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Changes in the Eastern North Pacific Gray whale Population Status: Monitoring a "Sentential" Population

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SUMMARY POINTS

- The eastern North Pacific (ENP) gray whale population recovered from post-commercial whaling depletion, and NOAA removed the population from the Endangered Species Act's (ESA) List of Threatened and Endangered Species in 1994.

- In 1997 the population was estimated to be approximately 26,000 animals.

- During 1999-2000 the population suffered an unusual and significant mortality event across all age and sex classes and throughout its entire geographic range.

- The 2000/2001 census estimate indicated that the population had declined to approximately 18,000 individuals, or a 30% decrease in population size since 1997.

- Censuses of annual calf production also show declines from 4-6% during the period 1994-1998 to less than 1.8% of the population in 1999.

- Counts of gray whales utilizing the winter breeding lagoons in Baja California at the peak of the reproductive season has declined by 50% since the 1980's, and counts of newborn calves in the lagoons have declined by 73%.

- Historical feeding areas in the Bering and Chukchi Seas have been disrupted by ongoing ocean regime shifts associated with Arctic climate change, and gray whales are foraging in alternative areas on alternative prey species.

- Observations of "skinny" whales suggest that some gray whales are experiencing stress and declining health possibly related to resource limitation and/or disease, especially in the winter breeding lagoons.

BACKGROUND

The eastern North Pacific (ENP) stock of gray whale was the first and only marine mammal population to date removed from the List of Endangered and Threatened Wildlife. The delisting officially occurred in June 1994 (NOAA 2004). Following the delisting a five year research and monitoring program was implemented by NOAA Fisheries Service, as required under the U.S. Endangered Species Act. During this time, the primary research activities involved estimating total abundance, trends in total abundance, and calf production based on the results of surveys conducted during the southbound and northbound migrations. The two surveys of southbound migrating whales conducted during the 5 year period following delisting indicated that the population was still growing and that the population, as of 1997, included approximately 26,000 animals. During this same time period, surveys of northbound migrating whales were conducted annually to estimate calf production. Calf production varied between 4-6% (i.e., 800 - 1400 calves) of total abundance between 1994 and 1998 (Rugh *et al.* 2005).

In 1999, the total number of stranded animals increased dramatically throughout the ENP gray whales' range from a relatively constant long-term average (Le Boeuf *et al.* 2000). For example, in California 38 gray whales were reported stranded compared to a yearly average of 15 strandings. The total number of strandings reported in 1999 was 273 animals. This is an increase of over 500% from the long-term average. In 2000, strandings increased to over 350 and estimated calf production for the eastern population continued to decline. Population abundance estimated from counts of southbound animals in 2000/2001 (18,246 whales) and 2001/2002 (16,848 whales) suggesting a possible 35% decline since the estimate from 1997 (Fig. 1). Calf production in 1999 dropped below 3% for the first time (i.e., in 1999, calf production was estimated to equal 1.8% of total abundance) (Perryman *et al*. 2002).

The numbers of gray whales observed and counted in the southern breeding and calving lagoons of Baja California, Mexico showed a steady decline throughout this period. During the 1980's, up to 400 adult whales and 140 calves of the year were counted in Laguna San Ignacio during the peak of the reproductive season in February (Urban *et al.* 1996, Urban *et al*. 2002). By 1996 this had dropped to 200 adult whales and 90 calves, and by 2007 only 217 adult whales and only 20 calves were counted (Urban *et al.* 2007). This was the lowest mid-February calf count in the 29-year history that such counts have been recorded.

In addition, researchers in Laguna San Ignacio photographed gray whales that appeared to be "skinny" or suffering from nutritional stress and/or possible disease (Urban *et al.* 2007). These symptoms varied among individuals but included at least one or more of the following diagnostic features: (1) an obvious sub-dermal protrusion of the scapulas from the body with associated thoracic depressions at the posterior and anterior insertion points of the flipper; (2) the presence of noticeable depressions on concavities around the blowholes and head; and (3) a pronounced ridge along the neural/dorsal spine of the lumbar and caudal vertebrae resulting in the appearance of a "bulge" along the lateral flank (Weller 2000; Brownell and Weller 2001) (Figs 1-3).

Our preliminary hypotheses as to the contributing cause(s) of these changes in the ENP gray whales are focused on the relationship between population abundance and carrying capacity of the eastern north Pacific marine ecosystem. These include recognition of the impacts of climate change on a wide range of living marine resources, especially gray whale prey species, and exposure to new disease vectors associated with switching to alternative prey species (Moore et al. 2001). It appears likely that this gray whale population is now responding to changing environmental conditions over several time and spatial scales.

<u>Prey resources:</u> Gray whales from the eastern Pacific population historically fed primarily on benthic invertebrates organisms (e.g., amphipods) in the Arctic (Grubemeyer 1989). During the summer months, large numbers of gray whales were previously found feeding on amphipods once in high densities on a region just north of the Bering Straits (Moore et al. 2003). These formerly rich feeding grounds support less than 10% of their previous biomass and gray whales have been forced to range farther during the summer months and to feed on different prey (Grubemeyer *et al*. 2006, Moore *et al.* 2007). While we don't know the specific impacts this shift in diet and feeding grounds is affecting this population, there is evidence from "shinny" whales that nutritional stress and possibly disease are operating to limit individual reproduction and population productivity.

Calf production: There may be at least two factors impacting calf production in this population. Surveys of northbound calves conducted from the Piedras Blancas Light Station have fluctuated broadly over the 14 year survey period from 1994 to the current season. Roughly 80% of this variability in calf production can be predicted based on the temporal and spatial distribution of seasonal ice in the Arctic. While the short term variability can be explained by ice distribution, the overall calf production figures indicate that there have only been enough calves produced to replace normal adult mortality (if we assume it is somewhere between 5 and 6%) in 4 or the 14 years of survey effort. Clearly we are seeing a change from the two year calving intervals that were reported in the past for this population. Certainly the drop in abundance in prey on historical feeding grounds and shifts to other prey are likely causal factors contributing to this change. Similar declines in the number of calves born each year have been documented in the breeding lagoons of Baja California (Swartz et al. 2007)

Mortality rates: The dramatic increase in observed mortality and drop in abundance during the late 1990s appear linked to a major El Nino/La Nina event (Philander 1990)which began in 1998 (LeBoeuf et al. 2000, Urban *et al*. 1999). It appears that while climate change has lead to an overall warming of the region and reductions in ice cover and benthic prey, possibly the root cause of the shift in prey selection for gray whales, the major reflection of this habitat shift, may be an increased sensitivity to short term climate events compounded by a longer-term decline in the prey base the north Pacific marine ecosystem can provide.

Population decline: The preliminary analysis of the 2006/2007 abundance survey indicates little change in gray whale abundance since the 2000-2001 and 2001/2002 censuses (Rugh et al. 2007). Currently, there is no clear explanation for the apparent 35% drop in abundance between 1996/1997 and 2000/2001 censuses. It is not known how extensively the shift in prey is affecting population condition (e.g., "skinny whales" observed in the breeding lagoons), and we can't predict how continued ocean warming and prey shifting will impact reproduction and survival in this population over the long-term. Weller *et al*. (2000) and Brownell and Weller (2001) note that some "skinny" western North Pacific gray whales that were pregnant returned to their summer feeding areas with apparently healthy calves, suggesting that "skinnyness" may not be a fatal condition, but perhaps the result of diminished but a tolerable reduction I nutritional resources. Such resource limitation could reduce the ability of female gray whales to bring calves to term, and this could reduce overall production rates within the population (Brownell and Weller 2002)

Population Monitoring: While ENP gray whales appear to be integrating the impacts of short and long term climate factors and resource limitation, their population appears to continue to decline from its peak abundance in the mid 1990s.

These gray whales are unique among cetaceans and well suited for monitoring because they migrate close to shore each fall past Central and Southern California to their Baja California, Mexico breeding lagoons where they gather within the lagoons in significant numbers. These near-shore migrations and tendencies to gather in the coastal lagoons of Baja California make them available for observation and monitoring at fraction of the cost of similar population monitoring surveys in the Arctic. In addition, the long time series of annual abundance estimates from the census of the southbound fall migration and counts of calves during the spring northward migration provide the frame work for examining the impacts on the ENP gray whale population of both long and short term environmental factors. As such, gray whales are key "indicators" or "sentinel" species that can inform on the health and status of the north Pacific ecosystem.

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Figure 1. Estimates of the gray whales in the eastern North Pacific population based on visual census of the fall migration past the Granite Canyon, California observation station between 1967/1968 to 2001/2002 (from Rugh *et al.* 2005).

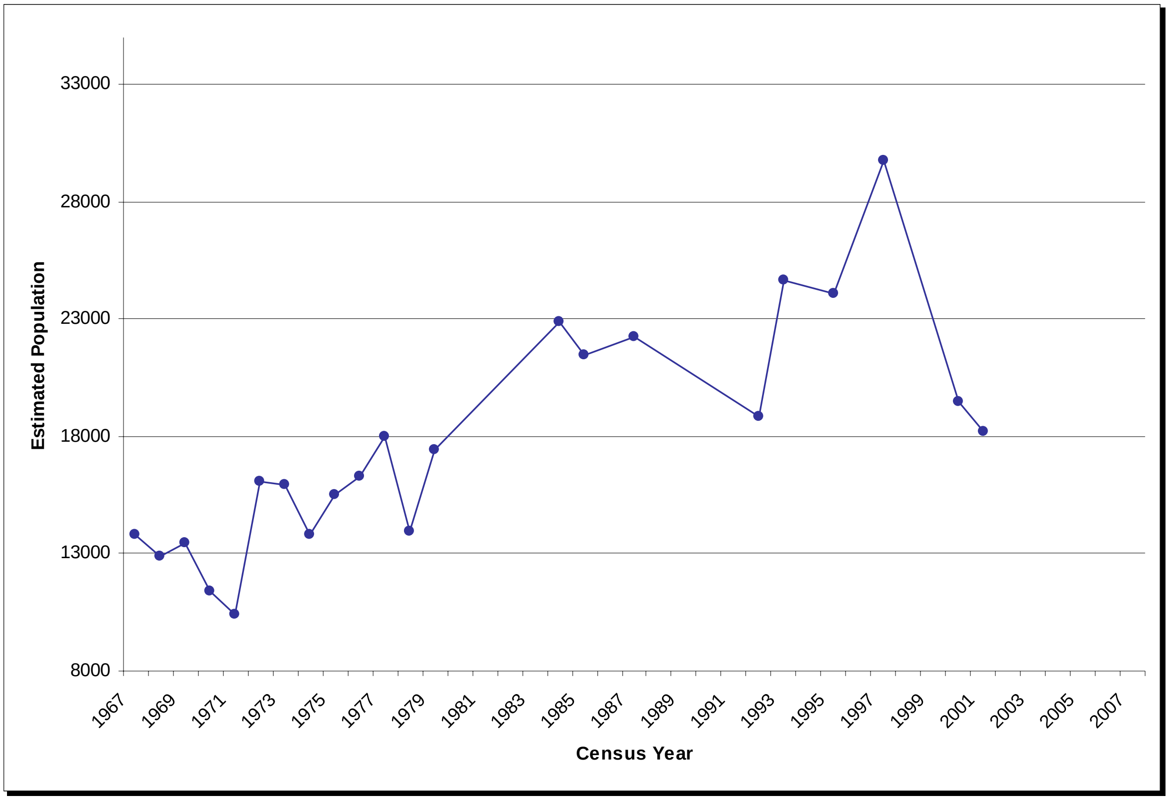

Figure 2. Number of adult whales counted in census surveys of Laguna San Ignacio between 1978 and 2007. Black diamonds = 1978-1982 surveys; White circles = 1996-2006 surveys; White squares = 2007 survey counts. Day 1 = 4 January; day 102 = 15 April.

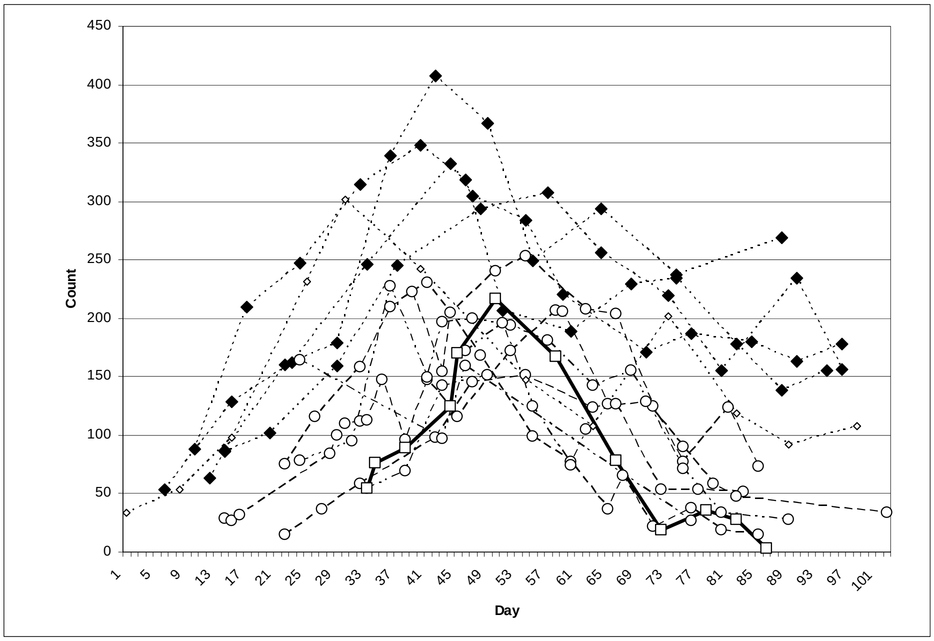

Figure 3. Example of normal gray whale head, neck and shoulder region.

Figure 4. Example of a “skinny whale” observed in Laguna San Ignacio in 2007showing sub-dermal protrusion of the scapula and concavities around the blowholes and neck.

Figure 5. Example of a “skinny whale” observed in Laguna San Ignacio in 2007 showing concavities along the flank and ridge along the neural/dorsal spine.