LENFEST OCEAN PROGRAM

RESEARCH SERIES

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New study suggests historic Pacific gray whale populations were three to five times larger than previously believed.

HAVE GRAY WHALES RECOVERED FROM WHALING?

A SUMMARY OF NEW SCIENTIFIC ANALYSIS:

Alter, S.E., Rynes, E., and S.R. Palumbi. 2007. "DNA evidence for historical population size and past ecological impacts of gray whales." *Proceedings of the National Academy of Sciences*.

IT CAN BE DIFFICULT to determine when a species once threatened with extinction has recovered. Pacific gray whales were hunted to critically low numbers until the mid-20th century, when they were given protection from commercial whaling by the International Whaling Commission (IWC). Since then, the eastern population of Pacific gray whales along the west coast of the U.S. and Mexico has been increasing in size. Questions remain, however, as to whether this population has reached pre-whaling levels because of uncertainty about historic population counts. A newly published study suggests gray whales may not have fully recovered from whaling because the size gap between historic and current populations is larger than previously estimated.

REGULATION OF PACIFIC GRAY WHALE POPULATIONS

International Whaling Commission (IWC)

- The IWC was set up under a 1946 international agreement among countries to provide for the conservation of whale stocks—the International Convention on the Regulation of Whaling.
- Convention measures that the IWC addresses include:
  - Complete protection of certain species;
  - Whale sanctuaries;
  - Limits on the numbers and sizes of whales caught.
- Since 1986, the IWC has maintained a moratorium on the commerical hunting of all whales.

Marine Mammal Protection Act (MMPA)

- The U.S. Congress passed the MMPA in 1972.
- The purpose is to prohibit, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and their products into the U.S.
- MMPA provisions include:
  - Stock assessments for all marine mammals in U.S. waters;
  - Prevention of species or populations from falling below sustainable levels;
  - Actions to replenish depleted species or populations;
  - Certain exceptions to the prohibitions, such as for Alaska Native subsistence.

Using genetic analysis, Elizabeth Alter, Eric Rynes and Stephen Palumbi found that historic populations of Pacific gray whales could have been three to five times higher than previously believed. Their results, published in 2007 in *Proceedings of the National Academy of Sciences,* suggest that Pacific gray whales could have numbered close to 100,000 individuals pre-whaling, instead of the current average population of 22,000, and probably played a much larger role in the functioning of the Arctic marine ecosystem. This *Lenfest Ocean Program Research Series* report is a summary of these scientists' results.

GRAY WHALE POPULATIONS

Two different populations of Pacific gray whales inhabit the coastal waters of the northern Pacific Ocean (see insert at right). They have one of the longest mammalian migrations in the world and support a sizeable whale-watching industry. The eastern gray whale is the most abundant population of whales along the coast of North America. The western gray whale feeding in Russian waters, however, is one of the most endangered populations of whales in the world, numbering little more than about 100 animals.

Gray whales are marine bulldozers that feed on the sea floor, consuming tube worms, mollusks and small crustaceans. Gray whales are important "ecosystem engineers" because as they feed on the bottom of the ocean, they suck in and expel sediment and water, redistributing large amounts of material. This mode of feeding makes significant quantities of food available for many other kinds of ocean life, including seabirds. The whales are themselves food for predators such as orcas, and for scavengers such as the nearly extinct California condor that once fed regularly on washed up marine mammal carcasses.

Commercial hunting of all Pacific gray whales has been banned by the IWC since 1947, though aboriginal subsistence hunting of eastern Pacific gray whales is still allowed. A total of 620 eastern Pacific gray whales were permitted to be caught through subsistence whaling from 2003–2007, almost all in Siberia, with a maximum of 140 whales in any one year allowed under the IWC catch limits.

The Marine Mammal Protection Act regulates human-caused mortality of Pacific gray whales in U.S. waters, which can be caused by entanglement with commercial fishing gear, ship strikes, and subsistence whaling by indigenous peoples. The Act's regulations currently permit 417 eastern Pacific gray whale deaths per year—the highest percentage allowed for any population of baleen whale. In 2005, however, only about 130 were actually killed. No human-induced western Pacific gray whale deaths are currently permitted because the population is so critically endangered.

Conservation efforts have improved population numbers, but the study's results suggest that eastern Pacific gray whales have not fully recovered.

EASTERN AND WESTERN GRAY WHALE POPULATIONS

Western

- Lives along the coasts of Russia, Japan and China
- Critically endangered—perhaps only 100 individuals left

Eastern

- Lives along the western coast of U.S. and Mexico
- Removed from the U.S. list of threatened and endangered species in 1995

USING GENETICS TO ESTIMATE HISTORIC POPULATION SIZE

Alter and her colleagues used genetic analysis to estimate the pre-whaling size of the Pacific gray whale. Genetic analysis can offer an estimate of population size because a large population should have more genetic variation than a small one (a small population tends to have more inbreeding).

In 2003, Stephen Palumbi and Joe Roman first used this method to estimate historic populations of humpback, fin and minke whales in the North Atlantic. They found that there was far too much genetic variation for a population of 10,000 to 20,000 humpbacks, the number then thought to be the original population size. Instead, levels of genetic variation were high enough to suggest populations of 150,000 or more.

The current analysis of gray whales adds important new tools to the use of genetic variation in estimating past whale numbers. Although the analysis specifically used eastern gray whale genes, genetic similarity across the eastern and western populations allowed an estimate for all Pacific gray whales to be generated. Most importantly, the new research increases the number of different genes sampled tenfold. Each of these separate genes gives an independent view of past population size, so the current work addresses requests of the IWC for independent confirmation of genetic conclusions. The new work also accounts for other sources of extra genetic diversity, such as an ancient migration from an extinct population of gray whales in the Atlantic, and the possible effects of past migrations if the western population were once larger.

Additional recommendations from the IWC to improve historic gray whale population estimates will be pursued by Palumbi and colleagues over the next few years. This includes improving the historic whaling logbook estimates and modeling the genetic and logbook estimates together.

STUDY FINDINGS

- Levels of genetic variation in eastern Pacific gray whales are higher than expected. The results, together with analyses indicating genetic similarity across the two populations, suggest that the historic population size of the entire Pacific gray whale population could have been three to five times the current population, or about 96,000 individuals.
- Gray whales would have had a significant impact on the marine ecosystem in the Pacific Ocean at these population sizes. A population size of 96,000 whales could have resuspended 700 million cubic meters of sediment (as much as twelve Yukon Rivers) and provided food to at least one million seabirds.
- Improving the genetic analysis pursuant to IWC recommendations still led to similar conclusions as prior genetic studies—historic populations of Pacific gray whales were likely much larger than currently estimated.

IMPLICATIONS FOR PACIFIC GRAY WHALE MANAGEMENT

- Eastern Pacific gray whales should be afforded higher protection given their potential historic population levels.
- Based on this study's estimates of past population size, the number of human-induced deaths of the eastern population that are permitted by the U.S. Marine Mammal Protection Act should be decreased by at least half, to 208 whales per year or less.
- Although the western population of the Pacific gray whale is already listed under the U.S. Endangered Species Act, this analysis suggests that the population has decreased even more than originally thought.
- The IWC currently prohibits commercial hunting of Pacific gray whales. This prohibition is consistent with the study's findings that current populations are likely substantially decreased from historic levels.
- Recent newspaper reports show gray whales to be thin and starving. A similar episode in 1999 also led to high adult and calf mortality. If the oceans can not support the current population of 22,000 gray whales but once supported 100,000, then the capacity of the oceans to support all kinds of life may be diminishing. Whether this diminishment is due to global warming, overfishing, pollution, or other factors is an important question for the future.

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A microdocumentary on this research is available at http://microdocs.org.

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Lenfest Ocean Program: Protecting Ocean Life Through Marine Science

The Lenfest Ocean Program brings the best scientific research to bear on identifying the causes, consequences and solutions to problems facing the global marine environment.

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