	Number	Area	Condition	Description
1999	1	Port Gravina, PWS, AK	Dead	Entangled in AK salmon purse seine net
1999	1	Bristol Bay, AK	Dead	Entangled
1999	1*	Offshore North Coronado Is., CA	Non-fatal injury	Ship strike
1999	1	Wreck Creek, WA	Dead	Net wrapped around flukes
1999	1	Twin Harbors State Park, WA	Dead	Rope through mouth
1999	1	1.5 mi. offshore Rancho Palos Verdes, CA	Injury; status unknown	Pink gillnet & attached float wrapped around flukes; swimming w/difficulty; unable to dive

1999	1	10 mi. offshore Port Hueneme, CA	Dead	Wrapped in pot gear & associated floats
1999	1*	2 mi. offshore Crescent City, CA	Non-fatal injury	Crab pot line wrapped around flukes & mouth; disentangled by rescue team
1999	1*	3 mi. offshore Crescent City, CA	Released alive	Crab pot line wrapped around body; released from entangling gear
1999	1	Pt. Loma, CA	Dead	18" harpoon tip embedded in left dorsum
1999	1	Muir Beach, CA	Dead	Ship strike
2000	1	Depoe Bay, OR	Alive	Trailing fish line with longline buoys attached
2000	1	Brookings, OR	Alive	Head entangled in line
2000	1	Offshore Pt. Loma, CA	Status unknown	Trailing lobster pot gear
2000	1	Offshore San Clemente, CA	Status unknown	Yellow polypropylene line wrapped around flukes of free swimming whale
2000	1	Redwood National Park, CA	Dead	Ship strike
2000	1	Offshore Pt. Dume, CA	Status unknown	Line & buoys wrapped around flukes of free swimming whale
2000	1	Vandenberg AFB, CA	Dead	Lobster trap & rope wrapped around flukes
2000	1	Seal Beach, CA	Dead	White sea-bass gillnet wrapped around flukes
2000	1	Offshore Shelter Cove, CA	Injury; status unknown	Free-swimming whale with harpoon in back
2000	1	Offshore Aptos, CA	Status unknown	Fishing gear & floats wrapped around right pectoral flipper of free-swimming whale

It should be noted that no observers have been assigned to most Alaska gillnet fisheries, including those in Bristol Bay which are known to interact with this stock, making the estimated mortality from U.S. fisheries a minimum figure. Further, due to a lack of observer programs there are few data concerning the mortality of marine mammals incidental to Canadian commercial fisheries, which are analogous to U.S. fisheries that are known to interact with gray whales. 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 commercial fisheries (8.9 whales; based on observer data (2.7) and

logbook/self-reports (0.5) or stranding reports (5.7) where observer data were not available) is not known to exceed 10% of the PBR (58) and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate.

Subsistence/Native Harvest Information

Subsistence hunters in Alaska and Russia have traditionally harvested whales from this stock. The only reported takes by subsistence hunters in Alaska during this decade occurred in 1995, with the take of two gray whales by Alaskan 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, the IWC approved a 5-year quota (1998-2002) 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. Russian aboriginals harvested 123 (+2 struck and lost) gray whales in 1998 (IWC 2000), 121 (+2 struck and lost) in 1999 (IWC 2001), and 113 (+2 struck and lost) in 2000 (Borodin 2001), while the Makah Tribe harvested 1 whale in 1999 (IWC 2001). Based on this information, the annual subsistence take averaged 97 whales during the 5-year period from 1996-00. This level of take is well below the 1968-93 average of 159 whales per year (IWC 1995b), during which time the population size increased.

Other Mortality

The near shore migration route used by gray whales makes ship strikes another potential source of mortality. Between 1996 and 2000, the California stranding network reported 5 serious injuries or mortalities of gray whales caused by ship strikes: 3 in 1998 and 1 per year in 1999 and 2000 (J. Cordaro, pers. comm.). One ship strike mortality was reported in Alaska in 1997 (B. Fadely, 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 25b). A Russian harpoon tip was found in a dead whale that stranded in 1999 (R. Brownell, pers. comm.), and an injured whale with a harpoon in its back was sighted in 2000. Since, these whales were likely harpooned during the aboriginal hunt in Russian waters, they would have been counted as "struck and lost" whales in the harvest data.

STATUS OF STOCK

The Eastern North Pacific stock of gray whales has been increasing in recent years while being subjected to known harvests. Based on currently available data, the estimated annual level of human-caused mortality and serious injury (107), which includes mortalities from commercial fisheries (9), Russian harvest (97), and ship strikes (1) does not exceed the PBR (575). Therefore, the Eastern North Pacific stock of gray whales is not classified as a strategic stock. In 1994 this stock 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). 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, followed a review of 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.

On 28 March 2001, NMFS received a petition from D. J. Schubert, on behalf of Australians for Animals, The Fund for Animals and several other organizations, to list the Eastern North Pacific stock of gray whales as threatened or endangered under the ESA. On 21 May 2001, NMFS determined that the petition did not present substantial scientific or commercial information sufficient to warrant the listing of this stock (66 FR 32305).

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