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Habitat Pressures

Peter GH. Evans

p0020 Like other animals, marine mammals may have preferred locations in which they spend the majority of time or where they engage in particular important life history activities such as giving birth, calf rearing, or feeding. The array of physical and oceanographic features that typify those locations forms the habitat of a species or local population. Often these are difficult to define. An ice-breeding seal clearly depends on pack ice upon which to give birth and that constitutes its' breeding habitat, and a gray whale (*Eschrichtius robustus*) may seek out a sheltered tropical lagoon to calve, but for a large open-ocean baleen whale like a fin whale (*Balaenoptera physalus*) or blue whale (*B. musculus*), identifying its habitat requirements for breeding can be a difficult task. The same applies to feeding habitats: manatees (*Trichechus* spp.) and dugongs (*Dugong dugon*), e.g., require specific habitats such as shallow seagrass beds for feeding, but oceanic dolphins may range the high seas in pursuit of shoaling (schooling) fishes, making it difficult to identify whether they have specific habitat requirements. Human activities impinge upon the lives of marine mammals if they damage or destroy those habitats which may be important to them. Our knowledge of habitat pressures facing marine mammals is therefore limited to particular species, and especially to locations nearshore where animals have been studied more intensively and their ecological requirements are better defined.

p0030 Habitats formed by eddies, thermoclines, and fronts, particularly if they are driven by currents or wind, may shift from one locality to another during the life span of a marine mammal, leading to shifts in their geographic distributions. Habitats determined by geomorphological features such as depth, topography, available haulout, or den sites [in the case of pinnipeds and polar bears (*Ursus maritimus*), respectively], are relatively stable over time in relation to location. Strong site fidelity may lead a population to have difficulty in adjusting to changes in local food availability.

p0040 Habitat pressures upon marine mammals from anthropogenic influences may be grouped into five categories: (1) physical damage to their environment: a river or seabed and its constituent communities; (2) contamination from chemical pollutants; (3) direct removal of important prey through fisheries; (4) disturbance from human activities either by the introduction of sound into the environment or through ship strikes; and (5) physical and oceanographic effects from global climate change.

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I. Physical Damage

p0090 Human population pressures frequently lead to direct changes to coastal and riverine environments. Estuaries are turned into industrial harbors, wetlands are drained for agricultural purposes or for tourism, and coastal waters are modified often irreversibly by dredging of the seabed and input of a wide variety of pollutants. Some of the most obvious detrimental changes to a habitat come from alteration of rivers inhabited by particular dolphin species (Reeves and Smith, 1999). Water is often taken out of rivers for other uses, such as for drinking, flood control, or irrigation agriculture. In Pakistan, e.g., most of the annual flow of the Indus River is diverted into canals, and this, along with dam construction, has resulted in the Indus river dolphin (*Platanista gangetica minor*) losing probably at least half of its historical range (Reeves *et al*., 1991). Dams modify water flow and affect the sedimentation of rivers; they also block traditional movement patterns of marine mammals that can lead to population fragmentation. The construction of large dams (such as the Ghezouba Dam and the Three Gorges Dam) along the Yangtze River system had serious consequences upon the already endangered baiji (*Lipotes vexillifer*) (Reeves and Leatherwood, 1994), which is now believed to be extinct. It may also restrict movements of more widespread species such as the Amazonian manatee (*Trichechus inunguis*) in Brazil (Rosas, 1994).

On land, one of the greatest habitat pressures leading to mass p0060
extinctions of fauna and flora is that of deforestation, particularly in the tropics. In the 1980s, Latin American countries are estimated to have eliminated 7.4 million hectares of tropical forests annually, with Brazil sustaining the greatest annual loss with 3.2 million hectares per year. This deforestation directly affects the fresh water habitats of the boto or Amazon river dolphin (*Inia geoffrensis*), as well as the Amazonian manatee (Rosas, 1994; Reeves and Smith, 1999; Reynolds, 1999).

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After centuries of direct exploitation, pinnipeds have largely p0070
sought sites remote from human activities to give birth to their pups. They, therefore, are less likely to experience direct physical damage to those breeding habitats.

II. Chemical Pollution s0020

Nearshore environments in particular are exposed to a poten- p0080
tial wide range of pollutants as a result of industrial and agricultural activities. Those pollutants may concentrate in the food web, and either degrade the habitat by removing important prey populations or cause health deficiencies in the local populations of marine mammal species. Although high levels of potentially damaging pollutants have frequently been detected in marine mammals, particularly seals and coastal small cetaceans inhabiting nearshore environments, direct causal links with health status have rarely been demonstrated. Baltic ringed (*Pusa hispida*) and gray (*Halichoerus grypus*) seals during the 1970s had lesions of the reproductive system attributed to high PCB and DDT levels in their tissues. By the late 1980s and through the 1990s, as levels in those pollutants declined, the proportion with lesions had declined substantially, along with an increase in their pregnancy rate (O'Shea, 1999; Reijnders *et al*., 1999). In an experimental study with harbor seals (*Phoca vitulina*), females fed with fish from the heavily polluted Dutch Wadden Sea had poorer reproductive success than those fed less contaminated fish from the North Atlantic. The effects were attributed to PCBs or their metabolites, and seals with the highest PCB intake were found to have reduced blood levels of thyroid hormones and vitamin A, both of which are known to be important in reproduction, including spermatogenesis.

Belugas (*Delphinapterus leucas*) in the highly polluted
St. Lawrence Estuary in North America had a high prevalence of p0050
tumors which had been attributed to carcinogenic compounds such

as polycyclic aromatic hydrocarbons (PAHs) and other toxic compounds such as PCBs (Martineau *et al*., 1999; Michaud and Béland, 2001). These were thought to account for low reproductive success in this population. However, although both sets of compounds occurred at high levels in this population, a direct link has not been clearly demonstrated, and the population in fact appeared to have increased since hunting ceased in 1979 (Kingsley, 2001).

p0100 Stranded harbor porpoises (*Phocoena phocoena*) from around the British Isles had PCB concentrations sufficiently high to cause adverse physiological effects, and mortality identified as from infectious diseases was considered to be associated with chronic exposure to these chemicals (Jepson *et al*., 2005). Mass mortalities of striped dolphins (*Stenella coeruleoalba*) in the Mediterranean, bottlenose dolphins (*Tursiops truncatus*) in the eastern United States, harbor seals in the North and Baltic Seas, and Baikal seals (*Pusa sibirica*) in Lake Baikal also have showed significantly high concentrations of PCBs, which were thought to have reduced resistance to disease, thus making these populations more susceptible to virus infection.

p0110 Despite examples like these of apparent links between contamination and health status, the biological significance and nature of effects generally remains uncertain, and it has been impossible to demonstrate conclusively that demographic changes to a population can be attributed to pollution. The only exceptions are where pollution can be shown to lead directly to mortality. After the Exxon Valdez tanker went aground in Prince William Sound, Alaska, in 1989, releasing large volumes of crude oil, several thousand sea otters (*Enhydra lutris*) and about 300 harbor seals died as a result of the oiled pelts losing their vital insulation properties (Loughlin, 1994).

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III. Competition with Fisheries

p0120 Habitats compromise animal and plant communities in an often complex web of interaction. When one or more members of the community are removed in large numbers, this can have repercussions throughout the food web, altering predator–prey relationships and competition for resources. Following the intense exploitation of large baleen whales in the Southern Ocean during the first half of the twentieth century, it was estimated that their overall biomass was reduced from 43 million tons to about 6.6 million tons, and that this made available a "surplus" of about 153 million tons of krill (Laws, 1985). These massive changes to the food web of the Southern Ocean had important effects on the remaining members with individual whales growing faster, reaching sexual maturity at an earlier age, and exhibiting increased pregnancy rates. Similar changes in life history parameters were seen in other marine species like the Antarctic crabeater seal (*Lobodon carcinophaga*) and several seabird species.

p0130 During the twentieth century, fisheries around the world intensified to such an extent that major changes in fish stocks were observed for many species. Rarely, however, has it been possible to show that prey depletion had reduced the numbers of a particular marine mammal species. Many marine mammals have catholic (broad or species rich) diets, and appear to respond by switching prey. The relative ease of capture and nutritive contents of different prey species may vary, but it has scarcely ever been possible to demonstrate that these have affected reproductive or survival rates, and hence led to a decline in that population. More often than not, the species appears to respond by shifting its distribution.

On both sides of the North Atlantic, fishing activities have markedly reduced the stocks of Atlantic mackerel and herring (*Clupea* spp.), resulting in other fish (upon which they prey) such as sand lance, sprat, and gadoid species becoming locally very abundant. Not only did some cetacean species like harbor porpoises and humpback whales (*Megaptera novaeangliae*) switch their diets to include those prey in greater amounts, but some also showed geographic shifts in distribution. Gray seals, feeding largely on sand lance, increased in number in the North Sea at around 7% per year, while right whales (spp.), feeding largely on plankton (the prey of sand lance) in the North-west Atlantic showed local declines. When some local sand lance and sprat populations crashed a few years later, further changes were witnessed. In the Gulf of Maine, e.g., fish-eating humpback and fin whales were replaced by plankton-eating right and sei (*Balaenoptera borealis*) whales, harbor porpoises moved nearer shore, and Atlantic white-sided dolphins (*Lagenorhynchus acutus*) became abundant and white-beaked dolphins rare (*L. albirostris*) (Kenney *et al*., 1996). p0140

In the Bering Sea and Gulf of Alaska, substantial declines in the numbers of Steller sea lions (*Eumetopias jubatus*), harbor seals, and northern fur seals (*Callorhinus ursinus*), as well as several species of fish-eating birds, have occurred since the 1970s. Although other factors may also be involved, most of these declines have been attributed to a decline in food availability resulting from the development of the Walleye pollock (*Pollachius pollachius*) fishery, a key prey species for many of these marine mammals following the demise of local herring stocks (Reeves and Reijnders, 2002). Similarly, the collapse of productivity of the Barents Sea ecosystem, brought on partly from excessive fishing mortality, has had far-reaching effects on a range of species from seabirds through to marine mammals (Bjørge, 2002). p0150

IV. Disturbance s0040

Sounds are introduced into marine and fresh water environments from a wide variety of sources: motor-powered vessel traffic of various sizes; active sonar for object detection including fish-finding and submarines; seismic exploration and subsequent drilling and production for oil and gas; explosions from military exercises and ocean science studies; and marine dredging and construction (Richardson *et al*., 1995; Würsig and Evans, 2002; Nowacek *et al*., 2007). Most of the sounds produced are concentrated between 10 and 500 Hz frequency. However, speedcraft of various types generate noise mainly between 2 and 20 kHz by cavitation of the propeller, and sidescan and military sonar generate sounds between 2 and 500 kHz (particularly in the lower-frequency range) (Evans, 1996). p0160

Among cetaceans, baleen whales have rather different hearing sensitivities to those of toothed whales and dolphins. The former are most sensitive at low frequencies below 5 kHz and the latter above 1 kHz. Thus, baleen whales are likely to be most vulnerable to large vessels, oil and gas activities, marine dredging and construction, whereas toothed whales and dolphins may be more susceptible to recreational speedboats and most forms of active sonar. p0170

Changes in behavior (e.g., movement away from the sound, increased dive times, clustering behavior) are often recorded in the vicinity of loud sounds. Few experimental studies have been conducted to test the nature and duration of negative responses. One such study in relation to low-frequency regular ATOC (Acoustic Thermometry of Ocean Climate project) sound pulses was conducted west of California (Calambokidis *et al*., 1998). Aerial surveys showed no significant differences in numbers of marine mammals of any species between control and experimental surveys, but humpback and p0180 sperm whales (*Physeter macrocephalus*) were on average further from the sound source during the experimental periods. Although many other studies have reported negative reactions, there is very little information concerning the long-term impact of sound disturbance. In Hawaii, humpback whale mothers with their calves are thought to have shifted their distribution offshore in response to the high volume of recreational traffic. Whale and seal watching itself can impose pressures upon marine mammals, disturbing seals from haulout or breeding sites, and whales (and dolphins) from favored feeding areas. These have even been found to have long-term consequences upon reproductive success, as in one bottlenose dolphin population from Australia (Bejder *et al*., 2006).

p0190 Besides those indirect effects where sound disturbance may interfere with or frighten marine mammals, there is some evidence that loud sounds can cause physical damage. Temporary or permanent shifts in hearing thresholds may occur which could affect auditory acuity, and post-mortem examination of humpback whales found dead in the vicinity of drilling operations has revealed ear damage. Most notably, mid-frequency sonar (mainly between 2 and 10 kHz) used in military activities has been linked to mass strandings of beaked whales, and there have been a number of recent such events (e.g., in the Bahamas and the Canaries) (Evans and Miller, 2004; Cox *et al*., 2006). In those cases, however, it has not been entirely clear whether the strandings have resulted from direct acoustic trauma or some behavioral change leading to gas bubble formation.

p0200 A new concern has arisen within Europe with the rapid expansion of offshore wind farms, mainly in shallow areas where harbor porpoises and harbor seals occur. Pile-driving activities during the construction phase in particular situations appear to have negative impacts on harbor porpoises, which can be relatively long-lasting (Carstensen *et al*., 2006).

p0210 Powered vessels pose an obvious threat to marine and fresh water mammals through direct damage. Collisions have been reported in a wide variety of species, and in some, such as the Florida manatee (*Trichechus manatus*) and the North Atlantic (*Eubalaena glacialis*) and North Pacific (*E. japonica*) right whale, they are regarded as the major threat to their survival. With the advent of high-speed ferries in many parts of the world, ship strikes are being reported with increasing frequency, especially affecting some of the larger baleen whales like fin whales and the slower swimming toothed whale species like sperm whales and pilot whales (*Globicephala* spp.).

s0050 V. Climate Change

p0220 As a result of emissions by humans of substances which deplete the ozone layer, our increasing use of hydrocarbons for energy and fuel, and large-scale deforestation and desertification, the world is experiencing climate change such that it is predicted that, in the next hundred years, temperatures will rise by 1.0–3.5°C and overall sea level will rise by anywhere from 15 to 95 cm. Obvious consequences will be the melting of polar ice, drowning of coastal plains, and changes to shallow seas. Other less direct implications include an increase in the frequency and velocity of storms, and more extreme seasonal fluctuations in local climate (including, e.g., El Niño Southern Oscillation events). Shifts in areas of primary productivity may lead to distributional changes for many marine mammal species, but some such as the polar bear, land-breeding pinnipeds, and coastal cetaceans and sirenians may find it difficult to adjust to the loss of important feeding or breeding habitat (Würsig *et al*., 2002). Already there is concern that less stable ice in some parts of the Arctic has reduced the availability of ringed seals to polar bears, thus reducing the breeding success of the bears, which in those areas depend upon this species for food (Tynan and DeMaster, 1997).

p0230 During recent El Niño events, there has been reproductive failure in many seabird populations and some colonies of fur seals. During the 1982 El Niño, e.g., all Galapagos fur seal (*Arctocephalus galapagoensis*) females lost their pups due to starvation (Trillmich and Dellinger, 1991). However, many pelagic toothed whales and dolphins, being less tied to a particular locality, simply shifted their distributions: short-finned pilot whales (*Globicephala macrorhynchus*), e.g., left southern Californian waters following the departure of a species of squid, their main prey. Such changes can affect other members of the ecosystem. When the squid returned some years later, the temporarily vacant niche became occupied by another cetacean species, the Risso's dolphin (*Grampus griseus*) (Shane, 1995).

p0240 Despite the many pressures upon their habitats, marine mammals appear to be remarkably resilient, often living in highly modified coastal and riverine environments. Of course, because demographic changes may be slow and difficult to detect, we rarely know whether these are nonetheless having negative effects. In the case of small local populations of endangered species like the northern right whales, vaquita (*Phocoena sinus*), various river dolphins, monk seals (*Monachus* spp.), and manatee populations, the dangers of habitat pressures are all too obvious. Howvever, even for other species, a precautionary approach would be prudent, and there is scope for the establishment of protective areas where human activities can be zoned.

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See Also the Following Articles s0060

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Habitat Use c0020

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I. Introduction s0070

A. Temporal and Spatial Scales in Ecology s0080

Ecology is the study of interactions between organisms and their environment, and the distribution and abundance of organisms resulting from these interactions. The environment of any organism includes abiotic factors—non-living chemical and physical factors such as temperature and light—and biotic factors—living organisms with which any individual interacts. For instance, other organisms may compete with an individual for food and resources, prey upon it, or change its physical and chemical environment. At the core of both ecology and conservation biology are questions that examine the relative importance of various environmental components in determining the distribution and abundance of organisms. p0260

Habitat use studies attempt to describe, explain, and predict the distribution and abundance of organisms. In these studies, identifying the factors that influence distribution and abundance at different spatial and temporal scales is fundamental. This concept can be illustrated by examining the distribution and abundance of blue whales (*Balaenoptera musculus*) from the California/Mexico populations and fin whales (*B. physalus*) from the Gulf of California population. Blue whales and to a lesser extent fin whales depend on krill (Euphausiacea) as a prey item. Krill form large, dense swarms during the day and have their largest concentrations below 100 m in depth. At night, krill come near the surface but are scattered over large areas. During winter in Bahía de Loreto, Gulf of California, México, blue and fin whales engage in deep, foraging dives during the day while at night they perform shallow dives, very few of which appear to be foraging dives. During the day, krill swarms are found around underwater edges, where depth diminishes rapidly, and blue and fin whales concentrate their movements and feeding in those areas. Both blue and fin whales move out of Loreto around early spring. Bahía de Loreto is thus a short-term feeding site for both whales, which behavior and movements closely match those of krill. p0270

By combining the information from Loreto to that from other studies, the following general picture of the California/Mexico population of blue whales emerges: In late spring, blue whales move north to feed during summer and early fall along the California coast in the Farallones Islands, Cordell Banks, and Monterey Bay, on large swarms of krill. The whales move back south in fall, feeding around the Channel Islands and perhaps off Bahia Magdalena, Mexico. During winter, whales are back in the Gulf of California, including Bahía de Loreto. However, there is a large degree of variation, and many whales may winter in the Costa Rica Dome, an oceanographic feature in the Pacific Ocean. Although the picture of the Gulf of California population of fin whales is less complete, we know that they feed during the spring in the southern region of the Gulf of California, including Loreto. During the summer, a time of year in which krill are less abundant in the gulf, they move further north into the gulf to prey on schooling fish. p0280

This example illustrates the importance of defining temporal and spatial scales in an ecological study, and documents how the distribution of marine mammals is influenced by the environment at different spatial and temporal scales. At scales of days and tens of kilometers, blue whales are found during the day along canyon edges, feeding on