As more humans inhabit coastal regions, a global “anxiety” is developing about the health of our aquatic ecosystems. This anxiety is particularly prevalent in the United States, where more than half the population now inhabits coastal freshwater or marine ecosystems. One component of the National Oceanic and Atmospheric Administration’s (NOAA’s) Oceans and Human Health Initiative addresses the concept of marine sentinel organisms. As discussed by Grosell and Walsh (this issue), such sentinels are used to gain early warnings about current or potential negative trends and impacts. In turn, such indicators and warnings will permit us to better characterize and potentially manage negative impacts on human and animal health associated with our oceans.

Marine mammals are probably one of the best sentinel organisms in aquatic and coastal environments because many species have long life spans, feed at a high trophic level, and have extensive fat stores that can serve as depots for anthropogenic toxins (Reddy et al., 2001; Wells et al., 2004). Additionally, marine mammals are conspicuous and charismatic megafauna that elicit strong human emotions and are thus more likely to be observed (Bossart, 1999). As such, health maladies that impact these species may make humans more likely to pay attention to deteriorating ocean health issues. Virtually all threats to marine mammals are ultimately related to the population size, growth rate, and the consumption patterns and behaviors of humans (Marine Mammal Commission, 2004). Therefore, it is in our own best interest to determine what marine mammals may be telling us about their own health that could potentially impact our own well being. The following examples illustrate the diversity of marine mammal sentinels and processes currently being monitored.

**INFECTIOUS DISEASES**

Marine mammal sentinel species for ocean health include the Californian sea lion (*Zalophus californianus*), Atlantic bottlenose dolphin (*Tursiops truncatus*), southern sea otter (*Enhydra lutris nereis*), bowhead whale (*Balaena mysticetus*), polar bear (*Ursus maritimus*), and the endangered West Indian manatee (*Trichechus manatus latirostris*) (Figure 1). For example, approximately 20 percent of sexually mature stranded California sea lions have an unusually high incidence of a newly described...
urogenital cancer. This cancer is associated with a novel herpes virus and exposure to anthropogenic contaminants (such as PCBs and DDTs) that persist in the sea lion's feeding grounds (King et al., 2002; Ylitalo et al., 2005). More genetically inbred sea lions, and those with a specific major histocompatibility complex (MHC) genotype, are more likely to develop cancer. These data suggest that interactions occur among genes, toxins, and viruses, resulting in cancer in this ubiquitous marine mammal that shares its coastal California environment with humans (Acevedo-Whitehouse et al., 2003; Ylitalo et al., 2005).

Toxoplasmosis is a sometimes fatal human and animal disease caused by infection with *Toxoplasma gondii*, a single-celled protozoal parasite. Toxoplasmosis is a major cause of mortality among southern sea otters. For example, a recent seroprevalence analysis showed toxoplasmosis infection in 52 percent of beachcast sea otters and in 38 percent in live sea otters sampled along the California coast (Miller et al., 2002). As nearshore predators, otters serve as sentinels of protozoal pathogen flow into the marine environment because they share the same environment and consume some of the same foods as humans. Investigation into the processes promoting *T. gondii* infections in sea otters provides a better understanding of terrestrial parasite flow and the emergence of disease at the interface among wildlife, domestic animals, and humans (Conrad et al., 2006).

**ANTHROPOGENIC POLLUTANTS**

Polar bears, bowhead whales, and bottlenose dolphins can serve as sentinels for coastal ecosystem pollution. Organohalogen and heavy-metal contaminant biomagnification among polar bears and bowhead whales may reflect Arctic Ocean health (Woshner et al., 2001; Kucklick et al., 2002; Hoekstra et al., 2003a; Hoekstra et al., 2003b; Hoekstra et al., 2003c; Hoekstra et al., 2005; O’Hara et al., 2005). Furthermore, for Alaskan residents dependent upon marine resources, a clear human connection exists with polar bear health because both humans and polar bears feed on similar prey, and the polar bear itself is consumed by humans.

Bottlenose dolphins reside in ocean, coastal, and estuarine communities, and are exposed to a variety of persistent pollutants (Stein et al., 2003; Houde et al., 2005). Additionally, bottlenose dolphins and manatees harbor diseases important to ecosystem health, as well as human health (Bossart et al., 2003b; Bossart et al., 2004; Bossart et al., 2005; Reif et al., in press). Recent pathologic studies of dolphins and manatees indicate, for example, that the emerging or resurging infectious and neoplastic diseases may reflect environmental distress, and these diseases have direct or indirect relevance to human health (Bossart et al., 1997; Miller et al., 2001; Bossart et al., 2002a; Bossart et al., 2003a; Rehtanz, et al., 2005) (Figure 2).

**Figure 2.** Infectious and neoplastic emerging disease in marine mammals may have ecosystem and public health significance. Examples of these diseases are (top to bottom) oral sessile papillomas associated with a novel herpesvirus in bottlenose dolphins; cutaneous papillomas caused by a novel papillomavirus in manatees; and cutaneous lobomycosis, a zoonotic fungal disease of bottlenose dolphins.
HARMFUL ALGAL BLOOMS (HABS) AND THEIR TOXINS

HABs and the potent biotoxins they elaborate are incriminated in mass mortalities of dolphins, sea lions, and manatees (Gulland, 2000; Bossart, 2001; Bossart et al., 2002b; Flewelling et al., 2005) (Figure 3). The range of biotoxins produced by HABs is extensive and associated with many human HAB illnesses. HAB biotoxins include the following: brevetoxins, the cause of neurotoxic shellfish poisoning; saxitoxins, the cause of paralytic shellfish poisoning; okadaic acid, the cause of diarrhetic shellfish poisoning; azaspiracid, the cause of azaspiracid shellfish poisoning; and numerous others (Landsberg, 2002). The HAB problem is significant, growing worldwide, and poses a major threat to human and ecosystem health (Kirkpatrick et al., 2004; Glibert et al., 2005). Fortunately, marine mammals appear to be good sentinels for the ecosystem and public health effects of HABs. For example, the inhalational route of brevetoxin exposure appears to be unique among marine mammals in manatees, but it is shared with humans (Bossart et al., 1998).

It is clear that new challenges and opportunities for interdisciplinary research exist for utilizing marine mammal sentinel species for oceans and human health. The value of this approach will expand as new additions are made to the list of marine mammal species and processes being monitored. In addition, this approach provides a new avenue for better understanding the intersection between intriguing ecosystem and public health issues.

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GREGORY D. BOSSART (gbossart@hboi.edu) is Director and Head of Pathology, Division of Marine Mammal Research and Conservation, Harbor Branch Oceanographic Institution, Ft. Pierce, FL, USA.