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Status Review of the Eastern North Pacific Stock of Gray Whales

by
D. J. Rugh, M. M. Muto, S. E. Moore, and D. P. DeMaster

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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Abstract

The National Marine Fisheries Service (NMFS) conducted a review of the status of the Eastern North Pacific stock of gray whales (*Eschrichtius robustus*). This review culminated in a workshop held by the National Marine Mammal Laboratory (NMML) in Seattle, Washington, on 16-17 March 1999. Based on the continued growth of this population (rising at 2.5% annually; currently at an estimated 26,600 individuals) and the lack of evidence of any imminent threats to the stock, workshop participants recommended the continuation of this stock's classification as non-threatened. They also concluded that abundance monitoring should continue at some level, especially as this stock approaches its carrying capacity, and that, ideally, research should continue on human impacts to critical habitats. This stock's annual migrations along the highly populated coastline of the western United States and their concentration in limited winter and summer areas may make them particularly vulnerable to impacts from commercial or industrial development or local catastrophic events. The Western North Pacific gray whale stock has not recovered and should continue to be listed as endangered.

The workshop and status review conclude the 5-year assessment of the Eastern North Pacific gray whale stock following its removal from the List of Endangered and Threatened Wildlife and Plants on 16 June 1994.

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Background

Under the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*; the MMPA), the National Marine Fisheries Service (NMFS) has jurisdiction over most marine mammal species[1], including whales. Under section 4(a) of the Endangered Species Act (16 U.S.C. 1531 *et seq.*; the ESA) and 50 CFR part 424 of NMFS' listing regulations, NMFS makes determinations as to whether a marine mammal species should be listed as endangered or threatened, or whether it should be reclassified or removed from the List of Endangered and Threatened Wildlife and Plants (the List). Accordingly, NMFS conducted comprehensive evaluations of the status of the Eastern North Pacific gray whale stock, *Eschrichtius robustus*, (sometimes referred to as the "California stock") in 1984 (Breiwick and Braham 1984). Based upon their review, NMFS concluded that this stock should be listed as threatened instead of endangered (49 FR 44774, 9 November 1984); however, no further action was taken at that time. Another review was completed and made available to the general public on 27 June 1991 (56 FR 29471). The 1991 review showed the best available abundance estimate, in 1987/88, was 21,296 (CV = 6.05%; 95% CI = 18,900 to 24,000) whales and the average annual rate of increase was 3.29% (SE = 0.44%) (Buckland et al. 1993). Back-calculations, dynamic response, and Bayesian estimations indicated that this stock was probably approaching current carrying capacity (Reilly 1992). Therefore, NMFS determined that the Eastern North Pacific stock no longer met the standards for classification as an endangered "species." Although individual and cumulative impacts might have the potential to adversely affect these whales, it was determined that this stock was neither in danger of extinction throughout all or a significant portion of its range (i.e., not endangered), nor was it likely to again become endangered within the foreseeable future (i.e., not threatened). Therefore, on 22 November 1991 (56 FR 58869), NMFS proposed that this stock be removed from the List. Of note, changes to the listing of this stock had no bearing on the status of the Western North Pacific gray whale stock (sometimes referred to as the "Korean stock"), which has not recovered and is still considered endangered throughout its range (USFWS 1997). After an extensive public comment period (22 November 1991 to 6 March 1992), NMFS published a final notice of determination that the Eastern North Pacific stock should be removed from the List (58 FR 3121, 7 January 1993). The population abundance and trends in the population's growth rate were deemed sufficient to allow this stock to be removed from the List without first being down-listed to threatened status.

As a result of NMFS' determination, the U.S. Fish and Wildlife Service (USFWS) removed the Eastern North Pacific stock of gray whales from the List under the ESA on 16 June 1994 (59 FR 31094) with the amendment of 50 CFR 17.11(h). To correspond with that ruling, NMFS also removed this stock from the List under its jurisdiction (50 CFR part 222) through an amendment of 50 CFR 222.23(a).

As required under section 4(g) of the ESA, NMFS drafted the "5-year Plan for Research and Monitoring of the Eastern North Pacific Population of Gray Whales"

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[1]The U.S. Fish and Wildlife Service (USFWS) has jurisdiction over polar bears, sea otters, manatees, dugongs, and walrus.

(NMFS 1993) to monitor the status of the stock for a period of at least 5 years following the delisting. This plan (NMFS 1993:25) states that a "Task Group will conduct a comprehensive 'status review' of the gray whale . . . Included in that report will be a recommendation on whether to 1) continue the monitoring program for an additional 5-year period; 2) terminate the monitoring program; or 3) consider changing the status of the gray whale under the ESA." The draft plan, dated October 1993, was not finalized by the NMFS Office of Protected Resources; however, it has provided the framework and guidelines for research, monitoring, and management over the past 5 years. The plan was prepared by 11 NMFS scientists (the Gray Whale Monitoring Task Group), including Howard Braham (Chair), Jeffrey Breiwick, Robert Brownell, Jr., Marilyn Dahlheim, Douglas DeMaster (Vice-Chair), Kenneth Hollingshead, Jeffrey Laake, Stephen Reilly, John Stein, Steven Swartz, and Grant Thompson.

On 16-17 March 1999, 3 months prior to the conclusion of the 5-year period following the delisting of the Eastern North Pacific gray whale stock, a workshop was convened by NMFS at the Alaska Fisheries Science Center's National Marine Mammal Laboratory (NMML) in Seattle. Most of the original Task Group participated in this workshop, and other participants were invited as well, depending on their expertise and contributions that could help in the review process (see the participant list, Appendix A). The workshop provided an opportunity for interactions among researchers conducting studies pertinent to the evaluation of the status of gray whales. Agenda and abstract materials were circulated prior to and following the workshop to provide additional time for detailed reviews. An expanded agenda, with summaries of critical information, is included in the following report under "Outline of Available Information." Most of this material is explained further in the attached abstracts (Appendix B). Research documents from the past 5 years that pertain to this subject are in the literature section, including the literature cited in the Status Review.

Information included in the Outline of Available Information is inclusive of all pertinent studies and available data collected up to and including 16 June 1999, the 5-year anniversary of the removal of the Eastern North Pacific stock of gray whales from the List.

This Status Review document will be forwarded to the NMFS Assistant Administrator for Fisheries for approval and release to the public. The NMFS Office of Protected Resources will publish a Federal Register notice to announce the availability of this document and invite public comment.

Workshop objectives

The central objective of the status review and workshop held 16-17 March 1999 was to evaluate available information pertinent to the health of the Eastern North Pacific stock of gray whales. Questions to be answered through this process were:

1. Was it appropriate to delist this stock 5 years ago?
2. Should this stock continue to be considered non-endangered and non-threatened?
3. Should the monitoring process continue for another 5-year period?

Factors to be considered in determining the status of gray whales

The ESA specifies regulatory elements that were used to determine the status of the Eastern North Pacific stock of gray whales both in the delisting process in 1993-94 (see above) and in the review of scientific materials available during the 5 years that followed delisting (i.e., this report). Listing, reclassifying, or removing a species from the List is based on review of five factors, of which only one need apply for a "species" to be listed as either endangered or threatened (ESA: 16 U.S.C. 1533(a)(1); NMFS: 50 CFR 424):

1. Present or threatened destruction, modification, or curtailment of its habitat or range.
2. Overutilization for commercial, recreational, scientific, or educational purposes.
3. Disease or predation.
4. Inadequacy of existing regulatory mechanisms.
5. Other natural or manmade factors affecting its continued existence.

The workshop participants used these five factors as a guide to determine whether or not the current status of the Eastern North Pacific gray whale stock should be changed from non-threatened. The following information is a collection of research pertinent to this decision. The outline was adapted from the list of research needs in the 5-year monitoring plan (NMFS 1993:52).

Outline of Available Information

1) **Abundance, distribution, population trend, and status**

1.1) **Abundance**

1.11) **1993/94 abundance:** Systematic counts of southbound migrating gray whales were conducted 10 December 1993 to 18 February 1994 at Granite Canyon, California (Laake et al. 1994), the census site used most years since 1975 by NMML. In total, 1,864 pods (3,411 whales) were recorded during 447 hours of good or better watch conditions at the primary observation site. The abundance estimate was 23,109 (CV = 5.42%; 95% CI = 20,800 to 25,700).

1.12) **1995/96 abundance:** Systematic counts of gray whales were conducted from 13 December 1995 to 23 February 1996 at Granite Canyon (Hobbs et al. in press). As during previous surveys, census methods included double-counting to assess observer performance as well as aerial surveys and high-powered binoculars to document that a negligible fraction of migrating whales passed beyond the sighting range of the observers. There were 2,151 pods (3,928 whales) counted during 472.7 hours of standard watch effort. Data analysis procedures were modified to account for differential sightability by pod size. Population size was estimated to be 22,263 whales (CV = 9.25%; 95% log-normal CI = 18,700 to 26,500).

1.13) **1997/98 abundance:** Systematic counts of gray whales were conducted from 13 December 1997 to 24 February 1998 at Granite Canyon and Point Lobos, California (Hobbs and Rugh 1999). Counting methods, similar to previous surveys, included double-counting to assess observer performance

and high-powered binoculars to document that a negligible fraction of migrating whales passed beyond the sighting range of the observers. In total, 2,318 pods (3,643 whales) were counted during 435.3 hours of standard watch effort. Data analysis procedures were identical to those used for the 1995/96 census. The population was estimated to be 26,635 whales (CV = 10.06%; 95% log-normal CI = 21,878 to 32,427).

1.14) **Counting methodology:** Systematic counts of gray whales have been conducted by NMML during 3 of the past 5 seasons (1993/94, 1995/96, 1997/98) (Hobbs and Rugh 1999). These surveys covered the duration of the southbound migration past the Granite Canyon research station. In addition to the standard primary watch, a second, independent watch was conducted once or twice daily. Offshore distribution of sightings was documented by comparing the paired counts on the standard watch; by searches through paired, fix-mounted 25 X binoculars; and by aerial surveys. In January 1993 and January 1994, pod-size estimation experiments involved an airplane circling pods of whales as several observers independently estimated pod sizes (Withrow in press). Tests of the counting system, but not full-season counts, were conducted in January 1995 and January 1997 (Rugh[2]). Analytical methods are described in Breiwick and Hobbs (1996).

1.15) **Night travel rates:** In studies conducted by Perryman et al. (1999a) in January 1994, 1995, and 1996, there was no significant diel variation in gray whale swimming speed. Prior to 15 January each year (the median migration date), diurnal and nocturnal rates (average number of whales/hour) were not significantly different; after 15 January, the nocturnal rate was significantly higher (28%, SE = 11.6%) than the diurnal rate.

1.16) **Database management:** Census data have been collected on gray whales during their southbound migration since 1952 (Shelden[3]). Currently the "raw" count data are not readily available to the scientific community or the general public. Therefore, researchers at NMML are in the process of creating a single, uniform, and easily accessible database. Before this can occur, the following tasks must be completed: 1) convert all computerized databases (Yankee Point/Granite Canyon/Point Lobos study sites used from 1967/68 to1997/98) into a common format, and place all data into one master database; 2) find and incorporate data from Point Loma (1952-78) into the master database; and 3) store the master database on CD-ROM for distribution to the public. It is anticipated that this product will be available by September 2000, pending support from the NMFS Office of Protected Species.

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[2]Pers. comm. Dave Rugh, National Marine Mammal Lab, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115-0070.

[3]Pers. comm. Kim Shelden, National Marine Mammal Lab, AFSC, NMFS,7600 Sand Point Way NE, Seattle, WA 98115-0070.

1.2) **Distribution**

1.21) **Migration**

1.211) **Relative to the census station**

1.2111) **Shore-based observations:** In January 1995 and 1996, using fixed-mounted 25X binoculars, paired independent searches for gray whales resulted in detection probabilities of 0.97 for pod sizes greater than 1 and 0.87 for single whales (5% of sampled population) within the critical sighting range of 1-3 nautical miles (nmi) (1.8-5.6 km) of shore (Rugh et al. in press).

1.2112) **Aerial observations:** Shelden and Laake (in press) compared the distribution of whales within 3 nmi (5.6 km) north and south of Granite Canyon during six aerial surveys (conducted concurrently with shore-based surveys in 1979, 1980, 1988, 1993, 1994, and 1996). They found that whale distributions within the typical viewing range of shore-based observers (3 nmi from shore) differed by year, but the shifts in the distribution were minor (< 0.3 nmi; < 0.5 km). Inshore (< 2.25 nmi; < 4.17 km) and offshore (> 2.25 nmi) distribution of gray whale pods did not differ significantly between survey years. A mean of 4.76% (SE = 0.85%) of the whale pods were observed beyond 2.25 nmi, and only 1.28% (SE = 0.07%) were observed beyond 3 nmi.

1.212) **Timing in 1998/99**

1.2121) **Oregon:** Alternate half-hour counts were made during the morning hours from 5 December 1998 through mid-February 1999 from the Yaquina Head Lighthouse (49 m above sea level) near Newport, Oregon (Mate and Poff 1999). The first whale was sighted on 23 December, and the peak passage occurred on 7 January. By comparison with previous data from the same site (1978-81), the migration started 3 weeks later than normal, and the migration peaked 6 days later than the latest date reported previously. Whales did not tend to come nearshore to the degree experienced in previous years. In this study, 60% of the sightings were greater than 5 nmi (> 9 km) offshore and 20% were less than 3 nmi (< 5.6 km).

1.2122) **Washington - aerial:** Shelden et al. (1999a, 1999b) conducted six (4 complete and 2 partial) surveys in November and December 1998 and January 1999. Four pods (6 whales) were observed on offshore transect lines from 5.5 to 47 km offshore, and two pods (2 whales) were observed on coastal tracklines from Cape Flattery to Carroll Island, Washington. The authors compared their results to surveys conducted off Granite Canyon, California, and suggested several factors that may have influenced the likelihood of detecting gray whales off the northern Washington coast: timing of the peak of the migration, lulls in the migration, width of the migration corridor, and limitations in the field of view from the aircraft. Of these four factors, corridor width

appeared to be the most likely contributor to reduced observer detection rates.

1.2123) **Washington - shore-based:** Gray whales were seen on three occasions (2, 4, and 13 December) during a survey conducted from the tower of the Tatoosh Island lighthouse, on the northwesternmost tip of Washington State, between 30 November and 16 December 1998 (Jones 1999). The maximum possible sighting distance was estimated at 25 km, but gray whales were only seen at a range of 0.6-5.9 km from shore. It is possible that whales passed offshore, out of the observer's sighting range, or that this time period represented the very early stages of the southbound gray whale migration past Washington.

1.2124) **California to Alaska:** According to Rugh et al. (1999a, 1999b), the median sighting date of southbound gray whales prior to 1980 was 8 January (ranging from 5 to14 January) at the Granite Canyon research station. However, since 1980 there has been a 1-week delay in the peak of the migration such that the median date is now closer to 15 January (ranging from 12 to 19 January). Using a travel rate of 144 km/day (Swartz et al. 1987) between shore stations, the expected peak dates in 1998/99 should have been 5 January for Tatoosh Island; 8 January for Yaquina Head; 15 January for Granite Canyon; and 18 January at Point Vicente, near Los Angeles, California. Although no observations were made at Granite Canyon in 1998/99, sightings collected at Yaquina Head (Mate and Poff 1999) and Point Vicente (Schulman-Janiger 1999a) indicate that the southbound migration was within 1 or 2 days of the expected date.

1.213) **Travel rates:** Gray whales migrate at a rate of approximately 144 km/day (SD = 31 km/day), based on radio tags placed on whales near the Granite Canyon research station (Swartz et al. 1987). This travel speed was similar to rates calculated from a comparison of timings of peaks in sightings as whales migrated south past several shore stations ($\bar{x}$ = 139 km/day; SD = 18 km/day) (Rugh et al. 1999a, 1999b).

1.214) **Relative to Arctic and subarctic conditions:** Rugh et al. (1999a, 1999b) determined that gray whale migratory timing is remarkably regular: the 20 peaks observed at Granite Canyon during the southbound migration from 1967/68 to 1997/98 varied less than 4 days from the overall median dates. Regularity of this sort is likely driven by photoperiod (that is, shortening day lengths), not by weather. Arctic and subarctic temperatures and ice conditions are far from being so regular. Inter-year variations of a few days in migratory dates may be explained in part by variations in the median location of whales in the Bering or Chukchi Seas just prior to the onset of the migration. The farther north the whales are in autumn, the shorter the photoperiod will be, which might accelerate the onset of their southbound migration.

1.22) **Summering areas**

1.221) **Arctic and subarctic:** During aerial surveys in the Alaskan Chukchi and Beaufort Seas in 1982-91 (Moore and DeMaster 1997), gray whales were associated with virtually the same habitat throughout the summer (40 m depth and $\leq$ 1% ice cover) and the autumn (38 m depth and $\leq$ 7% ice cover), unlike bowhead and beluga whales. Moore and DeMaster (1997) believe that shallow coastal and offshore-shoal areas provide habitat rich in gray whale prey, and there is little reason for whales to abandon this habitat prior to winter onset. The association of gray whales with discrete offshore shoals in the northern Chukchi Sea may indicate that these are important feeding areas for the expanding population.

1.222) **Washington:** From 1984 to 1997, 168 individual gray whales were photo-identified (as seasonal resident whales from spring through fall) in coastal areas of Washington State (Calambokidis and Quan 1999, Gosho et al. 1999a, 1999b). Gray whales showed some localized site fidelity but also moved widely within and between years. Expanded research in 1998 (Calambokidis and Quan 1999) revealed that seasonal resident gray whales in Washington also used coastal areas from northern California to southeast Alaska from spring to fall. This large feeding range may account for inconsistent year-to-year resightings. Whales in northern Puget Sound showed strong site fidelity for part of the season and then moved to unknown areas. Use of southern Puget Sound was variable, mortality was high, and whales were rarely seen more than once.

1.23) **Wintering areas:** According to Urbán et al. (1997, 1998a, 1998b), the annual maximum count of all whales in San Ignacio Lagoon during the winters of 1978-85 averaged 348.7 (SE = 35.2) adults, of which 238.2 (SE = 36.7) were single whales and 110.5 (SE = 27.6) were cow-calf pairs. From 1996 to 1998, there was an average of 230 (SE = 18.4) adults in the lagoon, of which 140 (SE = 33.5) were single whales and 90 (SE = 37) were cow-calf pairs. During photo-identification studies in the lagoon in 1996-98, 752 whales were identified, including 411 single whales, 332 cow-calf pairs, and 9 whales which could not be classified. Of these, 120 whales were resighted: 14 single whales and 106 cow-calf pairs. Cow-calf pairs stayed in the lagoon an average of 19.1 days (± 4.8 95% CI) in 1996, 19.6 days (± 3.5 95% CI) in 1997, and 20.6 days (± 4.1 95% CI) in 1998, while single whales used the lagoons an average of 2.6 days (± 0.9 95% CI) in 1996, 6.2 days (± 3.2 95% CI) in 1997, and 5.6 days (± 2 95% CI) in 1998. During surveys in 1996 and 1998 (Urbán et al. 1998b), most whales were observed heading west off the coast of Bahía Ballenas, Baja California Sur, Mexico. Single whales were observed farther offshore than the cow-calf pairs. The number of single whales recorded in 1996 and 1998 was higher than the recorded number of cow-calf pairs. Similar traveling patterns and group composition were reported by Sánchez Pacheco and Valdés Aragón (1997) in 1997.

1.3) **Population trend:** Between 1967/68 and 1995/96, the Eastern North Pacific gray whale population increased 2.5% per annum (SE = 0.3%), and the estimated asymptote from a logistic model was 26,046 (SE = 6,281) with the inflection point in 1971 (SE = 6.5) (Buckland and Breiwick in press). Using a generalized linear model to fit abundance estimates from 1967/68 to 1997/98, the *ROI* (rate of increase) was 2.52% per annum (SE = 0.27%); using a logistic model, *K* (carrying capacity) was estimated to equal 37,364 (SE = 24,854), which is larger by 11,000 than a similar estimate based on the 1967/68 to1995/96 data; and *RY* (replacement yield) equaled 612 (Breiwick 1999). Density-dependent slowing of the population growth rate was supported by use of a Bayesian statistical method to compare the fit of the data to density-dependent versus density-independent models. Point estimates of the equilibrium population size ranged from 24,000 to 32,000, depending on the model (Wade and DeMaster 1996). Using a Bayesian statistical method to assess the stock with 1966/67 to1995/96 data, point estimates of carrying capacity ranged from 24,640 to 31,840; the median depletion (population size as a fraction of carrying capacity) was 0.75, with a lower 2.5th percentile of 0.36; the probability that the population is still below one-half of the carrying capacity was 0.21, and the probability that it is still below its maximum sustainable yield level was 0.28 (Wade in press).

1.4) **Population status**

1.41) **Criteria for ESA listing status:** Using 19 years of abundance estimates for the Eastern North Pacific gray whale, Gerber et al. (in press) sampled subsets of the original survey data to identify the minimum number of years of data required to consistently recommend removing the population from the ESA List of Endangered and Threatened Wildlife. These subsets of data were then analyzed using their proposed classification criteria. It was found that a quantitative decision to delist was unambiguously supported by 11 or more years of data, but precariously uncertain with fewer than 10 years of data.

2) **Calf production and pregnancy rate**

2.1) **Southbound migration at Granite Canyon/Yankee Point and Point Loma:** Calf sightings (number of calves/total whales) recorded by NMFS observers during the gray whale southbound migrations were summarized by Shelden et al. (in press) for 1952-95 and by Shelden and Rugh (1999) for 1995-98. Percentages of calves ranged from 0.0 to 0.2% from 1952-74, 0.1-0.9% from 1984-95, and 0.3-1.5% from 1995-98. The apparent increase in the percentage of calf sightings may be related to a trend towards successively later migrations over the 43-year observation period, or it may be due to an increase in spatial and temporal distribution of calving as the population has increased. The distribution of cows with calves relative to shore was similar to earlier years where the majority of sightings occurred inshore of the main migration corridor (1.4-2.8 km) during both shore-based and aerial surveys. Aerial surveys (between 1979 and 1994) indicated that shore-based observers missed 62% of the calves within their viewing area

(0-2.6 km from shore), suggesting that calves are under-represented in the data (Shelden et al. in press).

2.2) **Southbound migration at Point Vicente:** Schulman-Janiger (1999b), of the American Cetacean Society, Los Angeles Chapter (ACS/LA), reported that percentages of calves in the southbound migrations from 1983/84 to 1989/90 ranged from 0.5% to 2.5%, averaging 1.7%. From 1990/91 to 1992/93, these percentages increased to 3.0-3.9%, averaging 3.5%. The calf percentages from 1993/94 to 1998/99 ranged from 2.0% to 8.6%, averaging 4.6%. However, the calf count in the 1998/99 migration (n = 15; 2.2%) was one of the lowest in the past nine seasons. The highest calf count (n = 106; 8.6%) was in the 1997/98 season.

2.3) **Northbound migration at Point Vicente:** Schulman-Janiger (1999b) reported that percentages of newborn calves sighted in the ACS/LA surveys of the northbound migrations from 1983/84 to 1991/92 ranged from 0.9% to 8.3%, averaging 3.4%. From 1992/93 to 1997/98, these percentages generally increased, ranging from 4.3% to 13.8% and averaging 9.6%. Some of the highest percentages, ranging from 9.4% to 13.8% (averaging 11.2%), occurred in recent years (1995/96 to1997/98). These were substantially higher than previously published figures for California waters. The highest calf count (n = 222, 13.8%) occurred in the 1996/97 season and was more than double the count of any of the preceding nine seasons. However, the percentage of calves in the 1998/99 northbound migration was only 2.5% (n = 34), well below percentages seen in recent years.

2.4) **Northbound migration at Piedras Blancas:** Perryman et al. (1999b) conducted shore-based surveys at Piedras Blancas in central California to estimate the number of calves in the northbound migration. There were 1,000 calves (SE = 88.85) in 1994; 601 calves (SE = 69.56) in 1995; 1,141 calves (SE = 72.23) in 1996; 1,439 calves (SE = 78.62) in 1997; a preliminary estimate of 1,316 calves (SE = 77.56) in 1998; and a preliminary estimate (Perryman[4]) of 471 calves (SE = 77) in 1999. Calf production indices (calf estimate/total population estimate) were 4.5%, 2.6%, 5.1%, 6.5%, 5.9%, and 1.8% for the years 1994-99, respectively .

2.5) **Photogrammetric studies:** According to Perryman and Lynn (1999), the southbound migration is led by large whales, many of them pregnant females; juvenile whales usually arrive late in the migration. Based on the proportion of pregnant and recent postpartum females, 15 January was estimated to be the median birth date for the Eastern North Pacific stock of gray whales. The estimated length at 1 year was 8.6 m. Results indicated that relatively small changes in condition or fatness of gray whales are detectable in measurements from photographs.

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[4]Pers. comm. Wayne Perryman, Southwest Fisheries Science Center, NMFS, P.O. Box 271, La Jolla, CA 92038-0271.

3) **Habitat use**

3.1) **Climate trends:** Changes in the extent and concentration of sea ice in the Arctic Ocean over the past 20-30 years, coincident with warming trends, may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and ultimately the abundance and stock structure of some species (Tynan and DeMaster 1997a). Effects of climate warming on Eastern North Pacific gray whales are unknown, but studies of benthic-pelagic coupling in the Arctic and subarctic (e.g., Grebmeier and Barry 1991) suggest depression of production in surface waters that may lead to reduced availability of gray whale prey in primary feeding areas offshore of Alaska.

3.2) **Food resources:** According to Highsmith and Coyle (1992), gray whales rely on rich benthic amphipod populations in the Bering and Chukchi Seas to renew fat resources needed to sustain them during their winter migration to and from Baja California Sur. Gray whale feeding areas offshore of northern Alaska are characterized by low species diversity, high biomass, and the highest secondary production rates reported for any extensive benthic community. Stoker (in press) studied one of the high-use areas, the central Chirikov Basin between St. Lawrence Island and the Bering Strait, and found that gray whales disturb at least 6% of the benthos each summer and consume more than 10% of the yearly amphipod production. There are indications that this resource is being stressed and that the gray whale population may be expanding its summer range in search of alternative feeding grounds. Specifically, Highsmith and Coyle (1992) showed that the abundance and biomass of the amphipod community decreased during the 3-year period from 1986 to 1988, resulting in a 30% decline in production. They noted that high-latitude amphipod populations are characterized by low fecundity and long generation times, and that large, long-lived individuals are responsible for the majority of amphipod secondary production. Therefore, a substantial reduction in the density of large individuals in the population will result in a significant, long-term decrease in production.

4) **Potential anthropogenic concerns**

4.1) **Contaminants:** Tilbury et al. (1999) studied contaminants in gray whales. During migrations, prolonged fasting may alter the disposition of toxic chemicals within the whales' bodies. Gray whales feeding in coastal waters may be at risk from exposure to toxic chemicals in some regions. The higher concentrations of polychlorinated biphenyls (PCBs) found in stranded animals compared to harvested animals may be due to the retention of organochlorines in blubber during fasting rather than to increased exposure to these contaminants. The elevated concentrations of certain trace elements (e.g., cadmium) found in some tissues, such as kidneys, of stranded animals and the high levels of aluminum found in the stomach contents and tissues of harvested whales, compared to other marine mammal species, is consistent with the ingestion of sediment by gray whales.

4.2) **Oil spills:** Moore and Clarke (in press) reported that gray whales were seen swimming through surface oil from the *Exxon Valdez* oil spill along the Alaskan coast. Also, gray whales showed only partial avoidance to natural oil seeps off the California coast. Laboratory tests suggest that gray whale baleen, and possibly skin, may be resistant to damage by oil, but spilled oil or oil dispersant in a primary feeding area could negatively affect gray whales by contaminating benthic prey.

4.3) **Noise:** Moore and Clarke (in press) summarized studies of short-term behavioral responses to underwater noise associated with aircraft, ships, and seismic explorations. These studies indicate a 0.5 probability that whales will respond to continuous broadband noise when sound levels exceed *ca*. 120dB, and to intermittent noise when levels exceed *ca*. 170dB, usually by changing their swimming course to avoid the source. They also reported that preliminary results from studies to determine gray whale responses to a low-frequency active (LFA) anthropogenic source indicate that whales avoided exposure to transmissions in the 100-500 Hz frequency band at levels of 170-178 dB by deviating from their swimming path. Moore and Clarke (in press) noted that gray whales 'startled' at the sudden onset of noise during playback studies but demonstrated a flexibility in swimming and calling behavior that may allow them to circumvent increased noise levels. Conversely, some whales swim toward small skiffs deployed from whale watching boats in breeding lagoons, seemingly attracted by the noise of idling outboard engines. Gray whales sometimes change course and alter their swimming speed and respiratory patterns when followed by whale watching boats. Dahlheim (1984, 1988) found that gray whales respond to variation in underwater noise by changing the structure and timing of their calls. Ambient noise (both natural and man-made) has a profound affect on the behavior of this coastal species, causing them to modify their calls to optimize signal transmission and reception. Jones et al. (in press) described the significant decline in the number of whales using San Ignacio Lagoon during acoustic playback research conducted in the winter of 1984, and the re-occupation of this lagoon the following winter, although the numbers seen in 1985 were lower than observed during the 1978-82 period. The noise playback experiments documented alterations in vocal behavior and a significant decline in the number of whales occupying the lagoon during continuous playback (24-hour periods) of industrial noise (Dahlheim 1988). This experiment demonstrated the sensitivity of gray whales to noise disturbance within the lagoon.

4.4) **Entanglement in fishing gear:** From 1990 through 1998, 47 gray whales were reported entangled in fishing gear off the coasts of Alaska, Washington, Oregon, and California. Of these animals, 13 appeared to have survived; the remaining 34 were either mortalities or their status was unknown (Hill 1999a). A whale mortality, due to entanglement in a net pen, was reported in British Columbia in 1999 (Lochbaum[5]).

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[5]Pers. comm. Ed Lochbaum, Marine Mammal Coordinator, Department of Fisheries and Oceans, 3225 Stephenson Point Road, Nanaimo, B.C., V9T 1K3 Canada.

4.5) **Salt extraction in Mexico's lagoons:** Exportadora de Sal, sometimes referred to as ESSA, has operated a salt extraction facility at the town of Guerrero Negro, midway along the Pacific Coast of Baja California Sur, since 1954, and it is planning to expand its operation to San Ignacio Lagoon (Mate 1995). In 1994, ESSA entered into negotiations with the Mexican environmental authorities to expand its salt extraction and marketing activities within the buffer zone of the El Vizcaíno Biosphere Reserve. Specifically, they propose development of a 52,150 ha salt production facility on the shore of San Ignacio Lagoon (Dedina and Young 1995a). In 1995, due to insufficiencies in the Statement of Environmental Impact (MIA, acronym in Spanish), the Mexican authorities denied the permit for the San Ignacio Lagoon expansion and established a Scientific Committee, made up of seven specialists of different nationalities, to specify the terms of reference necessary for a new MIA. This task was completed in July 1996; however, to date, no proposal based on the new terms of reference has been received (SEMARNAP 1997).

4.6) **Commercial developments in Bahía Magdalena:** The growth of gray whale tourism in the North Zone of Bahía Magdalena has led to a proposed Japanese owned and financed tourist resort development at Bahía Magdalena (Dedina and Young 1995a). Although this represents a potential threat to the whales and their habitat, at this time, there are no plans to proceed with this development (Rojas Bracho[6]).

4.7) **Whale watching**

4.71) **Regulations in Baja California Sur, Mexico:** Urbán Ramírez[7] reported that whale watching is allowed in every lagoon in Baja California Sur except in the southern part of Bahía Magdalena (also see Sánchez Pacheco 1997a). Since 1997, government whale watching regulations (modified annually) have existed for commercial operators. There are currently four specific whale watching areas in the lagoons where the numbers of boats and methods of approach are regulated. There are no minimum approach distances, but whales cannot be chased.

4.72) **Whale disturbance in Ojo de Liebre and San Ignacio Lagoons:** A change in a whale's direction of movement is considered an indicator of disturbance. Sánchez Pacheco (1997b) defined a procedure to estimate the Maximum Simultaneous Number (NMS, acronym in Spanish) of vessels that can watch whales in an area without disturbing more than 50% of them. The procedure was applied in Ojo de Liebre Lagoon and San Ignacio Lagoon during 1995. Vessels followed selected whales, while observers recorded whale reactions and the distance between the vessel and disturbed whales.

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[6]Pers. comm. Lorenzo Rojas Bracho, Bahía Vizcaíno 476, Col. Moderna, Ensenada, B.C., 22860 México.

[7]Pers. comm. Jorge Urbán Ramírez, Programa de Investigacion de Mamiferos Marinos, Dept. de Biologia Marina, Universidad Autonoma de Baja California Sur, Ap. Post. 12-B, La Paz, B.C.S., 23081 México.

The NMS was 6 vessels in each of two areas in Ojo de Liebre Lagoon and 13 vessels in San Ignacio Lagoon.

4.73) **Whale disturbance and regulations in Bahía Magdalena:** A shore-based study was conducted in the northern part of Bahía Magdalena, Estero A. Lopez Mateo, to observe the effect of whale watching boats on whale behavior (Pérez-Cortés Moreno[8]). In this narrow and shallow area of the lagoon, single-day visits predominate and enforcement is difficult. Regulations permit a maximum of 22 boats in the area at one time; boats must have a permit and fly a flag when whale watching; and only two boats can be close to a whale at one time. Preliminary results indicated that whales did not interact with the boats in 65.3% of the sightings; no impacts were recorded in 28.4% of the sightings; and behavior changes were recorded in only 6.3% of the sightings. Not all of these changes were negative as there were some "friendly" whales that approached boats. Although there did not appear to be any negative impacts on the whales, increased enforcement was recommended since there was an "observer effect" on the boat operators (i.e., they were more likely to obey regulations if under observation).

4.74) **Whale watching off California:** Schulman-Janiger[9] described whale watching guidelines and activities off the coast of California. The guidelines specify a minimum approach of 100 yards (100 m) and recommend that vessels approach whales from the rear and avoid separating cow-calf pairs. However, there is very little enforcement, and it is hard to prove harassment. Whale watching is a major seasonal industry off California. For example, a total of 44,125 people in 1996 and 41,879 people in 1997 participated in the Cabrillo Whalewatch Program trip cruises alone (on 6 vessels) off Los Angeles, California . During the mid-1980s, abundant nearshore gray whale sightings prompted many operators to start to guarantee whale sightings, which led to increased pressure to locate whales. During 1989-91, the number of nearshore gray whale sightings decreased, and commercial vessels began to cooperate to locate whales. Several vessel operators combined assets to charter a spotting plane, and another vessel hired staff to spot whales from the ACS/LA survey site. A significant problem is the number of private boats that follow commercial boats. Off Los Angeles, there can be 8-12 boats following one whale. Jet-skis are also a significant problem; they harass whales and can separate cows from calves close to shore.

4.75) **Regulation suggestions in California:** Recommendations for improved regulations (Schulman-Janiger[9]) include: 1) issue permit numbers to whale watching vessels and require them to fly flags while following a whale; 2) make ship traffic aware of whales in the area; 3) set speed limits for vessels moving in and out of harbors; 4) do not extend the current whale-watching season

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[8]Héctor Pérez-Cortés Moreno, Instituto Nacional de la Pesca, CRIP, Km 1, Carretera a Pichilingue, La Paz, B.C.S., 23020 México.

[9]Alisa Schulman-Janiger, American Cetacean Society, 2716 S. Denison, San Pedro, CA 90731

(26 December-31 March) to target cow-calf pairs; 5) do not guarantee sightings; and 6) schedule boat races to avoid concentrations of whales, especially cow-calf pairs, in the area.

4.8) **Strandings:** From 1990 to 1998, there were 250 gray whale strandings (excluding the stranded whales in which the cause of death was due to entanglement) reported along the coasts of Alaska, Washington, Oregon, and California (Hill 1999b). In 1999 (as of 16 June), there were 24 gray whale strandings reported in Alaska (Sternfeld[10]); 6 in British Columbia--not including one death due to entanglement (Lochbaum[5]); 21 in Washington (11 on the coast; 10 within inland waters) (Norberg[11]); 1 in Oregon (Norberg[11]); and 32 on the California coast (Cordaro[12]). Pérez-Cortés Moreno (1999) reported that from 1975 to 16 June 1999, there were 518 strandings in Mexico (also see Sánchez Pacheco 1998). Thorough surveys were conducted in Mexico in the early 1980s and in 1998 and 1999, while relatively high numbers of strandings were recorded only in 1980 (53 whales), 1982 (46), 1991 (45), and 1999 (114). Although the number recorded in 1999 was high relative to other years, this was in part due to increased survey effort. These strandings occurred in many locations between December 1998 and June 1999 and were not related to a single stranding event. Of 89 stranded whales examined, 72% were adults, and of these, 78% were females.

4.9) **Ship strikes:** From 1990 to 1998, seven vessel strikes of gray whales were reported off the coasts of Alaska, Washington, Oregon, and California (Hill 1999c). Three of these animals appeared to have survived, while the other four were either mortalities or their status was unknown. Additional mortalities probably go unreported if the whales do not strand or are not thoroughly necropsied.

5) **Aboriginal harvest**: The current International Whaling Commission (IWC) quota (for 1998-2002) allows for a harvest of 140 gray whales per year for local consumption by aborigines (IWC 1998a).

5.1) **Russian:** From 1970 to 1998, an average of 139 gray whales were taken annually along the coasts of the Chukotka Peninsula (Quan 1999, Brownell[13]). The Russian Federation has agreed to take no more than 135 whales annually from 1998 to 2002 (IWC 1998a).

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[10]Pers. comm. Mary Sternfeld, NMFS, AK Region, Protected Resources, P.O. Box 21668, Juneau, AK 99802.

[11]Pers. comm. Brent Norberg, NMFS, WASC, 7600 Sand Point Way NE, Seattle, WA 98115-0070.

[12]Pers. comm. Joe Cordaro, NMFS, WASC, 501 West Ocean Blvd, 4200 Long Beach, CA 90802-4213.

[13]Pers. comm., Robert Brownell, Jr., Southwest Fisheries Science Center, NMFS, P.O. Box 271, La Jolla, CA 92038-0271.

5.2) **Alaskan:** No gray whales have been allocated by the IWC to Alaskan Native subsistence hunters since 1991 (Quan 1999). Two incidental takes of gray whales by an Alaskan Native occurred in 1995 (Brownell[13], Quan 1999).

5.3) **Makah:** The Makah Indian Tribe received a 5-year quota from the IWC in 1997 to harvest 20 gray whales for ceremonial and subsistence purposes. The Tribe may harvest up to five gray whales per year from 1998 through 2002 (IWC 1998a, Gearin 1999). Makah whalers struck and killed one gray whale on 17 May 1999 (Gosho[14]).

6) **Review of potential research projects:** As a part of the conclusions of the workshop, it was recommended that the Eastern North Pacific stock of gray whales be monitored for another 5-year period. This would occur between June 1999 and June 2004. Monitoring could provide information relevant to the regular reviews conducted by NMFS (e.g., Hill and DeMaster 1998) and the IWC (e.g., IWC 1998b). The high visibility of this stock along the west coast of North America has made it very popular, so there is considerable public awareness and concern for the gray whales' status. This stock's annual migrations along highly populated coastlines and their concentration in limited winter and summer areas may make them particularly vulnerable to impacts from commercial or industrial development or local catastrophic events. Also, the ease and efficiency of monitoring this stock during its migration past shore stations has provided scientists a rare opportunity to document a large whale species recovering from near extinction. Never before has there been as good an opportunity to study life history parameters of a cetacean population approaching its carrying capacity–a study which will be very beneficial to research on other, less accessible whale stocks. The following list includes potential projects that will help in this monitoring and further improve our understanding of the status of this whale stock. Inherent in this research is the encouragement to keep open lines of communication among scientists studying gray whales, which includes researchers in Mexico, the United States, Canada, and Russia.

6.1) **Abundance and trends in abundance**

6.11) **Granite Canyon, California:** NMML frequently conducts full-season counts of gray whales during the southbound migration past this shore station in central California (Shelden et al. in press). This has proven to be an optimal site both logistically (easy access in an area with a relatively mild climate) and biologically (where most of the gray whale population passes close to shore each year). The census conducted at Granite Canyon has provided a long-term, consistent monitoring of stock abundance and trends (since 1968). Although this stock is not considered to be at risk, the continuation of the seasonal counts will provide an ideal opportunity to study a large cetacean population as it approaches carrying capacity. The Granite Canyon census is considered to be a low risk investment as it is a system that has been well tested. Further testing is needed to improve corrections for pod-size estimates,

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[14]Pers. comm. Merrill Gosho, National Marine Mammal Lab, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115-0070.

continue studies of observer performance, and increase the accuracy of statistical variances within the observation data.

6.12) **Point Vicente, California:** Every year, ACS/LA volunteers conduct full-season counts of both the southbound and northbound migrations past Point Vicente, near Los Angeles (Schulman-Janiger 1999a) . These counts have been collected consistently since 1984 and are beneficial to time-series analyses; however, only a portion of the population passes this site during the southbound and northbound migrations.

6.13) **Yaquina Head, Oregon:** A volunteer from Oregon State University conducted counts of gray whales at Yaquina Head, near Newport, Oregon, in the 1998/99 season (Mate and Poff 1999). This site was also used for counts of the southbound and northbound migrations in 1978-81 (Herzing and Mate 1984).

6.14) **Other sites:** NMFS has no plans for systematic counts at locations other than Granite Canyon since this has proven to be the best site for shore-based counts.

6.141) **Cape Sarichef, Alaska:** Cape Sarichef, on the west edge of Unimak Island, is an ideal location for studying the gray whale migration in and out of the Bering Sea. This site was used for gray whale counts during several southbound and northbound migrations in the 1970s (e.g., Rugh 1984). However, the U.S. Coast Guard no longer maintains a facility there, making it logistically impractical to conduct research.

6.142) **Narrow Cape, Kodiak Island, Alaska:** Narrow Cape, on the south side of Kodiak Island, is an accessible site with a good view of the migratory corridor in the area, but gray whales also migrate on the north side of Kodiak Island, so the portion of the population passing Narrow Cape each year is unknown. No full-season counts have been conducted from this site.

6.15) **Stock assessment:** NMFS conducts an assessment of the Eastern North Pacific stock of gray whales at least every 3 years (Hill and DeMaster 1998); the stock assessment is currently being updated. The IWC conducts comprehensive assessments of stocks before harvest quotas are set (IWC 1998b); the next gray whale assessment will be in 2003.

6.16) **Stock identification and discreteness:** Genetic analysis may provide information on the degree of genetic variety within the Eastern North Pacific gray whale stock as well as determine differences between this stock and the Western North Pacific (Korean) stock (e.g., Rosel and Kocher 1997). Genetic discreteness of summering populations may be a factor in management decisions (Darling et al. 1998), specifically with regard to the whales in northwestern Washington where Makah Indians are whaling.

6.2) **Population health and viability**

6.21) **Calf counts**

6.211) **Granite Canyon, California:** The whale counts conducted by NMML at Granite Canyon during the southbound migration include counts of calves (Shelden et al. in press).

6.212) **Piedras Blancas, California:** During the past several years, the NMFS Southwest Fisheries Science Center (SWFSC) has conducted shore-based counts of gray whale calves during the northbound migration (Perryman et al. 1999b). Sighting rates at Piedras Blancas are compared to abundance estimates made by NMML during the southbound migration.

6.213) **Point Vicente, California:** The ACS/LA chapter includes calf counts in their ongoing effort at Point Vicente. The results show the percentage of calves seen during both the southbound and northbound migrations (Schulman-Janiger 1999b).

6.214) **Baja California Sur:** Counts of calves will continue to be a part of the studies of gray whales in Baja California Sur (e.g., Urbán et al. 1997).

6.22) **Condition index:** Photogrammetric studies conducted by the SWFSC help provide data on number of pregnant whales, proportion of sightings with calves, and lengths and other dimensions of whales. Dimension data can indicate animal health as a function of fat reserves (Perryman and Lynn 1999).

6.23) **Biological sampling**

6.231) **Harvest:** Data from harvested whales can help establish pregnancy rates and indicate health of individuals (e.g., Reilly 1992, Blokhin in press c).

6.232) **Natural mortality:** Samples from stranded whales may provide information on biological parameters, including reproductive condition, age, length, contaminant loads, stock discreteness, types of parasites or diseases, and cause of death (e.g., Heyning and Dahlheim in press).

6.3) **Distribution and habitat use**

6.31) **Baja California Sur:** Proposed studies include photo-identification of individual whales, radio-telemetry, and satellite-tagging. Results will provide information on persistence and consistency of use of certain lagoons. There was an intense study in 1980-85 that involved several of the lagoons (e.g., Jones and Swartz 1984). A multi-dimensional study over another 5-year period would provide a valuable comparison to the previous research.

6.32) **Washington State:** Photo-identification studies conducted by Cascadia Research Collective and the NMML (e.g., Calambokidis and Quan 1999, Gosho et al. 1999a, 1999b) provide information on how often individual whales are found in areas around northwestern Washington. This research will help answer questions about the “resident” vs. “transient” whales in the area where Makah Indians hunt whales.

6.33) **Migration and foraging**

6.331) **Satellite tagging:** Satellite tagging of gray whales would provide information on the timing and location of whales during their northbound migration and where they spend time feeding.

6.332) **Distribution information:** Distribution data may be collected from a variety of marine mammal surveys, such as the NMML cetacean surveys across southern Alaska, observations on fisheries research cruises, records collected in the Platforms of Opportunity Program, etc.

6.333) **Migratory timing:** Migratory timing can be documented through shore-based observations at sites used in the past, such as Point Vicente, Granite Canyon, and Yaquina Head (Rugh et al. 1999a, 1999b).

6.34) **Summer distribution:** Aerial and/or vessel surveys may provide information on current gray whale use of historic feeding grounds in the Bering and Chukchi Seas. Oceanographic sampling could document potential changes in prey production and availability (e.g., Grebmeier and Barry 1991).

6.4) **Anthropogenic concerns**

6.41) **Contaminant loads:** Contaminant loads are documented by the NMFS Northwest Fisheries Science Center (NWFSC) from samples collected from strandings and biopsies (Tilbury et al. 1999).

6.42) **Oil spills and post-spill monitoring:** There is a need for an oil-spill response protocol to minimize the effects of oil spills on gray whales. To develop this protocol, experimental designs are needed to minimize impacts of oil spills and better understand the risks to gray whales relative to different locations and intensities of oil spills.

6.43) **Noise:** Peter Tyack (Woods Hole Oceanographic Institute) and Chris Clark (Cornell University) have recently conducted and will probably continue to conduct acoustic studies relative to the response of large cetaceans, including gray whales, to Low Frequency Active (LFA) underwater transmissions (Tyack and Clark 1998).

6.44) **Fishery interactions:** The degree of impact of commercial and recreational fisheries on gray whales may be assessed through examinations of stranded whales, permit reports, and ships' log books. In particular, more information is needed from Mexico and Canada.

6.45) **Commercial development in critical habitats**

6.451) **Salt extraction in Baja California Sur:** A large salt evaporation facility is proposed for San Ignacio Lagoon (SEMARNAP 1997). If this facility is developed, the impact on whales using this lagoon should be studied. A comparison could be made between potential impacts of proposed salt work developments in Baja California Sur and the observed impacts of northwestern Australian salt works on humpback whales.

6.452) **Oil and gas exploration and extraction:** Oil and gas exploration and extraction have the potential of impacting whales along much of the migratory route, including feeding areas in the Bering and Chukchi Seas.

6.453) **Coastal development:** Coastal development, and the concomitant increase in human activities offshore, along much of the western shores of Mexico, the United States, and Canada has the potential of adversely impacting gray whales along their migration route (Moore and Clarke in press).

6.46) **Whale watching**

6.461) **Regulations:** A monitoring system should be established for operators of whale watching vessels; for example, through permit reports and/or log

books. The IWC has established a subcommittee to provide guidelines for whale watching (IWC 1997d).

6.462) **Studies:** Studies should be conducted to evaluate the impact of whale watching operations. Whales and boats could be tracked using theodolites based on strategic shore-based sites. In Bahía Magdalena and San Ignacio Lagoon there are ongoing studies of whale watching operations (Pérez-Cortés Moreno[8], Sánchez Pacheco 1997b)

6.463) **Photographs:** Whale watching operations can be a source of photographs that may be used to identify individual whales. This could be beneficial in determining the amount of time individual whales stay in an area relative to the number of boats.

6.47) **Strandings:** Currently there are stranding networks in the United States and Mexico. On the U.S. West Coast, stranding information is collected by the NMFS Alaska Regional Office in Alaska, Northwest Regional Office in Washington and Oregon, and Southwest Regional Office in California. Besides aerial and vessel surveys of the lagoons in Mexico (Pérez-Cortés Moreno 1999), there is an ongoing research project in Scammon's Lagoon (Pérez-Cortés Moreno[8]).

6.48) **Ship strikes:** The number of strikes can be partially recorded through adequate documentation of marks on stranded whales and through ship logs (e.g., Hill 1999c, Heyning and Dahlheim in press).

6.5) **Research priorities:** Workshop participants were asked to select the five research projects that they would consider to be of the highest priority in evaluating the status of the Eastern North Pacific stock of gray whales. Preference was given to (in order of priority):

1) survey of the southbound migration at Granite Canyon (Section 6.11);
2) studies in the lagoons (Section 6.214, 6.31, 6.451, 6.453, 6.462, and 6.47);
3) photogrammetry/condition index (Section 6.22, 6.31, and 6.32);
4) calf counts (Section 6.21); and
5) Bering and Chukchi Sea surveys of foraging habitat/regime shifts (Section 6.34).

Summary

The workshop convened by NMFS at NMML in Seattle, Washington, on 16-17 March 1999, culminated the review of the status of the Eastern North Pacific stock of gray whales. This review was based on research conducted during the 5-year period following the delisting of this stock and includes information collected through 16 June 1999. The workshop followed guidelines outlined in the NMFS 5-year Plan to conduct the status review and recommend whether to: 1) continue the monitoring program for an additional 5-year period; 2) terminate the monitoring program; or 3) consider changing the status of the gray whale under the ESA. The 28 invited participants determined that this stock was neither in danger of extinction, nor was it likely to become endangered within the foreseeable future, according to the determining factors listed in section 4(a)(1) of the ESA. Therefore, there was no apparent reason to reverse the previous decision to remove this stock from the List.

Canada's Committee on the Status of Endangered Wildlife in Canada lists the "Northeast Pacific population" of gray whale as "not at risk." This is the lowest category for animals in their classification system, which also includes vulnerable, threatened, endangered, extirpated, or extinct.

The status of the Eastern North Pacific stock does not in any way alter the status of the still-endangered Western North Pacific ("Korean") stock of gray whales.

There was a consensus among the workshop participants that the Eastern North Pacific stock of gray whales should be monitored for an additional 5-year period (1999-2004), especially as this stock may be approaching its carrying capacity. Monitoring should include a continuation of surveys at Granite Canyon during the southbound migration; collaborative research with Mexican scientists on phenology of gray whales and the use of the lagoons in Baja California Sur; photogrammetry as a study of whale condition; calf counts; and an examination of the affect of environmental parameters, especially climate warming, on the whales' use of foraging areas.

Although the Eastern North Pacific stock of gray whales no longer receives protection under the ESA, it continues to be protected under the MMPA. As required by the MMPA, NMFS conducts an assessment of this stock every 3 years, or when new information becomes available. The last assessment occurred in 1997 (Hill and DeMaster 1998); it is currently being updated. Subsistence take is managed under quotas set by the IWC. Comprehensive assessments of gray whales are conducted by the IWC before quotas are set; the last assessment occurred in 1997 (IWC 1998b); the next will be in 2003 (IWC 1999a). There is no allowable commercial take of any gray whales, and the Convention on the International Trade in Endangered Species (CITES) regulates the transportation of animal parts. Furthermore, if there is evidence of a significant negative decline and research indicates that such a change would be warranted, this stock can be proposed to be listed again as threatened or endangered under the ESA.

This status review concludes the 5-year assessment of the Eastern North Pacific stock of gray whales (required by section 4(g)(1) of the ESA) that commenced on 16 June 1994 (59 FR 31094) when this stock was removed from the List.

Acknowledgments

Funding for travel to the workshop was provided by the NMFS Office of Protected Resources. Doug DeMaster was the chair for the workshop. Scientists making presentations at the workshop included: Héctor Pérez-Cortés Moreno, Lorenzo Rojas Bracho, and Jorge Urbán Ramírez from Mexico; Alisa Schulman-Janiger, from the American Cetacean Society/LA Chapter; John Calambokidis from Cascadia Research Collective; Jen Quan from the University of Washington; Bruce Mate from Oregon State University; Bob Brownell, Meghan Donahue, and Wayne Perryman from the NMFS Southwest Fisheries Science Center; John Stein and Gina Ylitalo from the NMFS Northwest Fisheries Science Center; and Jeff Breiwick, Marilyn Dahlheim, Doug DeMaster, Pat Gearin, Merrill Gosho, Scott Hill, Rod Hobbs, Sue Moore, Dave Rugh, and Kim Shelden from the NMFS Alaska Fisheries Science Center (National Marine Mammal Laboratory). Rod Hobbs provided the initial outline for the potential research projects. Helpful guidance at the workshop was provided by Greg Silber from the NMFS Office of Protected Resources, Steve Swartz from the NMFS Southeast Fisheries Science

Center, and Judy Zeh from the University of Washington. Greg Donovan, Helen Sharp, and staff of the International Whaling Commission provided abstracts of manuscripts from the IWC Journal of Cetacean Research and Management Special Issue 2 (in press) on gray whales. We are grateful to Ken Hollingshead and Greg Silber for their careful review of the Background section. Gary Duker and James Lee, of the AFSC Publications Unit, provided formatting edits. This document was improved by review comments from Héctor Pérez-Cortés Moreno, Lorenzo Rojas Bracho, Jorge Urbán Ramírez, José Sánchez Pacheco, Alisa Schulman-Janiger, Kim Shelden, Rod Hobbs, Tom Loughlin, and Steve Swartz.

Literature

The following list includes publications and unpublished documents dealing with gray whale research that has been conducted since 1993, following the circulation of the NMFS 5-year Plan for Research and Monitoring of the Eastern North Pacific Population of Gray Whales. Also included is any literature cited in the current status review and attached abstracts (indicated with an asterisk).

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Allison, C., A.E. Punt, and D.S. Butterworth. 1995. Report of the Scientific Committee, Annex F, Report of the Sub-Committee on Aboriginal Subsistence Whaling, Appendix 11. Census based estimate of RY for gray whales. Rep. Int. Whal. Commn. 45:162.

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Baird, R.W., P.J. Stacey, D.A. Duffus, and K.M. Langelier. In press. An evaluation of gray whale mortality incidental to fishing operations in British Columbia, Canada. J. Cetacean Res. Manage. Special Issue 2. (SC/A90/G21).

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Belikov, S., A. Boltunov, and Y. Gorbunov. 1996. Distribution and migration of polar bears, Pacific walruses and gray whales depending on ice conditions in the Russian Arctic. Proc. NIPR Symp. Polar Biol. 9:263-274.

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Berzin, A.A. In press. Gray whales (*Eschrichtius robustus*) of the Okhotsk-Korean population in the Sea of Okhotsk. J. Cetacean Res. Manage. Special Issue 2. (SC/A90/G28).

Blokhin, S.A. 1995. Results of research on gray whales caught off the Chukotka Peninsula in 1994. Unpubl. doc. SC/47/AS20 submitted to Sci. Comm. of Int. Whal. Commn. 11 p.

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APPENDIX A

PARTICIPANTS AT THE WORKSHOP TO REVIEW THE STATUS OF THE EASTERN NORTH PACIFIC STOCK OF GRAY WHALES

16-17 March 1999
At the National Marine Mammal Laboratory, Seattle, Washington

Participants	Affiliation and address	Attended
Will Anderson	PAWS 2122 8th Ave N, 201, Seattle, WA 98109	Yes
Mike Barber	Seattle Post-Intelligencer 101 Elliott Ave. W, Seattle, WA 98119	Yes
Howard Braham**	NMML, AFSC, NMFS (retired) 800 Acorn Circle, P.O. Box 1064, Ashland, OR 97520	No
Jeff Breiwick**	NMML, AFSC, NMFS 7600 Sand Pt Way NE, Seattle, WA 98115-0070	Yes
Robert Brownell, Jr.**	SWFSC, NMFS P.O. Box 271, La Jolla, CA 92038	Yes
Steve Buckland*	School of Mathematical and Computational Sciences University of St. Andrews, North Haugh, St. Andrews Fife, KY18 9SS, Scotland, UK	No
John Calambokidis*	Cascadia Research Collective 218 ½ W 4th Ave, Olympia, WA 98502	Yes
Leigh Calvez	naturalist	Yes
Marilyn Dahlheim**	NMML, AFSC, NMFS 7600 Sand Pt Way NE, Seattle, WA 98115-0070	Yes
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Meghan Donahue*	SWFSC, NMFS P.O. Box 271, La Jolla, CA 92038	Yes
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Participants	Affiliation and address	Attended
Leah Gerber*	National Center for Ecological Analysis and Synthesis Marine Science Institute University of California at Santa Barbara 735 State Street, Suite 300, Santa Barbara, CA 93101	No
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Rod Hobbs*	NMML, AFSC, NMFS 7600 Sand Pt Way NE, Seattle, WA 98115-0070	Yes
Robert Hofman*	Marine Mammal Commission 4340 East-West Hwy, Room 905, Bethesda, MD 20814	No
Ken Hollingshead**	Office of Protected Resources, NMFS 1315 East-West Hwy, Silver Spring, MD 20910-3282	No
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Marcia Muto*	NMML, AFSC, NMFS 7600 Sand Pt Way NE, Seattle, WA 98115-0070	Yes
Stephanie Norman	NMFS Contractor, DVM 1223 Spring St. #400, Seattle, WA 98104	Yes
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Dave Rugh*	NMML, AFSC, NMFS 7600 Sand Pt Way NE, Seattle, WA 98115-0070	Yes
José Sánchez Pacheco*	Reserva de la Biosfera "El Vizcaíno" Instituto Nacional de Ecología SEMARNAP A.P. #65 Guerrero Negro Baja California Sur, C.P., 23940 México jasanpa@compuserve.com	No
Alisa Schulman-Janiger*	American Cetacean Society, Los Angeles Chapter 2716 S. Denison, San Pedro, CA 90731	Yes
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Kim Shelden*	NMML, AFSC, NMFS 7600 Sand Pt Way NE, Seattle, WA 98115-0070	Yes
Greg Silber*	Office of Protected Resources, NMFS 1315 East-West Hwy, Silver Spring, MD 20910-3282	Yes
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Paul Wade*	NMML, AFSC, NMFS 7600 Sand Pt Way NE, Seattle, WA 98115-0070	No
Janice Waite*	NMML, AFSC, NMFS 7600 Sand Pt Way NE, Seattle, WA 98115-0070	Yes
Gina Ylitalo*	NWFSC, NMFS 2725 Montlake Blvd. E., Seattle, WA 98112-2097	Yes
Judy Zeh*	University of Washington, Statistics Box 354322, Seattle, WA 98195-4322	Yes

*Invited or asked to review workshop material.
**Invited and member of the Gray Whale Monitoring Task Group in 1990.

APPENDIX B

ABSTRACTS

Agenda Section 1.11

PRELIMINARY ESTIMATES OF POPULATION SIZE OF GRAY WHALES FROM THE 1992/93 AND 1993/94 SHORE-BASED SURVEYS

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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. SC/46/AS7 submitted to Sci. Comm. of Int. Whal. Commn. 13 p.

The California stock of gray whales (*Eschrichtius robustus*) has been recently proposed for removal from the U.S. list of endangered and threatened species. As part of the de-listing regulation under the U.S. Endangered Species Act, the National Marine Fisheries Service has begun a monitoring effort that has included shore-based surveys conducted 10 December 1992 to 7 February 1993 and 10 December 1993 to 18 February 1994, during the whales' southbound migration past Carmel, California. Survey methods were the same as those used in previous seasons. Paired, independent counts were made whenever possible but not during every watch as occurred in 1987/88. In total, 1,180 pods (2,112 whales) were recorded during 343 hours of watch from the main (south) observation site when visibility was classified as excellent to good in 1992/93, and 1,864 pods (3,411 whales) were recorded during 447 hours in 1993/94. The survey data were analyzed using methods consistent with those used in the 1987/88 data analysis. The population estimate from the 1992/93 survey is 17,674 (CV = 5.87%, 95% confidence interval, 15,800 - 19,800), which is significantly lower than the 1993/94 estimate of 23,109 (CV = 5.42%, 95% confidence interval, 20,800 - 25,700) ($z = -3.36$, $P = 0.0004$). Possible reasons for the difference are: 1) changes in the number of whales migrating as far south as Carmel; 2) poor sighting conditions in 1992/93, particularly during the peak of the migration; 3) missing sources of variation. The 1993/94 estimate is not significantly different than the 1987/88 estimate of 20,869 (CV = 4.37%) ($z = 1.46$, $P = 0.072$).

Agenda Section 1.12

ABUNDANCE OF GRAY WHALES IN THE 1995/96 SOUTHBOUND MIGRATION IN THE EASTERN NORTH PACIFIC

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Hobbs, R.C., D.J. Rugh, J.M. Waite, J.M. Breiwick, and D.P. DeMaster. In press. Abundance of gray whales in the 1996/96 southbound migration in the eastern North Pacific. J. Cetacean Res. Manage. Special Issue 2.

Systematic counts of gray whales (*Eschrichtius robustus*) were conducted from 13 December 1995 to 23 February 1996 at Granite Canyon, California. This study is the second of three during the 5-year period following the removal of gray whales from the U.S. government list of endangered and threatened wildlife. The counts were made at the same research station used most years since 1975 by the National Marine Mammal Laboratory to observe the southbound migration of the eastern North Pacific stock. Counting methods were kept similar to those used in previous surveys and included double counting to assess observer performance. In addition, aerial surveys and high-powered binoculars provided documentation that a negligible fraction of migrating whales passed beyond the sighting range of the counting observers. A total of 2,151 pods (3,928 whales) was counted during 472.7 hours of standard watch effort with a visibility recorded as fair to excellent. Data analysis procedures were substantially the same as in previous years with a modification to account for differential sightability by pod size. Population size is estimated to be 22,263 whales (CV = 9.25%; 95% log-normal CI = 18,700 to 26,500). This estimate is similar to the previous estimate of 23,109 (CV = 5.42%; 95% CI = 20,800 to 25,700) from the 1993/94 survey.

Agenda Section 1.13
1.14

THE ABUNDANCE OF GRAY WHALES IN THE 1997/98 SOUTHBOUND MIGRATION IN THE EASTERN NORTH PACIFIC

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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. SC/51/AS10 submitted to Sci. Comm. of Int. Whal. Commn. 18 p.

Systematic counts of gray whales (*Eschrichtius robustus*) were conducted from 13 December 1997 to 24 February 1998 at Granite Canyon and Point Lobos, California. This study is the third of three during the 5-year period following the removal of gray whales from the U.S. government list of endangered and threatened wildlife. The counts were made at the same research station used most years since 1975 by the National Marine Mammal Laboratory to observe the southbound migration of the eastern North Pacific stock of gray whales. Counting methods were kept similar to those used in previous surveys and included double counting to assess the performance of observers. In addition, high-powered binoculars provided documentation that a negligible fraction of migrating whales passed beyond the sighting range of the counting observers. In total, 2,318 pods (3,643 whales) were counted during 435.3 hours of standard watch effort when visibility was recorded as fair to excellent. Data analysis procedures were substantially the same as those used in previous years and identical to those used for the 1995/96 census. The population is estimated to be 26,635 whales (CV = 10.06%; 95% log-normal confidence interval = 21,878 to 32,427). This estimate is similar to the previous estimates of 23,109 (CV = 5.42%; 95% confidence interval = 20,800 to 25,700) from the 1993/94 survey and 22,263 whales (CV = 9.25%; 95% log-normal confidence interval = 18,700 to 26,500) from the 1995/96 survey.

Agenda Section 1.14

PRELIMINARY DOCUMENTATION OF GRAY WHALE ABUNDANCE ESTIMATION PROCEDURES

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Breiwick, J.M., and R.C. Hobbs. 1996. Preliminary documentation of gray whale abundance estimation procedures. Unpubl. doc. SC/48/AS2 submitted to Sci. Comm. of Int. Whal. Commn. 5 p.

The National Marine Mammal Laboratory (NMML) produces abundance estimates of the Eastern North Pacific stock of gray whales based on counts made from Granite Canyon, near Carmel, California. These abundance estimates are based on the number of pods observed and the average recorded pod size obtained directly from the field data. These numbers are corrected for 1) number of pods passing outside of count periods; 2) rate of night travel; 3) pods missed within the viewing range of observers while on watch; and 4) mean pod size. In conjunction with recent counts, aerial surveys have been flown to compare the offshore distribution of gray whale sightings with the distribution based on shore counts. Results since 1988 have indicated, however, that a correction factor for whales passing beyond the viewing range of shore-based observers is not necessary. Aerial observations of pod size have been used in comparison with shore-based pod size estimates to compute a correction factor for pod size bias. This document summarizes the analytical procedures used during the past decade.

Agenda Section 1.15

DIEL VARIATION IN MIGRATION RATES OF EASTERN PACIFIC GRAY WHALES MEASURED WITH THERMAL IMAGING SENSORS

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Perryman, W.L., M.A. Donahue, J.L. Laake, and T.E. Martin. 1999a. Diel variation in migration rates of eastern Pacific gray whales measured with thermal imaging sensors. Mar. Mammal Sci. 15(2):426-45.

We recorded the blows of southbound gray whales from central California in January 1994, 1995, and 1996 using thermal imaging sensors. For our sampling purposes, we defined day (0730-1630) and night (1630-0730) to coincide with the on/off effort periods of the visual surveys being conducted concurrently. We pooled data across the three years of sampling and tested for diel variation in respiration interval, pod size, offshore distance, migration rate, and swimming speed by comparing paired day/night means for samples collected within the same 24-hour period. We performed these tests using data from the entire migration period and then repeated the tests for samples collected prior to and after the approximate median migration date (January 15th). Over the entire migration period we observed significantly larger daytime pod sizes ($\bar{x}_{day}$ = 1.75 ± 0.280 km, noted here and throughout with one standard deviation, $\bar{x}_{night}$ = 1.63 ± 0.232km) and offshore distances ($\bar{x}_{day}$ = 2.30 ± 0.328 km, $\bar{x}_{night}$ = 2.03 ± 0.356 km), but found no significant diel variation in respiration interval. For the entire migration period, the nocturnal migration rate (average number of whales passing per hour) was significantly higher (t = -2.65, $\bar{x}$ = 20, p = 0.02). During the early migration period, we detected no significant diel variation in pod size or respiration interval, but daytime offshore distances were significantly larger ($\bar{x}_{day}$ = 2.28 ± 0.273 km, $\bar{x}_{night}$ = 1.96 ± 0.318 km). Diurnal and nocturnal migration rates prior to January 15th were not significantly different. During the late migration period, there was no significant diel variation in respiration interval, pod size, or distance offshore, but the nocturnal migration rate was significantly higher (28%, SE = 11.6%) than the diurnal rate. We found no significant diel variation in swimming speed in any comparison. We propose later migrants socialize more during the day, which effectively slows their diurnal rate of migration even though they maintain equal speeds day and night when swimming.

Agenda Section 1.2111

EVALUATION OF HIGH-POWERED BINOCULARS TO DETECT INTER-YEAR CHANGES IN THE OFFSHORE DISTRIBUTION OF GRAY WHALES

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Rugh, D.J., J.A. Lerczak, R.C. Hobbs, J.M. Waite, and J.L. Laake. In press. Evaluation of high-powered binoculars to detect inter-year changes in the offshore distribution of gray whales. J. Cetacean Res. Manage. Special Issue 2.

Paired, independent searches for gray whales (*Eschrichtius robustus*) were conducted through fix-mounted, 25-power binoculars during January 1995 and 1996 at Granite Canyon, California. This study was a test of an efficient method for documenting inter-year changes in the offshore component of the gray whale migration. The research site has been used most years since 1975 by the National Marine Mammal Laboratory to make gray whale counts for abundance estimates. Matching sightings between these paired observation efforts showed a very high agreement between observers (detection probability 0.97) for whale groups consisting of more than one animal within 1 to 3 nmi of shore, and a fairly high agreement (0.87) for animals that appeared to be traveling alone (5% of the sampled population) within 1 to 3 nmi of shore. Therefore, sighting probability remained high out to 3 nmi, a distance which includes most (98.7%) of the whale migration. For the critical sighting range of 1 to 3 nmi, the method we applied here, using paired, fix-mounted binoculars, is considered a feasible, cost-effective technique for detecting inter-year differences in the offshore tail of the distribution of gray whales.

Agenda Section 1.2112

COMPARISON OF THE OFFSHORE DISTRIBUTION OF SOUTHBOUND MIGRATING GRAY WHALES FROM AERIAL SURVEY DATA COLLECTED OFF GRANITE CANYON, CALIFORNIA, 1979-96

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Shelden, K.E.W., and J.L. Laake. In press. Comparison of the offshore distribution of southbound migrating gray whales from aerial survey data collected off Granite Canyon, California, 1979-96. J. Cetacean Res. Manage. Special Issue 2.

Aerial surveys provide an assessment of the offshore distribution of gray whales and an estimate of the proportion of whales that migrate beyond the visual range of shore-based observers. Six surveys were conducted concurrent with shore-based surveys during 1979, 1980, 1988, 1993, 1994 and 1996. Annual differences were tested for in the distribution of whales within an area 3 nmi north and south of Granite Canyon, and it was found that the distributions within 3 nmi of the shore differed by year but the shifts in the distribution were minor (<0.3 nmi). The inshore (<2.25 nmi) and offshore (>2.25 nmi) distribution of gray whale pods did not differ significantly between survey years. An average of 4.76% (SE = 0.85%) of the whale pods were observed beyond 2.25 nmi and only 1.28% (SE = 0.07%) were observed beyond 3 nmi.

Agenda Section 1.2121
1.2124

THE SOUTHBOUND MIGRATION OF GRAY WHALES WINTER 1998/99

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Mate, B.R., and A. Poff. 1999. The southbound migration of gray whales, winter 1998/99. 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.

Alternate half-hour counts were made during the morning hours from 5 December through mid-February from the Yaquina Head Lighthouse (162 feet above sea level). Observations were made on all fair-weather days (< Beaufort 4).

The first whale was sighted on 23 December and the peak passage of whales per hour occurred 7 January. By comparison with previous data from the same site (1978/81: Herzing and Mate 1984), the migration started 3 weeks later than normal and the migratory population peaked 6 days later than the latest date.

Aerial surveys in early December showed a number of animals along the coast but not moving consistently in southerly directions. Surveys closer to Christmas about 10 miles offshore showed more animals beyond 5 miles than inside 5 miles. This was an unusual distribution from efforts in previous years when most of the population was within 3 miles of the coast. Despite periods of good weather, whales did not tend to come nearshore to the degree experienced in previous years. In this study, 60% of the animals were 5 miles or farther offshore and 20% of the animals were within 3 miles of shore judging from lighthouse observations.

Agenda Section 1.2122

FIELD REPORT ON THE WINTER DISTRIBUTION OF GRAY WHALES IN WASHINGTON WATERS, 1998/99

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Shelden, K.E.W., J.L. Laake, P.J. Gearin, D.J. Rugh, and J.M. Waite. 1999a. Field report on the winter distribution of gray whales in Washington waters, 1998/99. 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.

The winter distribution of gray whales along the Washington coast has been difficult to characterize primarily because of low survey effort (due to poor surveying conditions). Aerial surveys were conducted during the months of November and December 1998 and January 1999 between Cape Flattery and Carroll Island, Washington. Flights included a coastal trackline extending from Cape Flattery (48°23' N, 124°44' W) to Carroll Island (48°00' N, 124°43' W) and 8 east-west oriented transect lines spaced at 7.4 km intervals, extending 55.6 km offshore. Survey flights were scheduled at 10-day intervals with modifications to the schedule occurring when weather conditions were not optimal. Four complete surveys and two partial surveys were flown between November 1998 and January 1999 for a total of 19.5 on-effort hours and 40 transect lines. Four gray whale pods (6 individuals) and two gray whale pods (2 individuals) were observed on offshore transect lines and coastal tracklines, respectively. Distances off the Washington coast for pods observed on transect ranged from 5.5 km to 47 km. One sighting of an extremely rotund whale on 22 December suggests that pregnant animals continued to pass the Washington coast late in December. No calves were seen. Other marine mammal sightings included aggregations of humpback whales and Pacific white-sided dolphins feeding in the survey area in November and early December. Based on this study and other reports, it appears that gray whales are widely dispersed across the outer continental shelf of Washington State during both migratory and non-migratory periods. Sightings indicate that some may migrate close to shore while others may be nearly 50 km offshore. Gray whales were also observed within Washington State's inside waters during the southbound migration period. Because gray whales utilize the inside waters and outer coast throughout the year, determining when a "resident" becomes a "migrant" has been based on migratory timing. Although migratory timing cannot be confirmed by the aerial survey results reported here because too few whales were seen during the flights, it does appear that the peak of the southbound migration passes through the area in early to mid-January.

Agenda Section 1.2123

GRAY WHALE OBSERVATIONS FROM TATOOSH ISLAND, WASHINGTON, DECEMBER 1998

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Jones, B. 1999. 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.

Gray whales (*Eschrichtius robustus*) were surveyed from the tower of the Tatoosh Island lighthouse from 30 November - 16 December 1998. The purpose of the study was to determine the onset of the southbound migration of gray whales past Cape Flattery, the most northwestern point of Washington State. Observations were conducted primarily without the use of optical aids. 7 X 50 Fujinon binoculars, equipped with reticles and a magnetic compass, were used to document sighting location. Gray whales were seen on three occasions (2, 4, and 13 December) during 49.3 hours of observation effort over a total of 12 days. The average daily observation effort for this time was 4.1 hours. The maximum possible sighting distance was estimated at 25 km. Gray whales were seen at a range of 0.6 - 5.9 km from shore. Although few migrating gray whales were observed during this period, it is possible that whales passed offshore, out of the observer's sighting range. It is also possible that this time period (30 November - 16 December) represented the very early stages of the southbound gray whale migration past Washington, thus few whales were in the vicinity. Aerial and vessel surveys conducted by the National Marine Mammal Laboratory in November and December 1998, and January 1999 support the latter hypothesis.

Agenda Section 1.2124

SOUTHBOUND GRAY WHALE MIGRATION TIMING OFF LOS ANGELES, 1985-99

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Schulman-Janiger, A. 1999a. Southbound gray whale migration timing off Los Angeles, 1985-99. 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.

TENTH PERCENTILE, MEDIAN DATES, AND NINETIETH PERCENTILE FOR THE SOUTHBOUND GRAY WHALE MIGRATION OFF PT. VICENTE/LONG POINT, CALIFORNIA, 1985-99

Season number	Census dates	10th percentile Sightings (whales)	Median (50th percentile) Sightings (whales)	90th percentile Sightings (whales)
3	1 Dec 85 - 17 May 86	7 Jan (5 Jan)	30 Jan (29Jan)	20 Feb (18 Feb)
4	1 Dec 86 - 3 May 87	2 Jan (4 Jan)	28 Jan (28 Jan)	12 Feb (12 Feb)
5	1 Dec 87 - 14 May 88	5 Jan (5 Jan)	18 Jan (18 Jan)	5 Feb (5 Feb)
6	1 Dec 88 - 30 Jun 89	2 Jan (4 Jan)	15 Jan (17 Jan)	31 Jan (31 Jan)
7	1 Dec 89 - 6 Jun 90	1 Jan (1 Jan)	24 Jan (24 Jan)	11 Feb (11 Feb)
8	1 Dec 90 - 12 May 91	25 Dec (30 Dec)	19 Jan (19 Jan)	16 Feb (16 Feb)
9	1 Dec 91 - 3 May 92	2 Jan (3 Jan)	21 Jan (23 Jan)	14 Feb (14 Feb)
10	1 Dec 92 - 8 May 93	30 Dec (30 Dec)	18 Jan (16 Jan)	15 Feb (11 Feb)
11	1 Dec 93 - 7 May 94	3 Jan (5 Jan)	28 Jan (27 Jan)	15 Feb (14 Feb)
12	1 Dec 94 - 5 May 95	22 Dec (24 Dec)	17 Jan (18 Jan)	11 Feb (11 Feb)
13	1 Dec 95 - 10 May 96	30 Dec (31 Dec)	24 Jan (26 Jan)	17 Feb (16 Feb)
14	1 Dec 96 - 16 May 97	30 Dec (30 Dec)	18 Jan (18 Jan)	12 Feb (9 Feb)
15	1 Dec 97 - 15 May 98	1 Jan (2 Jan)	17 Jan (17 Jan)	9 Feb (5 Feb)
16	1 Dec 98 - 15 May 99	28 Dec (31 Dec)	21 Jan (22 Jan)	8 Feb (8 Feb)

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TIMING OF THE SOUTHBOUND MIGRATION OF GRAY WHALES IN 1998/99

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Rugh, D.J., K.E.W. Shelden, and A. Schulman-Janiger. 1999a. Timing of the southbound migration of gray whales in 1998/99. 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.

The southbound migration of gray whales has been documented most seasons since 1967 from Granite Canyon, a shore-based observation station in central California. Prior to 1980, median dates of sightings ranged from 5-14 January, with an overall median date of 8 January. Since 1980, there has been a 1-week delay in the peak, such that the median date is now closer to 15 January (ranging 12-19 January). Allowing for this delay, and using a travel rate of 144 km/day between shore stations, expected peak dates in 1998/99 should have been 11 December for Cape Sarichef, at the tip of the Alaska Peninsula/Unimak Island; 18 December for Narrow Cape near Kodiak, Alaska; 5 January for Tatoosh Island, the northwesternmost tip of Washington State; 8 January for Yaquina Head, near Newport, Oregon; 15 January for Granite Canyon, central California; and 18 January at Point Vicente, near Los Angeles, California. Although no observations were made at Granite Canyon in 1998/99, sightings collected at Yaquina Head and Point Vicente indicate that the southbound migration was within 3 days of the expected date. Inter-year variations of a few days in migratory dates may be explained in part by variations in the median location of whales in the Bering or Chukchi Seas just prior to the onset of the migration. The further north the whales are in late October, the shorter the days will be (i.e., a perceived reduction in photoperiod), which seems to be the primary cue to initiating the southbound migration.

Agenda Section 1.221

CETACEAN HABITATS IN THE ALASKAN ARCTIC

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Moore, S.E., and D.P. DeMaster. 1997. Cetacean habitats in the Alaskan arctic. J. Northwest Atl. Fish. Sci. 22:55-69.

Marine mammals can be used as indicators of environmental productivity because they must feed efficiently and therefore aggregate where prey is plentiful. Three species of cetaceans, bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*), and white whales (*Delphinapterus leucas*) migrate to the Alaskan arctic each year to feed. These species have distinctly different feeding modes and forage at dissimilar trophic levels. Bowhead whales filter zooplankton from the water column, gray whales siphon infaunal crustaceans from the benthos and white whales catch a variety of nekton including crustaceans, cephalopods and fishes.

Line transect aerial surveys were conducted over the Alaskan Chukchi and Beaufort Seas each late summer and autumn 1982-91. The resulting database, consisting of 634 flights, was post-stratified by survey type and sea state (Beaufort $\leq$ 04) to provide a database of cetacean sightings made along random transects during good survey conditions. Sightings made during connect and search legs of the survey, and in rough seas were excluded. Post-stratification resulted in a cumulative (1982-91) database of 276,754 transect-km of survey effort during which there were 554 bowhead, 608 gray and 831 white whale sightings.

Habitat partitioning and variability in habitat use among cetaceans in offshore areas of northern Alaska is poorly defined. Available data suggest that cetacean distribution and abundance patterns can be quantified on the basis of water depth and surface ice cover, and that these indices can be linked to large-scale oceanographic processes. In summer, mean depth and percent surface ice cover were significantly different ($p < 0.001$) among bowhead (900 m, 52%; $n = 79$), gray (40 m, 1%; $n = 497$) and white whales (1,314 m, 60%; $n = 146$). All pairs were significantly different ($p < 0.003$), except for bowhead-white whale ice cover ($p < 0.13$). Similarly in autumn, mean depth and percent ice cover were significantly different ($p < 0.001$) among bowhead (109 m, 22%; $n = 475$), gray

(38 m, 7%; *n* = 111) and white whales (652 m, 52%; *n* = 685); all pairs were significantly different ($p < 0.001$). In addition, mean depth and percent ice cover were significantly different ($p < 0.001$) between summer and autumn for bowhead and white whale sightings. Currents are bathymetrically driven, and ice cover influenced by currents and wind, in the Chukchi and Beaufort Seas. The association of cetaceans with specific bathymetric and ice cover regimes provides a foundation for further investigation of inter-specific habitat selection, zones of productivity and insight to the role of cetaceans in Alaskan arctic ecology.

Agenda Section 1.222

PHOTOGRAPHIC IDENTIFICATION RESEARCH ON SEASONAL RESIDENT WHALES IN WASHINGTON STATE

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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.

Photographic identification of gray whales in Washington State has been conducted by Cascadia Research since 1984. This has been part of an ongoing research effort to study the abundance, movements, residence times, and return rate of seasonal resident gray whales that spend the spring, summer, and fall feeding in these areas. Starting in 1992, surveys were more frequent and encompassed a broader region. Since 1996, this effort has also included identifications from the National Marine Mammal Laboratory from systematic surveys along the northern Washington Coast and western Strait of Juan de Fuca.

Through 1997, more than 600 identifications of whales have been made, representing 168 unique individuals. In 1996 and 1997, 47 and 37 different gray whales were identified primarily on the northern coast of Washington State and near the western entrance to the Strait of Juan de Fuca (both the Washington and Vancouver Island sides). Movements among these three regions were very common and most animals were seen multiple times (up to 11) over periods of up to 163 days. Of whales identified in northwest Washington in 1996 and 1997, 64%-83% had been identified in a previous year. Gray whales identified near Grays Harbor in the spring were less likely to have been seen multiple times (52%) or a previous year (26%). Comparison of photographic catalogs with researchers working in British Columbia revealed that many of the whales that feed along the Washington coast through the summer range along the British Columbia coast to areas north of Vancouver Island. Gray whale occurrence in Puget Sound has been more variable from year to year.

Analysis is currently underway of the 1998 sample which is the largest and most comprehensive to date. Effort by Cascadia Research included surveys and identifications off California, Oregon, several regions of Washington State (including Puget Sound), southern British Columbia, and southeast Alaska. Photographs of animals in specific regions within this range were also obtained by collaborating researchers with NMML, West Coast Whale Research Foundation, Humboldt State University, University of Victoria, University of British Columbia, Department of Fisheries and Oceans, Vancouver Aquarium, Juan de Fuca Express, and Coastal Ecosystems Research Foundation. These

represent close to 500 records of over 150 different individuals. Preliminary results of this analysis has provided new information on the status and movements of these seasonal resident whales.

Overall conclusions include:

1. Seasonal resident gray whales utilize coastal areas from northern California to southeast Alaska from spring to fall with some interchange of animals among most of these areas.
2. Gray whales show some localized site fidelity to certain areas but also move widely within and between years. Gray whales seen in northern Puget Sound show a strong site fidelity to this area but only for part of the season and then move to other unknown areas (not currently sampled).
3. Utilization of some areas, such as southern Puget Sound, are highly variable year to year and whales seen in this area have a high mortality rate and are rarely seen in more than one year.
4. The total number of seasonal resident animals is not known (in the hundreds), nor is how they are recruited to this group, or the degree to which they need to be managed as a separate unit.

Agenda Section 1.222

THE SUMMER AND FALL DISTRIBUTION OF GRAY WHALES IN WASHINGTON WATERS

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Gosho, M.E., P.J. Gearin, J. Calambokidis, K.M. Hughes, L. Cooke, L. Lehman, and V.E. Cooke. 1999a. The summer and fall distribution of gray whales in Washington waters. 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.

The National Marine Mammal Laboratory has been studying gray whale distribution and identification since 1996 in the Strait of Juan de Fuca, off the northern Washington coast, and off the southwest coast of Vancouver Island. Each year the animals were concentrated in different locations. In 1996, the largest concentration of gray whales occurred off Portage Head and Makah Bay on the northern Washington coast. In 1997, the majority occurred in the westernmost Strait of Juan de Fuca from Bullman Beach to Mushroom Rock. In 1998, most of the gray whales were sighted off the southwest coast of Vancouver Island. Photographs of gray whales allowed the identification of 18 individual animals in 1996 and 28 animals in 1997. Photo-identification and co-operation with other researchers showed that gray whales moved freely between areas in the Strait of Juan de Fuca, off the Washington coast, and off the southwest coast of Vancouver Island.

Agenda Section 1.23

GRAY WHALE STUDIES AT LAGUNA SAN IGNACIO, B.C.S., MÉXICO, WINTER 1996

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Urbán R., J., A. Gómez-Gallardo U., V. Flores de Sahagún, J. Cifuentes L., S. Ludwig, and M. Palmeros R. 1997. Gray whale studies at Laguna San Ignacio, B.C.S., México, winter 1996. Rep. Int. Whal. Commn. 47:625-633.

Laguna San Ignacio, located on the west coast of the Baja California Peninsula, is one of the four main calving-breeding lagoons of the eastern Pacific gray whale (*Eschrichtius robustus*). Uncertainty exists concerning the potential effects of both whale watching and the development of a proposed salt project on gray whales and the lagoon ecosystem. This note documents the current use of Laguna San Ignacio by gray whales for comparison with previous studies and, as far as possible, to provide a baseline to detect and analyse changes in the whales' use of this lagoon. Twenty boat censuses were carried out from 17 January to 27 March 1996. The maximum combined count was 207 (115 single whales and 92 cow-calf pairs). The peak numbers of both single whales and cow-calf pairs were at the same time in early March when almost 40% fewer whales were observed in 1996 than the 1978-82 average. Density estimates at the maximum combined count were: 8.6 whales/km^2 in the lower zone, 3.8 whales/km^2 in the middle zone and 1.3 whales/km^2 in the upper zone. Of the 329 identified whales, 164 were singles, 141 cow-calf pairs and 24 undetermined; 51 whales were seen more than once (43 cow-calf pairs and 8 singles). Different residency intervals were documented: cow-calf pairs stayed in the lagoon 18.3 ± 4.8 (95% C.I.) days and single whales 2.6 ± 1 (95% C.I.) days. Four systematic aerial surveys were carried out at Bahía Ballenas between 1 February and 4 March. The maximum count in this bay was on 28 February with 127 adult whales (119 single whales and 8 cow-calf pairs). These observations must be continued for a period of years to establish a new basis for comparison with previous research results. Further photographic and tagging studies may help in developing turnover rates, which will allow the number of whales using the lagoon to be calculated, based on visual surveys.

Agenda Section 1.23

A NOTE ON THE 1997 GRAY WHALE STUDIES AT LAGUNA SAN IGNACIO, B.C.S., MÉXICO

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Urbán R., J., A. Gómez-Gallardo U., and M. Palmeros R. 1998a. A note on the 1997 gray whale studies at Laguna San Ignacio, B.C.S., México. Rep. Int. Whal. Commn. 48:513-516.

This note includes the results of our second year of gray whale studies at Laguna San Ignacio, B.C.S., México. Uncertainty exists concerning the potential effects of both whalewatching and the development of the proposed salt project on gray whales and the lagoon ecosystem. The purpose of this report is to document the current use of Laguna San Ignacio by the gray whales for comparison with previous studies. Eleven complete censuses of the lagoon were done by boat to determine whale abundance and distribution from 11 February to 29 March 1997. The maximum combined count was 253 (127 single whales and 126 cow-calf pairs) during the last week of February. Six dead calves (four males and two females) were found inside the lagoon. The upper zone of the lagoon was the most important for cow-calf pairs and the lower zone for single whales. There were 22% more whales than in the 1996 winter season, but this is still 36% lower than the highest count in 1985. Different residency intervals were documented: cow-calf pairs stayed in the lagoon 19.6 ± 3.5 days (95% C.I.), and the single whales 6.2 ± 3.2 days (95% C.I.). Nine whales photo-identified in 1996 were also photographed during the 1997 winter season.

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TRANSITO DE BALLENA GRIS (*ESCHRICHTIUS ROBUSTUS*) EN BAHÍA BALLENAS, BAJA CALIFORNIA SUR, MÉXICO

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Sánchez Pacheco, J.A., and J.L. Valdés Aragón. 1997. Transito de ballena gris (*Eschrichtius robustus*) en Bahía Ballenas, Baja California Sur, México. [The transit of the gray whale (*Eschrichtius robustus*) in Bahía Ballenas, Baja California Sur, Mexico.] Boletín Pesquero CRIP-La Paz 7:26-33.

Results are presented on observations of the transit of gray whales at different distances from the coast in Bahía Ballenas, Baja California Sur, during the 1996 and 1997 seasons. Whales that moved northwards prevailed (96%). There were fewer single whales in 1997 than in 1996; the reverse situation occurred in whales with calves. Single whales transited further from the coast (75.4% $\geq$2 km) than whales with calves (82.32% within 3 km). The number of single whales estimated to migrate north from the observation point was 2,888 and 2,195 for 1996 and 1997, respectively. There were 418 cow/calf pairs seen in 1996 and 621 in 1997.

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Agenda Section 1.3

ESTIMATED TRENDS IN ABUNDANCE OF EASTERN PACIFIC GRAY WHALES FROM SHORE COUNTS, 1967/68 TO 1995/96

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Buckland, S.T., and J.M. Breiwick. In press. Estimated trends in abundance of eastern Pacific gray whales from shore counts, 1967/68 to 1995/96. J. Cetacean Res. Manage. Special Issue 2.

Estimates of abundance of eastern Pacific gray whales are obtained from counts made during their southbound migration past a shore-based station near Monterey, California. Assuming an exponential rate of increase, the population is estimated to have increased at 2.5% per annum (SE = 0.3%) between 1967/68 and 1995/96. However, there is some indication that the population growth is slowing, so that an asymptotic growth curve may be more appropriate. The estimated asymptote from a logistic model is 26,046 (SE = 6,281) and the inflection point is approximately in 1971 (SE = 6.5). The onset of the migration, when 10% of the whales have passed the station, has occurred increasingly later through this sample period, by approximately one day every 2 years. Median dates show a similar trend of roughly one day every 3 years. However, there is no significant change in the date at which 90% of whales have passed the station.

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GRAY WHALE ABUNDANCE ESTIMATES, 1967/68 - 1997/98: *ROI*, *RY*, AND *K*

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Breiwick, J.M. 1999. Gray whale abundance estimates, 1967/68 - 1997/98: *ROI*, *RY* and *K*. 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.

Gray whale abundance estimates for the period 1967/68 to 1997/98 were fit using a generalized linear model (Poisson error, logarithmic link), giving a rate of increase of 2.52% per annum (SE = 0.27%). In addition, a (continuous) logistic model fit to the data gave a *K* (carrying capacity) of 37,364 (SE = 24,854), larger by 11,000 than a similar estimate based on the 1967/68 - 1995/96 data. Both estimates have very large CVs associated with them. A discrete logistic model was also used to estimate R_{max} and *K*. A replacement yield (*RY*) of 612 was calculated based on the rate of increase estimate, average catches and the abundance estimates. A Monte Carlo procedure was used to calculate a 95% confidence interval for *RY*.

Agenda Section 1.3

A BAYESIAN ANALYSIS OF EASTERN PACIFIC GRAY WHALE POPULATION DYNAMICS

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

A Bayesian statistical method was used to investigate the population dynamics of eastern Pacific gray whales. Apparent stability in the three most recent abundance estimates may be due to a density-dependent slowing of the population growth rate. This hypothesis was tested by comparing how well density-dependent population models fit the data relative to density-independent population models. Additionally, a second hypothesis was tested, which was whether using a parameter representing additional variance in the abundance estimates provided a better fit to the data than not including it. In total, the fit of eight different models were compared through the use of the Bayes factor. Density-dependent models were decisively supported by the data over density-independent models when the additional variance term was not used. However, the use of the additional variance term was also decisively supported by the comparisons. When the additional variance term was included, the data still favored the density-dependent models, but only marginally. Point estimates of the equilibrium population size ranged from 24,000 to 32,000 depending upon which model was used, but values as high as 70,000 still had some probability.

Agenda Section 1.3

A BAYESIAN STOCK ASSESSMENT OF THE EASTERN PACIFIC GRAY WHALE USING ABUNDANCE AND HARVEST DATA FROM 1967 TO 1996

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Wade. P.R. In press. A Bayesian stock assessment of the eastern Pacific gray whale using abundance and harvest data from 1967 to 1996. J. Cetacean Res. Manage. Special Issue 2.

Abundance and harvest data since 1966/67 were used to assess the eastern Pacific stock of gray whales. A Bayesian statistical method was used to estimate probability distributions for the parameters of both a simple and an age and sex structured population dynamics model, as well as output quantities of interest. Model comparisons using the Bayes Factor provided conclusive evidence that an additional parameter should be used to account for unexplained variation in the abundance time series. Incorporating the additional variance parameter decreased the precision of the estimates of the other parameters. Point estimates of carrying capacity ranged from 24,640 to 31,840 for the different models, but the posterior distributions from the selected models were very broad and excluded few values. The current depletion level (population size as a fraction of carrying capacity) was estimated to be about 0.75, with a lower 2.5th percentile of 0.36. The probability that the population was still below one-half of its carrying capacity was estimated to be 0.21, with a corresponding probability of 0.28 that the population was still below its maximum sustainable yield level. Quantities from which catch limits could potentially be calculated were estimated, including current replacement yield, maximum sustainable yield and the quantity Q_1 (described in Wade and Givens 1997).

Agenda Section 1.41

GRAY WHALES ILLUSTRATE THE VALUE OF MONITORING DATA IN IMPLEMENTING THE ENDANGERED SPECIES ACT

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Gerber, L.R., D.P. DeMaster, and P.M. Kareiva. In press. Gray whales illustrate the value of monitoring data in implementing the Endangered Species Act. Conserv. Biol.

Many scientists lament the absence of data for endangered species and argue that more funds should be spent acquiring basic information regarding population trends. Using nineteen years of abundance estimates for the eastern North Pacific gray whale *(Eschrichtius robustus)*, we sampled subsets of the original survey data to identify the number of years of data required to remove the population from the Endangered Species Act's (ESA) List of Endangered and Threatened Wildlife. For any given duration of monitoring, we selected all possible combinations of consecutive counts. To incorporate variability in growth rates we extracted a maximum likelihood estimator of growth rate and confidence interval about that growth rate on the assumption that the population changes can be approximated by a simple diffusion process with drift. We then applied a new approach to determine ESA status for each subset of survey data and found that a quantitative decision to delist is unambiguously supported by eleven years of data, but precariously uncertain with fewer than ten years of data. The data needed to produce an unequivocal decision to delist gray whales cost the National Marine Fisheries Service an estimated $660,000, a surprisingly modest expense given the fact that delisting can greatly simplify regulatory constraints. This example highlights the value of population monitoring in administering the ESA, and provides a compelling example of the utility of such information in identifying both imperiled species and recovered species. The economic value of such data should be clear: they provide the foundation for delisting, which could ultimately save much more money than the collection of the data would ever cost.

Agenda Section 2.1

GRAY WHALE CALF SIGHTINGS COLLECTED DURING SOUTHBOUND MIGRATIONS, 1952-95

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Shelden, K.E.W., D.J. Rugh, and S.A. Boeve. In press. Gray whale calf sightings collected during southbound migrations, 1952-95. J. Cetacean Res. Manage. Special Issue 2.

For the past 43 years, scientists at the National Marine Mammal Laboratory and preceding organizations, have collected information on sightings of gray whale calves during the whales' annual migration between Alaska and Mexico. The data document the timing and location of calving during the southbound migration along the California coast. Calf-sighting data were collected by observers conducting abundance surveys of gray whales from shore-based sites at Point Loma, near San Diego, in 1952-69 and 1975-78; Yankee Point, Carmel, in 1967-74; and Granite Canyon, Carmel, during most years between 1974 and 1995. Although some reporting methods have changed over the years, all records indicate that observers searched for and recorded calves. In addition to shore-based surveys, aerial surveys were conducted in five seasons between 1979 and 1994. Results indicate that shore-based observers missed 62% of the calves within their viewing area (0-2.6 km from shore), suggesting that calves are significantly under-represented in the shore-based data record. For many of the early census years (1952-74), the percentage of calves sighted (number of calves/total whales) was within the range 0.0-0.2%. In 1975 the percentage of calves sighted at Point Loma increased substantially (to 0.7%) but it did not show up at the Carmel shore stations, 570 km north of Point Loma, until 1984. The highest calf count (n = 36; 0.8%) occurred during 1993/94 at Granite Canyon, when migration dates were later than for any other year. The apparent increase in calf sightings may be related to a trend towards successively later migrations over the 43 year observation period, or to an increase in spatial and temporal distribution of calving as the population has increased. As the population reaches carrying capacity, food resources may be more limited, resulting in pregnant females departing from the feeding grounds later and with reduced fat reserves. As a result, parturition may be occurring prior to reaching the preferred calving grounds at Baja California, Mexico.

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Agenda Section 2.1

GRAY WHALE CALF SIGHTINGS DURING SOUTHBOUND MIGRATIONS, 1995-98

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Shelden, K.E.W., and D.J. Rugh. 1999. Gray whale calf sightings during southbound migrations, 1995-98. 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.

As an addendum to Shelden et al. (in press), this report provides data on sightings of gray whale calves that were collected during aerial surveys conducted in January 1996 and shore-based surveys conducted during the winters of 1995/96, January 1997, and 1997/98 near the shore station at Granite Canyon, California. The proportions of calves to adults observed from 1995 to 1998 (0.003 - 0.015) were similar to those recorded from 1984 to 1995 (0.001 - 0.009). The highest number of sightings occurred during the 1997/98 season with 61 calves reported. The proportion of calves visible from the air in 1996 (0.0308) was much higher than the proportion observed in 1988 (0.0024) but fell between the proportions observed in 1993 and 1994 (0.0238 and 0.0440). The distribution of cows with calves relative to shore was similar to earlier years where the majority of sightings occurred inshore of the main migration corridor (1.4 - 2.8 km) during both shore-based and aerial surveys. The median distance for shore-based sightings was 0.79 km compared to 1.34 km from the air during the 1995/96 season. Although calves appeared to be closer to shore in 1995/96 when comparing shore-based observations from earlier years (1.1 km from pooled data 1987-95); median distances during aerial surveys were not different (1.3 km from pooled data 1988, 1993 and 1994). Shelden et al. (in press) noted that it was rare that more than one independent observer at a time recognized the presence of a calf. During the 1995/96 season, 12 calves were identified during paired-independent observations of which only 3 were also seen by the second observer. In January 1997, only 1 of 7 sightings were matched between observers, and during the 1997/98 season only 5 matches occurred among 40 sightings.

Agenda Section 2.2
2.3

SOUTHBOUND AND NORTHBOUND GRAY WHALE CALF SIGHTINGS OFF LOS ANGELES, 1984-99

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Schulman-Janiger, A. 1999b. Southbound and northbound gray whale calf sightings off Los Angeles, 1984-99. 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.

For the past 16 seasons, trained volunteers have conducted the shore-based full-season Gray Whale Census and Behavior Project, sponsored by the Los Angeles Chapter of the American Cetacean Society (ACS/LA), at or near Point Vicente (near Los Angeles, California). Gray whales and other cetaceans are counted from shore, 10-12 hours per day, 7 days a week, for 5 to 6 months. Southbound counts have ranged from 301 to 1,301 per year, including 3 to 106 newborn calves. The percentage of southbound calves sighted (number of calves/total southbound whales) during the first 7 years of our study (1983/84 to 1989/90) ranged from 0.5% to 2.5%, averaging 1.7%. During the next three seasons (1990/91 to 1992/93) these percentages increased to 3.0-3.9%, averaging 3.5%. The calf percentages from 1993/94 to 1998/99 ranged from 2.0% to 8.6%, averaging 4.6%. However, the calf count in the 1998/99 migration (n = 15; 2.2%) was one of the lowest in the past nine seasons. The highest calf count (n = 106; 8.6%) was in the 1997/98 season. These calf percentages are considerably higher than those published for other censuses. As their numbers increase, more gray whales may delay departures from northern feeding grounds (especially in seasons that include warmer arctic waters and late ice formation); more females may give birth off southern California rather than in Mexican calving lagoons, possibly subjecting calves to higher mortality rates. Gray whales with newborns appear to favor a more protected coastal (rather than offshore) migratory corridor, thus raising nearshore percentages of southbound calves. The relatively high (and apparently increasing) percentage of southbound gray whale calves documented here indicate that births off southern California are more common than previously thought.

The northbound migration of cow/calf pairs peaks between 6 April and 27 April, generally during the last half of April; this peak occurs 4-8 (averaging 6) weeks after the earlier migration peak that primarily consists of whales with no calves. Northbound counts have ranged from 793 to 3,412 per year, including 11 to 222 newborn calves. The percentage of newborn calves sighted (number of calves/total number of northbound whales) during the first nine seasons of our study (1983/84 to1991/92) ranged from 0.9% to 8.3%, averaging 3.4%. During three seasons (1987/88, 1989/90, and 1990/91) the percentage of northbound calves observed was actually lower than the percentage of southbound calves

observed earlier in those migrations; this occurred during a period of generally lower whale counts. During the next six seasons (1992/93 to 1997/98) this percentage generally increased: it ranged from 4.3% to13.8%, averaging 9.6%. Some of the highest percentages, ranging from 9.4% to 13.8% (averaging 11.2%), have occurred in recent years (1995/96 to1997/98). These were substantially higher than previously published figures for California waters. The highest calf count (n = 222, 13.8%) occurred in the 1996/97 season and was more than double the count of any of the preceding nine seasons. However, the percentage of calves in the 1998/99 northbound migration was only 2.5% (n = 34), well below percentages seen in recent years. Factors that may be contributing to this increase in northbound calf percentages include: shore-based observers are detecting a higher percentage of calves; there may be some shortening of gray whale calving intervals; and, more calves may be surviving the first few months of life. These annual counts, complementing those conducted from other areas, could help indicate whether gray whale calf production is decreasing, stabilizing, or increasing.

Agenda Section 2.4

ANNUAL CALF PRODUCTION FOR THE CALIFORNIA STOCK OF GRAY WHALES 1994-98 [Preliminary Analysis]

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Perryman, W.L., M.A. Donahue, S.B. Reilly, and P.C. Perkins. 1999b. Annual calf production for the California stock of gray whales 1994-98 [Preliminary analysis]. 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.

We conducted shore-based sighting surveys to estimate the number of northbound migrating gray whale calves passing Piedras Blancas, California, for four consecutive years (1994-98). In addition, we conducted aerial surveys to determine offshore distribution of the migration in 1994 and 1995, measured day/night migration rates with thermal sensors in 1994-96, and maintained concurrent replicate watches near the peak of each migration to estimate the proportion of the northbound cow-calf pairs missed by the census team. During good weather conditions, we counted 325, 194, 408, 501, and 440 calves during 1994-98 respectively. Correcting these counts for periods not on watch, calves passing far offshore (1994 only), and for calves missed by the census team produced final estimates of 1,000 calves (SE = 88.85) for 1994; 601 calves (SE = 69.56) for 1995; 1,141 calves (SE = 72.23) for 1996; 1,439 calves (SE = 78.62) for 1997; and a preliminary estimate of 1,316 calves (SE = 77.56) for 1998. Calf production indices (calf estimate/total population estimate) are 4.5%, 2.6%, 5.1%, 6.5%, and 5.9% for the years 1994-98, respectively.

Agenda Section 2.5

RESULTS OF PHOTOGRAMMETRIC WHALING FOR GRAY WHALES ALONG THE CENTRAL AND SOUTHERN CALIFORNIA COAST BETWEEN 1994 AND 1998

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Perryman, W.L., and M.S. Lynn. 1999. Results of photogrammetric whaling for gray whales along the central and southern California coast between 1994 and 1998. 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.

More than 25 years after the last gray whale was taken along the California coast under a special permit issued by the IWC to study the biology and ecology of this population, we began an aerial photogrammetric sampling effort with the goal of revisiting some of the results derived from the examination of specimens. Analysis of length, maximum width, and fluke width data for southbound gray whales indicate that the migration is led by large whales, many of them **?**pregnant females," and that juvenile whales are most common late in the migration. Calves photographed around the California Channel Islands averaged 4.60 m in length. Based on the proportion of **?**pregnant" and recent postpartum females, we estimate 15 January to be the median birth date for eastern Pacific gray whales. Northbound calves photographed in late May averaged 7.10 m in length which is inconsistent with the accepted growth curve for young gray whales. We estimate length at 1 year to be 8.6 m and propose a new growth curve. There was a significant positive linear relationship between the length of a cow and her associated northbound calf. Lengths of cows with calves were shorter on average than adult females examined by Rice and Wolman (1971: 12.3 m versus 12.7 m), which may reflect gunner selection for large whales, stretching of specimens during processing, or bias in the photographic sample. Based on the relationship between log length and log width, northbound whales were significantly thinner than those photographed southbound. This difference was most pronounced between **?**pregnant females" and northbound cows with calves. Our results indicate that relatively small changes in condition or fatness of gray whales are detectable in measurements from photographs.

Agenda Section 3.1

OBSERVATIONS AND PREDICTIONS OF ARCTIC CLIMATIC CHANGE: POTENTIAL EFFECTS ON MARINE MAMMALS

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Tynan, C.T., and D.P. DeMaster. 1997a. Observations and predictions of arctic climatic change: potential effects on marine mammals. Arctic 50(4):308-322.

Recent analyses have revealed trends over the past 20-30 years of decreasing sea ice extent in the Arctic Ocean coincident with warming trends. Such trends may be indicative of the polar amplification of warming predicted for the next several decades in response to increasing atmospheric CO_2. We have summarized these predictions and nonuniform patterns of arctic climate change in order to address their potential effects on marine mammals. Since recent trends in sea ice extent are nonuniform, the direct and indirect effects on marine mammals are expected to vary geographically. Changes in the extent and concentration of sea ice may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and ultimately the abundance and stock structure of some species. Ice-associated seals, which rely on suitable ice substrate for resting, pupping, and molting, may be especially vulnerable to such changes. As recent decreases in ice coverage have been more extensive in the Siberian Arctic (60°E-180°E) than in the Beaufort Sea and western sectors, we speculate that marine mammal populations in the Siberian Arctic may be among the first to experience climate-induced geographic shifts or altered reproductive capacity due to persistent changes in ice extent. Alteration in the extent and productivity of ice-edge systems may affect the density and distribution of important ice-associated prey of marine mammals, such as arctic cod *Boreogadus saida* and sympagic ("with ice") amphipods. Present climate models, however, are insufficient to predict regional ice dynamics, winds, mesoscale features, and mechanisms of nutrient resupply, which must be known to predict productivity and trophic response. Therefore, it is critical that mesoscale process-oriented studies identify the biophysical coupling required to maintain suitable prey availability and ice-associated habitat for marine mammals on regional arctic scales. Only

an integrated ecosystems approach can address the complexity of factors determining productivity and cascading trophic dynamics in a warmer Arctic. This approach, integrated with monitoring of key indicator species (e.g., bowhead whale, ringed seal, and beluga), should be a high priority.

Agenda Section 3.1

THE INFLUENCE OF OCEANOGRAPHIC PROCESSES ON PELAGIC-BENTHIC COUPLING IN POLAR REGIONS: A BENTHIC PERSPECTIVE

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Grebmeier, J.M., and J.P. Barry. 1991. The influence of oceanographic processes on pelagic-benthic coupling in polar regions: a benthic perspective. J. Mar. Syst. 2:495-518.

Benthic community abundance and biomass in polar marine systems is directly influenced by food supply from the overlying water column. Variability in hydrographic regimes, ice coverage, light, water column temperature and pelagic food web structure limit the amount of organic carbon reaching the benthos. Data from the high Arctic and Antarctic indicate that a large percentage of surface-produced organic matter is consumed by both macro- and micro-zooplankton as well as recycled in the water column via the microbial loop. This results in food-limited regimes for the underlying benthos. The few exceptions are nearshore continental shelf systems, such as in the Bering and Chukchi Seas in the western Arctic and portions of the Canadian Archipelago and Barents Sea in the eastern Arctic, where high benthic abundance and biomass occurs due to a tight coupling between water column primary production and benthic secondary production. A major difference between the Antarctic and Arctic is that the nearshore deep Antarctic is characterized by relatively high benthic abundance and biomass despite low water column production, suggesting that stability, low disturbance levels and cold temperatures enable benthic organisms to grow larger than in the Arctic. Both physical and biological disturbance levels are high in the marginal seas of the Arctic and may directly influence benthic productivity. The relationship between primary production and sedimentation of organic material to the benthos is nonlinear due to its dependence on the role of the pelagic food web. Therefore, in this review we will only discuss the pelagic system with respect to how it impacts the net food supply reaching the benthos. A major objective of this review paper is to demonstrate the influence of oceanographic processes on pelagic-benthic coupling in polar regions from a “bottom-up” perspective, using benthic studies from various regions in both the Arctic and Antarctic. Similarities and differences in oceanographic processes, benthic abundance and biomass, and benthic carbon cycling within these polar marine systems are discussed and areas for further research identified.

Agenda Section 3.2

PRODUCTIVITY OF ARCTIC AMPHIPODS RELATIVE TO GRAY WHALE ENERGY REQUIREMENTS

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Highsmith, R.G., and K.M. Coyle. 1992. Productivity of arctic amphipods relative to gray whale energy requirements. Mar. Ecol. Prog. Ser. 83:141-150.

Amphipod crustaceans dominate the benthic community in vast areas of the northern Bering Sea; they are the major prey of the California gray whale *Eschrichtius robustus*. The protected whale population is growing steadily and may be approaching the carrying capacity of the amphipod community, one of the most productive benthic communities in the world. The abundance and biomass of the amphipod community decreased during the 3-year period 1986 to 1988, resulting in a 30% decline in production. High-latitude amphipod populations are characterized by low fecundity and long generation times. Large, long-lived individuals are responsible for the majority of amphipod secondary production. A substantial reduction in the density of large individuals in the population will result in a significant, long-term decrease in production.

Agenda Section 3.2

DISTRIBUTION AND CARRYING CAPACITY OF GRAY WHALE FOOD RESOURCES IN THE NORTHERN BERING AND CHUKCHI SEAS

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Stoker, S.W. In press. Distribution and carrying capacity of gray whale food resources in the northern Bering and Chukchi seas. J. Cetacean Res. Manage. Special Issue 2.

During their summer residency in the Bering and Chukchi Seas, gray whales rely on the rich benthic amphipod populations of the region to renew fat resources needed to sustain them during their winter migration to and from the breeding lagoons of Mexico. Surveys of gray whale population distribution on these northern grounds indicate that concentrations of feeding whales return annually to certain locations, and that these locations coincide, in most cases, with high density and high productivity amphipod communities.

The annual impact of gray whales feeding within these preferred areas is probably considerable. Studies of one of the high-use areas, the central Chirikov Basin between St. Lawrence Island and the Bering Strait, indicate that gray whales disturb at least 6% of the benthos each summer and consume more than 10% of the yearly amphipod production. Whether or not this rate of consumption is within sustainable bounds is unclear since it is impossible, at this time, to assess additional demands imposed upon amphipod populations by other predators such as epibenthic invertebrates and demersal fishes. There are indications, however, that this resource is being stressed and that the gray whale population is expanding its summer range in search of alternative feeding grounds.

Agenda Section 4.1

CHEMICAL CONTAMINANTS IN GRAY WHALES (*ESCHRICHTIUS ROBUSTUS*) FROM THEIR WESTERN BERING SEA ARCTIC FEEDING GROUNDS AND THE CALIFORNIA AND WASHINGTON COASTS

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Tilbury, K.L., J.E. Stein, C.A. Krone, G.M. Ylitalo, R.L. Brownell, Jr., M. Gosho, A. Blokhin, J.L. Bolton, and D.W. Ernest. 1999. Chemical contaminants in gray whales (*Eschrichtius robustus*) from off their western Bering Sea arctic feeding grounds and the California and Washington coasts. 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.

The gray whale (*Eschrichtius robustus*) is a coastal migratory baleen whale (Mysticete) with a benthic feeding strategy and a long period of fasting during its southbound migration and residence in the breeding grounds. The prolonged fasting may alter the disposition of toxic chemicals within the animal. Additionally, gray whales have been observed feeding in coastal waters, which may present a risk of exposure to toxic chemicals in some regions. We measured the concentrations of organochlorines (OCs) and trace elements in tissues and stomach contents collected from juvenile gray whales that were taken off their Arctic feeding grounds in the western Bering Sea during a Russian subsistence harvest. Blubber biopsy samples that were taken from gray whales off the California and Washington coasts were also analyzed for OCs; previously we measured these contaminants in tissues and stomach contents of gray whales that stranded along the U.S. west coast and Alaska. There were no differences in the concentrations (based on wet weight of tissue) of contaminants between female and male subsistence animals. The lipid content [48 (5)%] of blubber for animals from the Arctic feeding grounds was higher than that in the biopsy samples [9.4 (0.8)%] from free-ranging, apparently healthy whales. Concentrations on a lipid basis of the sum of polychlorinated

biphenyls (∑PCBs) in the juvenile stranded whales and the juvenile subsistence whales were significantly different [19,000 (14,000) and 680 (67) ng/g lipid, respectively]. The mean concentration of the ∑PCBs for the biopsy samples was 2,000 (280) ng/g lipid weight. We hypothesize that the higher concentration of ∑PCBs in the stranded animals may be due to the retention of OCs in blubber during fasting rather than to increased exposure to these contaminants. The concentrations of certain trace elements (e.g., cadmium) is some tissues, such as kidney, were also elevated in the stranded animals. Moreover, aluminum in stomach contents and tissues of the subsistence whales was high compared to other marine mammal species, which is consistent with the ingestion of sediment during feeding.

Agenda Section 4.2
4.3

POTENTIAL IMPACT OF OFFSHORE HUMAN ACTIVITIES ON GRAY WHALES

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Moore, S.E., and J.T. Clarke. In press. Potential impact of offshore human activities on gray whales. J. Cetacean Res. Manage. Special Issue 2.

Gray whale (*Eschrichtius robustus*) reactions to offshore human activities have been relatively well studied compared to those of other mysticetes. Studies of short-term behavioural responses to underwater noise associated with aircraft, ships and seismic explorations indicate a 0.5 probability that whales will respond to continuous broadband noise when sound levels exceed *ca*. 120dB[2] and to intermittent noise when levels exceed *ca*. 170dB, usually by changing their swimming course to avoid the source. Gray whales 'startled' at the sudden onset of noise during playback studies, but demonstrated a flexibility in swimming and calling behaviour that may allow them to circumvent increased noise levels. Whales may be 'harassed' by noise from large commercial vessels, especially in shipping lanes or near busy ports. Gray whales sometimes change course and alter their swimming speed and respiratory patterns when followed by whalewatching boats. Conversely, some whales swim toward small skiffs deployed from whalewatching boats in breeding lagoons, seemingly attracted by the noise of idling outboard engines. Reported gray whale reactions to aircraft are varied and seem related to ongoing whale behaviour and aircraft altitude. Whale response to research involving tagging and biopsy sampling appears to be short term. Gray whales were seen swimming through surface oil from the *Exxon Valdez* oil spill along the Alaskan coast and showed only partial avoidance to natural oil seeps off the California coast. Laboratory tests suggest that gray whale baleen, and possibly skin, may be resistant to damage by oil, but spilled oil or oil dispersant in a primary feeding area could negatively affect gray whales by contaminating benthic prey. Gray whales are sometimes injured or killed in collisions with vessels or entanglement in fishing gear. Concern about the cumulative long-term impact of offshore human activities is particularly acute in the Southern California Bight, where many activities are often concurrent.

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[2]dB re 1 μPa.

Agenda Section 4.3

BIO-ACOUSTICS OF THE GRAY WHALE (*ESCHRICHTIUS ROBUSTUS*)

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Dahlheim, M.E. 1988. Bio-acoustics of the gray whale (*Eschrichtius robustus*). Ph.D. Thesis, University of British Columbia. xiii+266 p.+appendices.

Gray whales (*Eschrichtius robustus*), while engaged in underwater signalling, circumvent noise in the acoustical channel by the structure and timing of their calls. Data yielding this conclusion were collected during an acoustical study on gray whales and their habitats (1981-84). Sonographic analyses of tape recordings were used to quantify the acoustical repertoire, the ambient noise characteristics of the area, and the relationship between the animals' calls and the environment. The acoustical responses of whales to artificially increased levels of noise were documented during playback experimentation in Mexico. Nine sound parameters were inspected and compared between control and experimental conditions: calling rates, call types, frequency range of signals (Hz), emphasized frequencies (Hz), received levels of sounds (dB re 1 μPa), call duration (sec), percentage of calls exhibiting frequency modulation, number of pulses per series, and repetition rates of signals. The observed surface behavior of gray whales in response to noise (i.e., dive durations, movements and abundance) was also investigated. Analyses yielded: a description of gray whale call types; a characterization of the acoustical habitats occupied by this species, including a list of sources contributing to the ambient noise and a profile of the propagation characteristics of the study area; a determination of the relationship between whale calls and their habitats; and the acoustical capabilities and strategies of whales in response to noise. The plasticity observed in the overall behavior of this whale is of adaptive significance when considering the dynamic nature of noise in the environment. Typically, the multiple strategies employed by the whales when faced with various noise situations enable them to minimize the detrimental effect that noise has on their underwater signalling. Gray whale responses varied with the sound source and may also differ relative to the geographical range and/or general behavior of the animal. It is concluded that ambient noise (both natural and man-made) has a profound effect on the behavior of this coastal species and that acoustical calling is modified to optimize signal transmission and reception.

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Agenda Section 4.4

GRAY WHALE ENTANGLEMENTS IN CALIFORNIA, OREGON/WASHINGTON, AND ALASKA, 1990-98

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Hill, P.S. 1999a. Gray whale entanglements in California, Oregon/Washington, and Alaska, 1990-98. 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.

Total number of entanglements reported during 1990-98 along the west coast of the United States (values in parentheses indicate known mortalities and reports in which the status of the whale is unknown)

	1998	1997	1996	1995	1994	1993	1992	1991	1990
CA	4[1] (2)	6[1] (5)	5[2] (4)	4 (1)	4[2] (4)	1 (0)	4 (3)	4 (3)	5 (5)
OR/WA	0	0	0	2 (2)	0	0	0	1 (0)	2 (1)
AK	3 (3)	1 (1)	0	1 (0)	0	0	0	0	0
Total	7	7	5	7	4	1	4	5	7

Data provided by J. Cordaro (SWR), B. Norberg (NWR), and M. Sternfeld (AKR).
[1]May include 2 sightings of the same entangled whale.
[2]Includes an unidentified whale that was most likely a gray whale.

Agenda Section 4.5

A REPORT TO THE MARINE MAMMAL COMMISSION ON PROPOSED SALT PRODUCTION FACILITIES AT SAN IGNACIO LAGOON BAJA CALIFORNIA

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Mate, B.R. 1995. A report to the Marine Mammal Commission on proposed salt production facilities at San Ignacio Lagoon, Baja California. Unpubl. report to U.S. Marine Mammal Commission, Washington, D.C. 13 p.

Exportadora de Sal, sometimes referred to as ESSA, has been a business partnership between Mitsubishi, Japan (49%), and Mexico (51%) since 1954. It operates a salt production facility at the town of Guerrero Negro, midway along the Pacific Coast of Baja California. It is the world's largest solar evaporative operation and produces 6.5 million metric tons of salt per year from the adjacent Laguna Ojo de Liebre. ESSA is planning to expand its operation to San Ignacio Lagoon.

Laguna Ojo de Liebre and San Ignacio Lagoon are both in the Vizcaíno Desert Biosphere Reserve, Mexico's largest refuge administered by Secretaria de Desarrollo Social (SEDESOL), the Secretariat of Social Development. An Environmental Impact Assessment was completed in July 1994 and was reviewed by SEDESOL. The application was either denied or withdrawn in March 1995.

This report summarizes the activities of the current operation and the proposed activity based on interviews with company officials in January 1995 and a review of the Environmental Impact Assessment.

Agenda Section 4.5
4.6

CONSERVATION AND DEVELOPMENT IN THE GRAY WHALE LAGOONS OF BAJA CALIFORNIA SUR, MEXICO

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Dedina, S., and E. Young. 1995a. Conservation and development in the gray whale lagoons of Baja California Sur, Mexico. Final report to U.S. Marine Mammal Commission, Washington, D.C. NTIS PB96-113154. iii+56 p.

In this report we identify ongoing and possible future development and related activities that could have a negative impact on two of the three main calving/breeding habitats for the eastern North Pacific gray whale (*Eschrichtius robustus*) population in Baja California Sur, namely Laguna San Ignacio and Bahía Magdalena. We also identify steps that are being or could be taken to assess and to prevent or minimize activities that may have adverse effects. We provide: 1) a brief summary of the natural history, exploitation, protection, and current status of the gray whale population in Mexico; 2) a description of the physical and human geography of the study area; 3) a history of environmental conservation efforts in the study area; 4) an overview of the environmental management structure in the study area and the environmental impact review process in Mexico; 5) descriptions of past, existing, and planned development and commercial activities in the study area; and 6) descriptions of impediments to effective assessment and control of activities with potentially adverse impacts and possible means to strengthen current gray whale conservation.

This study is based on field research undertaken in Laguna San Ignacio and Bahía Magdalena. We also conducted background research and interviews in San Diego, California, La Paz, Baja California Sur, and Mexico City. The research included: 1) open-ended and semi-structured interviews with local residents, government officials and others with knowledge of the area and matters of interest or concern to this study; 2) participant observation of local residents' activities; 3) a review of archival sources on the history of the study area and gray whale conservation; and 4) a review of newspaper coverage of issues related to gray whale conservation in Baja California Sur. This enabled us to compare actual use and management of gray whale habitats with: how government officials think these areas are and should be used and managed; and how different user groups in the study area view regulations of their activities for gray whale habitat management.

Laguna San Ignacio is the only primary gray whale breeding/calving area in Mexico that remains superficially unaltered. In contrast, portions of Bahía Magdalena have been changed by industrial and mining activities, as well as part of the Vizcaíno Biosphere Reserve. Bahía Magdalena remains unprotected.

Three federal agencies are responsible for on-site protection of gray whales and regulation of human activities in Laguna San Ignacio and Bahía Magdalena. These are the National Institute of Ecology (INE), the Federal Attorney General's Office for Environmental Protection (PROFEPA), and the Secretariat of Fisheries (Pesca).

The greatest potential threats to the whales and their habitat are from: 1) the proposed development of a 52,150 ha salt production facility on the shore of Laguna San Ignacio; 2) a proposed tourist resort development at Bahía Magdalena; and 3) the growth of gray whale tourism in the North Zone of Bahía Magdalena. Strict review and monitoring of development and whale-tourism by INE, PROFEPA, and Pesca under existing environmental impact assessment regulations, and the review of project plans and tourism activities by non-governmental organizations, research institutions, and scientists familiar with gray whale habitat, could help to minimize potentially adverse impacts.

Agenda Section 4.5

SAN IGNACIO SALTWORKS: SALT AND WHALES IN BAJA CALIFORNIA

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SEMARNAP (Secretaria de Medio Ambiente, Recursos Naturales y Pesca). 1997. San Ignacio saltworks: Salt and whales in Baja California. 25 p.

The desert-like central region of the Baja California peninsula has characteristics that are unique in the world. One notable facet of its rich wildlife is that some of its coastal waters are winter sanctuaries where the gray whale reproduces. A significant area of this region was declared a Biosphere Reserve in 1988 (El Vizcaíno, the largest in the country: more than two and a half million hectares).

In 1994, a company (Exportadora de Sal, S.A. de C.V.) entered into negotiations with the environmental authorities to considerably expand its salt extraction and marketing activities within the Reserve's buffer zone. In 1995, owing to insufficiencies in the Statement of Environmental Impact (MIA, acronym in Spanish), the authorities denied the corresponding permit. In view of the company's wish to reopen negotiations for the project, and in order to address the unusual complexity of the analysis, the authorities established a Scientific Committee made up of seven distinguished specialists of different nationalities. This Scientific Committee was entrusted with specifying the terms of reference necessary for a new MIA (July 1996). Mexico's environmental authorities also pledged to submit to the consideration of the Committee any new MIA that might be presented, and to respect its opinion in any decision taken. The establishment of such a significant Scientific Committee and its public performance in assessing environmental impact is without precedent in this country, and possibly in Latin America.

To date, no proposal based on the rigorous terms of reference agreed upon has yet been received.

Irrespective of the economic importance of the project, the Government of Mexico will not authorize any proposal that runs counter to current regulations and that could jeopardize conservation of the region's natural resources, and in particular, its biological richness, which is the heritage of all Mexicans.

Agenda Section 4.71

DESCRIPCIÓN Y DESARROLLO DE LAS ACTIVIDADES TURÍSTICAS DE OBSERVACIÓN DE BALLENA GRIS EN LAS LAGUNAS DE LA RESERVA DE LA BIOSFERA "EL VIZCAÍNO" Y BAHÍA MAGDALENA, BAJA CALIFORNIA SUR, MÉXICO, TEMPORADAS 1996 Y 1997

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Sánchez Pacheco, J.A. 1997a. Descripción y desarrollo de las actividades turísticas de observación de ballena gris en las lagunas de la reserva de la Biosfera "El Vizcaíno" y Bahía Magdalena, Baja California Sur, México, temporadas 1996 y 1997. [Description and development of tourist gray whale watching activities in the lagoons of the biosphere reserve "El Vizcaíno" and Magdalena Bay, Baja California Sur, Mexico, during the 1996 and 1997 seasons.] Boletín Pesquero CRIP-La Paz 7:8-18.

A description is given of the development and monitoring of gray whale watching in the lagoons of the biosphere reserve "El Vizcaíno" and Magdalena Bay in 1996 and 1997. Described are the operations of the tourist industry in each lagoon, the observation time, the number of vessels involved, and an analysis of the demand for services. The above is discussed in light of the rules that regulate whale watching activities in Mexico. The 4 lagoons were visited by 23,971 tourists to whale watch in 1996 and 28,484 in 1997. This activity was estimated to generate a total of $321,590 in 1996 and $453,300 in 1997 for whale watching trips alone. An estimation of the economic activity generated included all services and expenses incurred by tourists at their whale watching destination and while traveling.

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Agenda Section 4.72

DETERMINACION DE LA CAPACIDAD DE CARGA EN TERMINOS DEL NÚMERO MÁXIMO SIMULTÁNEO DE EMBARCACIONES EN LAGUNA OJO DE LIEBRE Y LAGUNA SAN IGNACIO AREAS DE OBSERVACIÓN DE BALLENA GRIS EN BAJA CALIFORNIA SUR, MÉXICO

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Sánchez Pacheco, J.A. 1997b. Determinacion de la capacidad de carga en terminos del número máximo simultáneo de embarcaciones en Laguna Ojo de Liebre y Laguna San Ignacio areas de observación de ballena gris en Baja California Sur, México. [Determination of the carrying capacity in terms of maximum simultaneous number of vessels in the Ojo de Liebre Lagoon and San Ignacio Lagoon gray whale observation areas in Baja California Sur, Mexico.] Boletín Pesquero CRIP-La Paz 7:19-25

The change in the direction of movement of whales is considered an indicator of disturbance. A procedure was defined to estimate the Maximum Simultaneous Number (NMS, acronym in Spanish) of vessels that can watch whales in an area without disturbing more than 50% of them. In this procedure, vessels followed selected whales, while observers recorded whale reactions and the distance between the vessel and disturbed whales. The procedure was applied in Ojo de Liebre Lagoon and San Ignacio Lagoon during 1995. The NMS was 6 vessels in each of two areas in Ojo de Liebre Lagoon and 13 vessels in San Ignacio Lagoon.

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Agenda Section 4.8

GRAY WHALE STRANDINGS IN CALIFORNIA, OREGON/WASHINGTON, AND ALASKA, 1990-98

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Hill, P.S. 1999b. Gray whale strandings in California, Oregon/Washington, and Alaska, 1990-98. 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.

Total number of strandings (excluding dead stranded whales in which the cause of death was due to entanglement) reported during 1990-98 along the west coast of the United States

	1998	1997	1996	1995	1994	1993	1992	1991	1990
CA	30	9	10	12	15	11	14	15	9
OR/WA	3	3	3	8	3	2	3	13	13
AK	1	0	0	1	4	14[1]	13[1]	14[1]	27[1]
Total	34	12	13	21	22	27[1]	30[1]	42[1]	49[1]

Data provided by J. Cordaro (SWR), B. Norberg (NWR), and M. Sternfeld (AKR).

[1]1990-93 data for Alaska include 26, 12, 12, and 13 whales, respectively, seen during aerial surveys. Thus, the 1990-93 data are not comparable to the data collected during 1994-98.

Agenda Section 4.8

GRAY WHALES STRANDED IN MEXICO, 1975-99

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Pérez-Cortés Moreno, H. 1999. Gray whales stranded in Mexico, 1975-99. 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.

Location/year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Baja California	-	-	-	-	-	-	-	-	-	-	-	1	-
Guerrero Negro Lagoon	-	-	-	-	-	8	4	2	-	*	*	*	*
Outer Beach (Vizcaíno Bay)	4	-	-	-	-	23	10	21	3	*	*	*	*
Ojo de Liebre Lagoon	16	-	-	-	4	16	-	12	13	10	7	6	11
San Ignacio Lagoon	-	-	4	7	5	6	6	4	10	5	-	-	-
Outer Beach (San Ignacio area)	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahía Magdalena	-	1	-	1	-	-	-	6	-	1	-	-	-
Outer Beach (Magdalena area)	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf of California	-	-	-	-	-	-	-	1	1	-	1	1	1
Total	20	1	4	8	9	53	20	46	27	16	8	8	12

Gray whales stranded in Mexico, 1975-99 (continued).

Location/year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	**Total**
Baja California	-	-	-	-	-	-	1	-	-	-	-	-	2
Guerrero Negro Lagoon	*	*	*	*	*	*	*	*	-	-	1	3	18
Outer Beach (Vizcaíno Bay)	*	*	*	*	*	*	*	*	-	-	1	28	90
Ojo de Liebre Lagoon	12	21	16	45	22	8	5	13	-	-	1	40	278
San Ignacio Lagoon	-	3	-	-	-	-	-	-	3	7	3	5	68
Outer Beach (San Ignacio area)	-	-	-	-	-	-	-	-	-	-	-	5	5
Bahía Magdalena	-	-	-	-	1	-	-	-	-	1	1	20	32
Outer Beach (Magdalena area)	-	-	-	-	-	-	-	-	-	0	0	11	11
Gulf of California	1	6	-	-	-	-	-	-	-	-	-	2	14
Total	13	30	16	45	23	8	6	13	3	8	7	114	518

Data are as available from 1975 to 16 June 1999. Dashes indicate no data are available. Asterisks indicate that data from Guerrero Negro Lagoon and Vizcaíno Bay are summarized with the data for Ojo de Liebre Lagoon for the respective years.

Data Sources:

Heyning and Dahlheim (in press).
Sánchez Pacheco (1998).
Urbán et al. (1998a).
Unpublished data, Instituto Nacional de la Pesca, CRIP.

Agenda Section 4.8

GRAY WHALE MORTALITY AT OJO DE LIEBRE AND GUERRERO NEGRO LAGOONS, BAJA CALIFORNIA SUR, MEXICO: 1984-1995

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Sánchez Pacheco, J.A. 1998. Gray whale mortality at Ojo de Liebre and Guerrero Negro lagoons, Baja California Sur, Mexico: 1984-1995. Mar. Mammal Sci. 14(1):149-155.

During a study of gray whale strandings at Ojo de Liebre and Guerrero Negro lagoons, conducted from 1984 to 1995, a total of 191 whales was found. Length was determined for 176 whales, sex was determined for 146, and time of death was estimated for 117. Common stranding locations within and adjacent to the lagoons were identified. Most (77%) of the calf mortality occurred between 15 January and 15 February. Stranded whales were divided into three size/age classes based on the frequency distributions of their lengths: calves (3.4 to 6.5 m, $\bar{x}$ = 4.63), yearlings (6.6 to 9.5 m, $\bar{x}$ = 8.13), and 2 years and older (9.6 to 14.2 m, $\bar{x}$ = 11.94). During 1990-1992, an extraordinary number of whales 2 years and older stranded in the study area, with a maximum of 37 in 1991. Differences in the average lengths between female and male neonates and yearlings were not statistically different, but females were longer than males at two years and older. It was possible to determine causes of death in only a few cases.

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Agenda Section 4.9

GRAY WHALE SHIP STRIKES IN CALIFORNIA, OREGON/WASHINGTON, AND ALASKA, 1990-98

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Hill, P.S. 1999c. Gray whale ship strikes in California, Oregon/Washington, and Alaska, 1990-98. 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.

Total number of vessel strikes reported during 1990-98 along the west coast of the United States (values in parentheses indicate known mortalities and reports in which the status of the whale is unknown)

	1998	1997	1996	1995	1994	1993	1992	1991	1990
CA	3 (2)	0	0	3 (1)	n/a	n/a	n/a	n/a	n/a
OR/WA	0	0	0	0	0	0	0	0	1
AK	0	1 (1)	0	0	0	0	0	0	0
Total	3	1	0	3	-	-	-	-	-

Data provided by J. Cordaro (SWR), B. Norberg (NWR), and M. Sternfeld (AKR).
n/a indicates that data are incomplete for that year.

Agenda Section 5.1
5.2

RECORDS OF HARVESTED GRAY WHALES

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Quan, J. 1999. Records of harvested gray whales. 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.

Level of aboriginal harvest: In 1997 the International Whaling Commission set an aboriginal subsistence quota. A total of 620 gray whales, not to exceed 140 annually, may be taken over the years 1998-2002.

5.1) **Russian take:** Over the years 1998-2002 the Russian Federation has agreed to take no more than 135 whales annually. From 1970 to 1998 an average of 139 gray whales were taken annually (Table 1).

5.2) **Alaskan take**: Currently there are no allocations for a gray whale harvest by Alaskan Natives and none have been in place since 1991. An incidental take of two gray whales by Alaskan Natives occurred in 1995 (Table 1).

Table 1 (Continuation of Agenda Sections 5.1 and 5.2). Numbers of Eastern North Pacific gray whales harvested (including whales that were lost) between1970 and 1998. Parenthetic numbers in the USSR/Russia column indicate alternate counts from other sources.

Year	USSR/Russia		USA	Totals
1970	146 [1,2,3]		5 [4]	151
1971	150 [1,2,3]		3 [4]	153
1972	181 [1,2,3]		1 [4]	182
1973	178 [1]	(173) [2,3]		178
1974	181 [1,2,3]		3 [4]	184
1975	171 [1,2,3]			171
1976	165 [1]	(163) [2,3,5]		165
1977	186 [1,2,3]		1 [4]	187
1978	182 [1,2,3]		2 [4]	184
1979	178 [1,2,3]		4 [4]	182
1980	179 [1,2,3]		3 [4]	182
1981	136 [1]	(135) [2,3,6]		136
1982	165 [1,2,3]		4 [6]	169
1983	169 [1]	(168) [2,3]	2 [7]	171
1984	169 [1,2,3]			169
1985	169 [1,2,3]		1 [8]	170
1986	169 [1,2,3]		2 [9]	171
1987	158 [1]	(154) [2,3]		158
1988	150 [1,2,3]		1 [10]	151
1989	179 [1,2,3]		1 [11]	180
1990	162 [1,2,3]			162
1991	169 [1,2,3]			169
1992	0 [12]	(169) [2]		0
1993	0 [2,3,12]			0
1994	44 [2,3]	(42) [13]		44
1995	90 [2,3]	(85) [14]	2 [15]	92
1996	43 [2]	(38) [3]		43
1997	79 [16]			79
1998	122 [17]			122

[1]Ivashin (in press): Table 2.
[2]Russian Federation (1997): Table 3; the number reported in 1992 (169) was later found to be inaccurate (see IWC 1995).
[3]Blokhin (in press d).
[4]Marquette and Braham (1982).
[5]IWC (1979).
[6]IWC (1984).
[7]IWC (1985).
[8]IWC (1987).
[9]IWC (1988).
[10]IWC (1990).
[11]IWC (1991).
[12]IWC (1995).
[13]IWC (1996).
[14]IWC (1997a).
[15]IWC (1997b).
[16]IWC (1999b).
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Agenda Section 5.3

MAKAH WHALING

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Gearin, P. 1999. Makah whaling. 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.

The Makah Indian Tribe received a five-year quota from the International Whaling Commission (IWC) in 1997 to harvest 20 gray whales for ceremonial and subsistence purposes. The Tribe may harvest up to five gray whales per year from 1998 through 2002 with no more than 33 strikes. The IWC approved a combined 5-year quota of 620 gray whales for aboriginal subsistence whaling by U.S. and Russian aboriginals based on the aboriginal needs statement from each country. The U.S. government requested the quota on behalf of the Makah Tribe in acknowledgment of the Makah's explicit treaty right to whaling (Treaty of Neah Bay, 1855). The NMFS-Northwest Regional Office will monitor the hunt and work with the tribe to ensure that the hunt is conducted within IWC guidelines. In accordance with an agreement between NOAA and the Makah Tribe, the Makah whalers will limit their hunting to the Pacific Ocean areas to the west of the entrance of the Strait of Juan de Fuca. The Makah hunt has no commercial aspects; the meat will be used only for local consumption and will not be sold. The Makah Tribe will use traditional methods of harvest including use of a cedar canoe and hand-thrown harpoon. However, to ensure humaneness of the hunt, the tribe will use a .50-caliber rifle to dispatch the whale. Makah whalers struck and killed one gray whale on 17 May 1999 (Gosho[14]).

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