

Marine Mammals as Sentinels for Oceans and Human Health

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Introduction

Concern is being raised about the health of the Earth's aquatic ecosystems due to many factors including anthropogenic impacts and global climate change. The concept of marine sentinel organisms provides one approach to evaluating aquatic ecosystem health. Such sentinels provide indications of current or potential negative trends and impacts on individual and population health. In turn, such indicators will permit the characterization and potential management of environmental impacts associated with our oceans that ultimately affect human and animal health¹.

Marine mammals are sentinels for oceans and human health because many species have long life spans, are often long-term coastal residents, feed at a high trophic level, and have unique fat stores that can serve as depots for anthropogenic toxins. Additionally, marine mammals are charismatic megafauna that typically stimulate a human behavioral response and are thus more likely to be observed². Similarly, diseases that impact these species may make humans more likely to pay attention to ocean health issues.

Infectious and Neoplastic Disease

Newly documented complex diseases involving emerging infectious and neoplastic components are being reported in some marine mammal species. In turn, these diseases may provide important information on aquatic ecosystem health. For example, approximately 20% of sexually mature stranded California sea lions have a newly described urogenital cancer, which is associated with a novel herpesvirus, as well as exposure to anthropogenic contaminants such as PCBs and DDTs that persist in the sea lion's feeding grounds^{3,4}. Genetically inbred sea lions, and those with a specific MHC genotype, are more likely to develop urogenital cancer. Recently, urogenital papillomatosis that occasionally undergoes transformation to metastatic squamous cell carcinoma was found to be associated with another novel herpesvirus and a papillomavirus in Atlantic bottlenose dolphins (Figure 1) ^{5,6,7}. The dolphin disease is associated with immunologic perturbations that may have an environmental basis⁶. Additionally, cutaneous viral papillomatosis with concurrent immunologic suppression was recently documented in endangered Florida manatees ^{8,9}. These data suggest that interactions occur among genes, anthropogenic toxins, immunologic factors and/or emerging viruses in these marine mammals that share a coastal environment with humans¹⁰.

Toxoplasmosis is a major cause of mortality among southern sea otters and is a serious infectious disease in humans, particularly in the congenital form. A recent analysis of seroprevalence or antibodies to *Toxoplasma gondii* showed evidence of prior infection in 52% of beachcast sea otters, and 38% of live sea otters sampled along the California coast. As coastal predators, otters serve as sentinels of the

distribution of marine ecosystem pathogenic protozoans since they share the same environment as humans.

Investigations of the pathogenesis of sea otter *T. gondii* infection is providing important information about terrestrial parasite flow and the emergence of disease at the boundary between wildlife, domestic animals, and humans^{1,11}.

We recently reported the emergence of lobomycosis in a free-ranging Florida bottlenose dolphin health assessment study along Florida's Atlantic coast. Lobomycosis is a rare chronic mycotic disease of the skin and subcutaneous tissues caused by a yeast-like organism known as *Lacazia loboi* (formerly *Loboa loboi*). Dolphins and humans are the only species known to be naturally susceptible to infection with *Lacazia loboi*. The reasons for the emergence of this rare disorder are unclear, but our data indicate that the disease in some dolphins is associated with humoral and cell-mediated immunosuppression of suspected environmental origin¹³. Limited evidence exists to suggest that lobomycosis may be transferred from infected animals to people. However, the high prevalence of lobomycosis in the dolphin population of this Florida coastal region, which is used extensively for recreational purposes, raises concerns for zoonotic or common source transmission.

Anthropogenic Toxins

Bottlenose dolphins reside in ocean, coastal, and estuarine communities and are exposed to a variety of persistent organic and inorganic pollutants. High levels of mercury have been reported in dolphins from the eastern U.S. coast and the Gulf of Mexico^{14,15}. Additionally, elevated organohalogen compounds have been found in dolphins from this region including PCBs and organochlorine pesticides and polybrominated diphenyl ethers (PBDEs) in blubber and perfluoro alkyl compounds (PFCs) in liver¹⁶. The high concentrations of PFCs and PBDEs are of concern in these dolphin populations as well as in the coastal human populations that are exposed to the same toxins.

Harmful Algal Blooms

Harmful algal blooms (HABs) and the potent neurotoxins they produce are associated with mass mortalities of dolphins, sea lions and manatees. The range of biotoxins produced by HABs is extensive and these toxins directly or indirectly impact human health. Biotoxins associated with HABs include: brevetoxins, the cause of neurotoxic shellfish poisoning; saxitoxins, the cause of paralytic shellfish poisoning; okadaic acid, the cause of diarrhetic shellfish poisoning; and others. The HAB problem is significant, growing globally, and posing a major threat to human and ecosystem health. Marine mammals appear to be good sentinels for the ecosystem and public health effects of HABs¹. Recent often unprecedented Florida manatee and Atlantic bottlenose dolphin epizootics have been associated with potent marine neurotoxins known as brevetoxins, which are produced by the 'red tide' dinoflagellate *Karenia brevis*¹⁷. Brevetoxins are known to kill large numbers of fish and cause illness in humans who

ingest toxic filterfeeding shellfish or inhale toxic aerosols. The pathogenesis of brevetoxicosis is suspected to involve direct inhalation of toxins (in manatees) or ingestion of toxins in food sources (in manatees and dolphins). New data indicate that brevetoxin vectors such as seagrasses and fish can result in delayed or remote exposure causing intoxication in the absence of toxin-producing dinoflagellates¹⁸. Manatee mortality resulting from brevetoxicosis may not necessarily be acute but occur after chronic inhalation and/or ingestion and involve the release of inflammatory mediators that result in fatal toxic shock¹⁷. The inhalational route of brevetoxin exposure in manatees is shared with humans. Increases in human pulmonary emergency room diagnoses are temporally related to 'red tide' occurrences, which may be increasing in frequency along Florida coastlines.

Conclusion

Marine mammals are proving to be good sentinels for oceans and human health due to their many unique natural attributes. New opportunities for interdisciplinary and multi-institutional projects are emerging for utilizing marine mammal sentinel species. Additionally, these novel sentinel projects will provide important information in the One Health worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health.

References

http://www.doh.state.fl.us/Environment/medicine/One_Health/MarineMammals_References.pdf

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