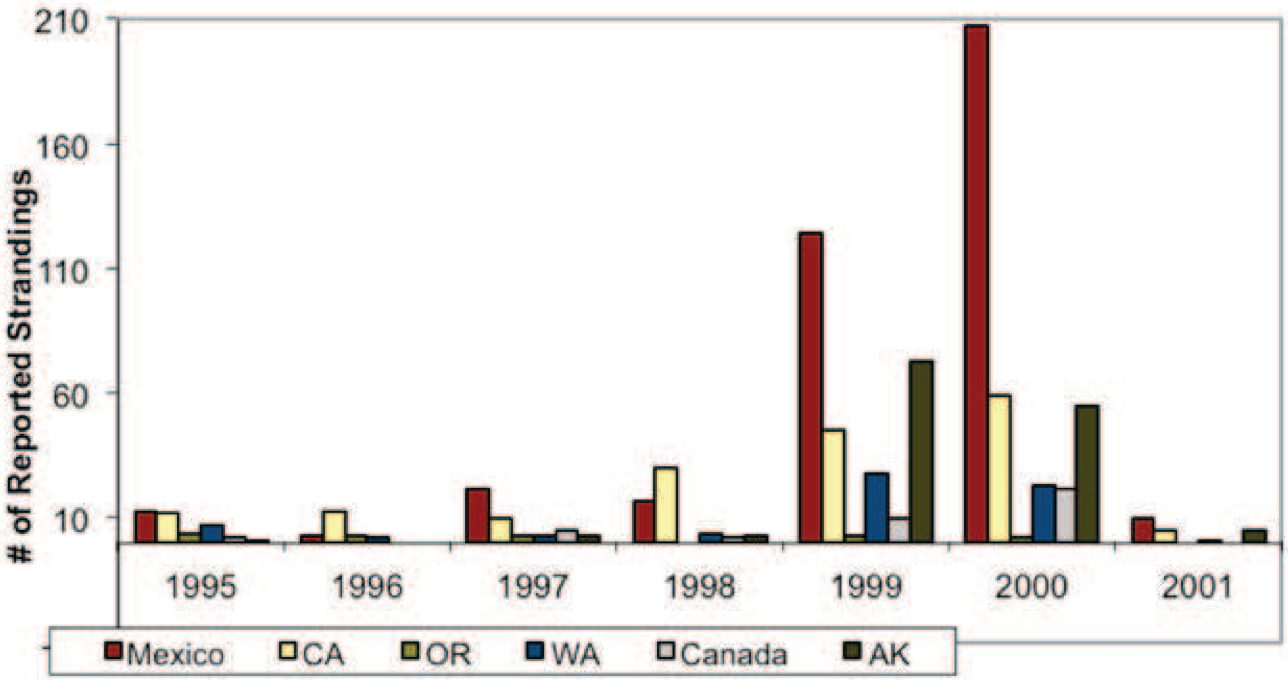
# Gray Whale Strandings, Health Evaluations and an Unusual Mortality Event in 1999-2000

**by Frances Gulland**

Beached and stranded animals offer a rare glimpse into the health status of marine mammals, yet often they raise more questions than they give us answers. For many years, marine mammalogists have advanced knowledge of anatomy, genetics, evolution and life history by examining beached whale carcasses, and now veterinarians are beginning to learn about health and diseases of whales through these strandings. I say “beginning,” as some health changes are easy to detect in a long-dead whale, such as fractured bones resulting from ship strike, or even subtle changes on bone that can result from inflammation, infection or even the “bends.” However, subtleties such as inflamed brain tissue due to encephalitis viruses like West Nile Virus, or dead neurons following biotoxin exposure, are extremely hard to find in stranded whales. This is partly due to the logistics involved in examining a large dead whale and extracting tissues such as brain, but it’s mostly due to the rapid rate of decomposition of soft tissues, making them mostly worthless for detection of morphological changes or infectious diseases unless collected within hours from time of death. Blubber lipid that is useful in other species to assess nutritional status leaks rapidly from the blubber of decomposing whale carcasses, making even basic assessment of nutritional status hard in non-fresh carcasses. Hence, most of what we know about gray whale health from strandings are obvious traumatic changes and we have only a few glimpses that other health problems occur.

*A gray whale apparently killed by a ship collision. This and other photographs in this article courtesy The Marine Mammal Center.*

Stranding records on eastern gray whales have been maintained for decades and show spatial and temporal patterns that reflect their migration along the west coast of North America. Thus most dead calves are observed in Mexico, and adults are found along the coast with ship struck carcasses most common around the ports of Los Angeles, San Francisco and Seattle. The number of gray whales that strand each year along the migration route is small relative to the estimated annual mortality, with total observed annual strandings along the west coast between 1980 and 1995 being rarely more than 10 animals. To date, the most common causes of death identified are ship strikes and entanglements in nets, crab pot lines and other fishing gear.




*Frequency of reported gray whale strandings, 1995-2001, by region.*

**An Unusual Mortality Event**

In 1999 and 2000 the number of gray whale strandings along the west coast of North America increased to approximately six times the annual mean for 1995-1998.

The unusually high number (283) of stranded whales in 1999 convinced the National Marine Fisheries Service to designate the strandings as an "Unusual Mortality Event" (UME). The increase continued in 2000 with 368 carcasses reported. Then in 2001 and 2002, total observed strandings decreased to 21 and 26 animals respectively. Most of the UME strandings occurred in Mexican waters during the breeding season, but increases in all regions except Oregon were significant in 1999 and 2000, with proportionate increases being greatest in Alaska where there was also an increase in survey effort to locate stranded whales. In 1999 and 2000, adults and sub-adults were the most common age classes among stranded animals, whereas between 1995 and 1998, calves were the most common age class. Although there was an apparent difference in the sex composition of the strandings, with females being reported more commonly in 1999 (66%) and males were reported more commonly in 2000 (70%), sex of many carcasses was not determined and aerial surveys biased sex determination in favor of males because their sex is easier to confirm from aircraft.

Two stranded animals in the Alaska region were entangled in fishing gear. There were no confirmed ship strikes in 1999. However, the first vertebra of an animal stranded at Olele Point, Washington on April 24, 1999, was found to have lesions that were possibly due to trauma. In 2000, one whale that stranded in the San Francisco Bay area had parallel cuts of equal length in the dorsal blubber typical of propeller injuries, but this whale was not necropsied fully to determine the extent of the damage.

It is likely that the wounds were ante-mortem as dead whales usually float with the ventral abdomen facing up and are therefore struck by propellers there. A second whale in San Francisco Bay was reported as hit by a tugboat operator, but was not observed stranded (it sank on site) and therefore was not included in this dataset.

Only three UME animals (0.5% of the total) were examined thoroughly and their cause of death determined.

*A dead beached gray whale with apparent propeller wounds.*

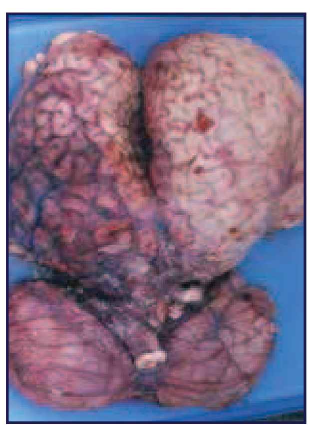
These three whales (two male juveniles and one male yearling) stranded alive and were euthanized due to their poor prognosis for survival. This gave us the opportunity to collect very fresh samples for diagnostic tests. The three euthanized whales had different proximate factors contributing to death. The first animal was a juvenile male that live-stranded in Monterey, California, on May 11, 1999. On gross examination, the animal was deemed severely emaciated based on the protrusion of the vertebrae along the dorsal midline and loss of the fat pad behind the skull.

Ulcers were present along the leading edges of the pectoral fins, and there was a dense infestation of lice and barnacles. The blood vessels of the meninges were distended, and some swelling of the brain cortex was apparent.

Histopathology showed evidence of encephalitis (inflammation of the brain), suggestive of a viral infection, and blood sample collected at euthanasia had antibodies to equine encephalitis virus. Virus isolation was negative for all tissues later examined, which may have been a result of culture conditions.

A second necropsied whale was a yearling male that stranded in Marin County, California, on 26 June 1999. The most notable gross lesions were granulomas in the wall of the entire length of intestine associated with parasitic thorny headed worms, and the stomach was distended with round worm parasites and food material.

A third juvenile whale that stranded alive in Santa Cruz County, California on April 8, 2000 (above) had a ventral blubber thickness of 7cm, depletion of



*Left: A very emaciated gray whale that beached in May, 1999. Center: The excised brain of that whale. Right: Intestinal granulomas caused by thorny headed worms Bulbosoma balanae.*

*A stranded juvenile whale showing signs of malnutrition, as indicated the depressed region behind the skull.*

the granules that store digestive enzymes in the pancreas (both consistent with fasting or starvation), and dark neuronal change in the frontal cortex and the hippocampus of the brain. Domoic acid, a biotoxin from phytopkankton, was detected in serum, urine and feces of this whale.

The proximate cause of death was thus determined in only three of the 651 UME animals and each presented unique etiologies (viral, parasitic, biotoxin). Each of these three animals was emaciated, which may have been a cause or consequence of the disease processes occurring in these animals because malnutrition could result from feeding in unusual sites and acquiring atypical parasites or biotoxins. Malnutrition also can suppress the immune system and increase a whale's susceptibility to infectious disease. As most of the whales were not examined thoroughly, no evidence is available for the actual cause of death of most of the animals involved in this event. The emaciated shape of many stranded and living whales in 1999 and 2000 suggests that starvation may have been a predisposing cause for many of the mortalities, this starvation being either primary, resulting from a decrease in the availability of prey, or secondary, due to disease and the inability of sick whales to feed.

**What You Can (and Can't) Learn From Blubber**

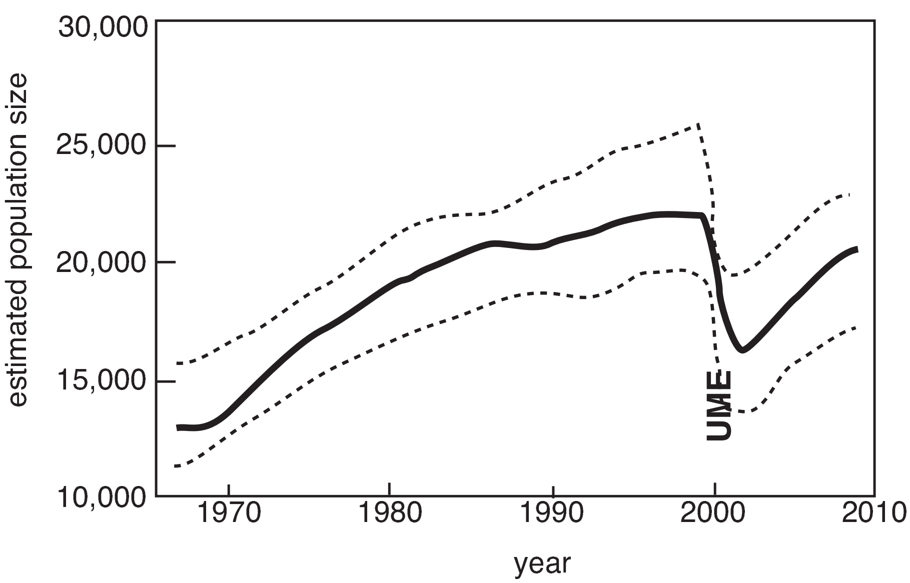
No reliable quantitative measure of nutritional status is available from these dead stranded whales, and not all stranded whales were visibly emaciated. Measurements of blubber thickness have been the most common way to qualitatively assess body condition and degree of starvation of cetaceans in the field. However, measurements of blubber thickness are affected by the state of carcass decomposition, the site measured and the sampling technique. Lipid content of blubber has also been used to assess nutritional status. In gray whales, blubber thickness and lipid content vary according to season, sex, age and reproductive status. In other mysticetes, blubber lipid composition is not uniform throughout the blubber depth or across the body, so this is likely to be the case in gray whales as well. Lipid content of blubber from the UME stranded whales was low compared to published values measured in subsistence-harvested, and presumably healthy, whales, and lipid composition was influenced by degree of decomposition. The blubber samples of stranded whales that were classified as "decomposed" contained relatively low lipid concentrations (< 10%) and lower proportions of triglycerides but higher cholesterol and phospholipid levels in comparison to blubber of fresher animals.

Decomposition also has dramatic effects on blubber lipid composition. The decreased proportions of triglycerides in the blubber from these stranded animals compared to lipid levels in subsistence-harvested gray whales may be due to decomposition and to leaching of these compounds from the blubber, resulting in higher proportions of polar compounds. Blubber samples from subsistence-harvested gray whales from Russia in 1994 were 43% lipid, thus considerably higher than the 12% lipid in blubber from the 22 fresh whale samples in 1999-2000. Relatively high lipid concentrations were expected in the subsistence harvested gray whales because samples were taken in the early fall after these animals had been feeding in the Bering and Chukchi Seas and the samples were fresh. In contrast, most of the stranded gray whales were on their northward migration in winter, spring, and early summer, and many of the samples were from carcasses that were more decomposed. The low lipid content of blubber from the stranded whales may thus be due to poor nutritional condition, decomposition, or sampling differences.

**A Tentative Conclusion**

Factors which may have contributed to the increased mortalities observed in the 1999- 2000 UME are: 1) nutritional stress; 2) chemical contaminants; 3) biotoxins, 4) disease, in which animals are either directly affected or are incapacitated and unable to feed, migrate, or reproduce; and 5) direct anthropogenic factors such as fishery interactions or ship traffic. The latter three factors are considered unlikely to be the cause of the UME. The mean concentrations of organochlorines in the blubber of gray whales that stranded in 1999 were well below those observed in apparently healthy subsistence-harvested gray whales suggesting that acute organochlorine toxicity was unlikely important as a factor in this mortality event. Tissues of four gray whales that stranded in the Gulf of California during 1999 had low levels of total mercury and methylmercury in muscle, kidney and liver. The importance of ship strikes, disease and biotoxins as factors in this mortality event cannot be adequately assessed as too few carcasses were sampled adequately to assess these factors. In the three animals sufficiently examined to detect disease or biotoxins, viruses, parasites and domoic acid were all detected and played a role in the death of the individuals. The magnitude and the wide temporal and spatial distribution of the strandings, however, suggest that a common factor was involved in mortality of these whales, so it is unlikely that a single infectious disease or biotoxin was responsible for the entire die-off. Thus nutrition remains the most likely dominant factor in precipitating this mortality event, although direct evidence of starvation in stranded whales is limited.

If poor nutrition is accepted as the most plausible explanation for the 1999-2000 UME, the main question remaining is "why?" Why does a large mammal capable of migrating thousands of miles and moving amongst different sources of food starve? Determining whether malnutrition in those years resulted from an increase in whale numbers approaching "carrying capacity," (essentially reducing prey availability by overgrazing) or to changes in ice distribution limiting access to feeding grounds, or even to some yet unexplained change in prey distribution, will require continued collaborations amongst population biologists, physiologists and veterinarians. New techniques are needed to evaluate nutritional status in live and dead whales that can be used to distinguish starvation from seasonal fasting. The susceptibility of gray whales to malnutrition coupled with their proximity to the coast line make them an ideal species to evaluate impacts of climate change in the Arctic on a marine mammal. Whatever the cause of the mortality associated with this event, the consequences to the eastern gray whale population were severe. The event and its immediate aftermath is estimated to have reduced the eastern gray whale population by almost one-quarter (5,000-6,000 whales) of its pre-UME numbers.




*Impact of the 1999-2000 UME on the eastern gray whales population, based on the model of population abundance by Punt and Wade (2010).*