Chapter 37. Marine Mammals

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1. Introduction

Marine mammals occupy a wide range of marine and some freshwater habitats around the world. They have been used by humans for millennia for food and to obtain other products. Marine mammals consist of cetaceans (whales, dolphins and porpoises), pinnipeds (seals, sea lions and walruses), sirenians (dugongs and manatees), mustelids (sea otters and marine otters) and the polar bear – 130 or more species in total, including several that range into fresh water and some that exclusively occupy rivers and lakes. Human interactions, both direct and indirect, have negatively affected most marine mammal species at least to some degree. Historically, industrial harvesting greatly reduced the abundance of many populations. Although the intensity of such exploitation has declined in recent decades for many species, humans continue to use certain species of marine mammals in some places for food, skins, fur, ivory and increasingly as bait for fisheries. In addition, human activities continue to reduce the availability and quality of marine mammal habitats and cause substantial numbers of marine mammals to die incidentally as a result of entanglement or entrapment in fishing gear and from being struck by vessels. Mitigation of ongoing and future threats to marine mammals from human activities requires improved knowledge of those human activities and of the animals' ecology, behaviour and habitat use.

1.1 Changes in Biological Diversity

Globally, certain species of marine mammals have become extinct over the last several centuries, i.e., Steller's sea cow, the Japanese sea lion, the Caribbean monk seal. The Yangtze River dolphin (baiji) is also likely to have become extinct although there has been one unconfirmed sighting in 2005. In addition, many populations have been reduced to remnant status, such that they no longer play a significant role in the ecosystem, i.e., they are functionally extinct. For example, right whales have essentially disappeared from the eastern North Atlantic, and walruses are gone from their former strongholds in south-eastern Canada (Gulf of St. Lawrence and Sable Island). The loss of marine mammal diversity due to actual and functional extinctions has had significant effects on marine ecosystems at varying scales from local to ocean-basin-wide (Estes et al., 2006).

1.2 Magnitude of changes

Besides the above-mentioned extinctions and extirpations, the numerical abundance

(and biomass) of many other marine mammal populations has been greatly reduced. All of the commercially valuable great whales were depleted by whaling. A good example is the world's largest animal, the blue whale. Within the 20th century more than 360,000 Antarctic blue whales were taken, leaving a remnant population of only hundreds of animals and a current abundance of roughly 5 per cent of original numbers (Branch et al., 2007). Some populations of virtually all types of marine mammals have been depleted to low levels; for example, southern and northern hemisphere populations of fur seals and elephant seals were all depleted by harvesting for either their fur or their oil (Busch, 1985). Similarly, many populations of sirenians and sea otters have been reduced to small fractions of historic levels.

Although the abundance of almost all populations of marine mammals has been reduced by human activities, a number of them have recovered since they were protected from deliberate exploitation. Eastern Pacific gray whales, northern elephant seals, eastern Steller sea lions, humpback whales and some populations of right whales provide some of the most clear-cut examples. Certain populations of those species, however, have not recovered and remain at small fractions of historic levels (e.g., western Pacific gray whales, Arabian Sea humpback whales, western Steller sea lions, North Atlantic right whales, and southern right whales in some areas).

2. Population trends or conservation status

2.1. Aggregated at global scale

Because of the great diversity of marine mammal species and their habitats, it is difficult to characterize their conservation status and population trends in the aggregate or at a global scale. Many of the marine species suffered major declines over the past several hundred years as a result of commercial hunting. Massive changes in human demography and economy have unquestionably affected the environmental carrying capacity, particularly in coastal regions, and as a result less suitable habitat (including forage base) is available to support marine mammal populations. These changes make 'full' recovery unfeasible for some species.

2.2. Major taxonomic and/or geographic subdivisions

2.2.1. Large whales

Commercial exploitation began as long ago as the 10th century, and by the late 19th century intensive whaling had caused severe depletion, and even near-extinction, of some species and populations. Industrial mechanized whaling in the 20th century led to further major declines. Some populations of large whales have been recovering in recent decades: for example, humpback whales globally, blue whales in some regions and southern hemisphere right whales when treated as a single group (Figure 1, from IWC, 2013a). At the same time, many populations have failed to recover to anywhere near their original abundance. For example, right whales are effectively extirpated from the eastern North Atlantic, and are only barely surviving in the eastern North

Pacific the eastern South Pacific, and around New Zealand (Jackson et al., 2011).

2.2.2. Pelagic dolphins and porpoises

Pelagic (off-shore) dolphins are generally less susceptible to human interactions than many marine mammals because they are relatively small, of little commercial importance, wide-ranging (some species are also extremely numerous) and live far from most human activities. There are potential interactions with military activity, and clear interactions with fishing gear in the eastern tropical Pacific. Several dolphin species in that region have been significantly affected by humans because they have symbiotic relationships with other pelagic animals that are of commercial interest, notably yellowfin tuna. Purse seine fishermen learned to chase and encircle these dolphins to facilitate the capture of tuna, and in the past large numbers of dolphins drowned in the nets. This mortality greatly reduced the abundance of several dolphin species in the latter half of the 20th century. Due to international efforts, fishing methods have changed and the by-catch has been reduced significantly (Hedley, 2010, NMFS, undated).

2.2.3. Coastal and Estuarine dolphins and porpoises

Coastal dolphins and porpoises are hunted for food and bait by a number of States. Furthermore, they often die accidentally in fishing gear in coastal commercial and artisanal fisheries. This has contributed to declines in abundance, at times to critical levels. For example, vaquitas in the Gulf of California (Mexico) declined by 57 per cent from 1997-2008, and continue to decline (Gerrodette et al., 2011). In New Zealand, the Māui dolphin (a subspecies of Hector's dolphin) has declined to very low levels (Currey et al., 2012; Hamner et al., 2012). In both cases, there have been management interventions aimed at minimizing direct mortalities and entanglements. However, under current levels of direct mortalities and entanglements, these trends are expected to continue, with both the vaquita and the Māui dolphin at risk of becoming extinct within the next few decades (CIRVA 2014).

Several species of small cetaceans live in estuaries and in large rivers, often in close proximity to humans, and are threatened by artisanal fisheries, pollution, and coastal development. Two species of South American river dolphins are relatively widespread and at least locally common in Amazonia and Orinoquia: the tucuxi and the boto (Trujillo et al., 2010). The endemic blind river dolphins of the South Asian subcontinent still inhabit large portions of the Indus, Ganges, Brahmaputra and Karnaphuli rivers. Although they are locally common in a few places, their numbers and ranges have declined markedly over the past century. Three relict populations of 100 or fewer Irrawaddy dolphins persist in the Ayeyarwady (Irrawaddy) River of Myanmar, the Mahakam River of eastern Borneo, Indonesia, and the Mekong River of Cambodia and Laos. All three populations are at high risk of extirpation from a variety of human activities (Kreb et al., 2010). The baiji (*Lipotes vexillifer*), endemic to the Yangtze River, (China), is likely to have become extinct in the early 21st century (Turvey et al., 2007), and the Yangtze population of narrow-ridged finless porpoise (*Neophocaena phocaenoides asiaeorientalis*) is declining rapidly, probably due to mortality in fishing gear, vessel strikes and habitat degradation (Wang et al., 2013).

2.2.4. Pinnipeds

Populations of many species of commercially exploited pinnipeds were greatly reduced in abundance from the 18th to the 20th century. They were targeted mainly for the oil from their insulating blubber and for their fur. Some species, such as the Caribbean monk seal and the Japanese sea lion, were driven to extinction, and others, such as the Mediterranean monk seal, as well as fur seals in many areas, were reduced to very low numbers. The hooded seal in the Greenland Sea has been hunted down to 10-15 per cent of its original population. However, some regional and ocean-basin-wide pinniped populations have been recovering, such as the harp seal in Canada and grey and common seals in the United Kingdom of Great Britain and Northern Ireland. In some cases they have been recolonizing habitat where they had long been absent, for example, the New Zealand fur seal has expanded into former habitats in New Zealand and Australia (Shaughnessy et al., 2014). In other cases populations have increased to historical levels, such as the Antarctic krill-eating seals (Kovacs et al., 2012).

2.2.5. Sirenians

Manatees and dugongs are the only totally aquatic herbivorous mammals, feeding primarily on submerged vegetation. Sirenians have a global range in about 90 tropical and subtropical countries. They have been and continue to be hunted, trapped, and netted for food, and human activities of many kinds have modified or otherwise degraded their habitat. Overall, populations have been greatly reduced in terms of both abundance and range. One species discovered in 1741, Steller's sea cow, was hunted to extinction in less than a quarter of a century after its discovery. The present status varies regionally (Marsh et al. 2014, Hines et al. 2014).

2.2.6. Mustelids

Two species of mustelids are truly marine: the sea otter (*Enhydra lutris*), along the Pacific coast of North America and East Asia, and the marine otter (*Lontra felina*), along the Pacific coast of South America. Both species are very coastal and they have been extensively exploited for their pelts. The sea otter has recovered substantially in many areas of its original distribution, whereas the marine otter has not, as it continued to be harvested through much of the 20th century. Its contracted range is fragmented due to various kinds of human interaction (IUCN, 2015).

2.2.7. Polar bears

Polar bears are endemic to high latitudes of the northern hemisphere. They have a circumpolar distribution and depend on both sea ice (for hunting pinnipeds and for denning and reproduction in some areas) and land (for hunting hauled-out pinnipeds such as walruses, as well as for denning and reproduction). Most populations have been subjected to extensive killing, at least historically, mainly for meat, hides, and sport, and to protect human life and property. Commercial hunting is now prohibited, although substantial numbers of bears are killed every year (legally) by aboriginal people in Alaska (United States of America), Canada and Greenland (Denmark). The main long-term and range-wide threat to polar bears is the projected loss of sea ice habitat associated with climate change. Sea ice provides essential breeding habitat for ringed seals, the principal prey of polar bears, and the bears rely

on ice as a hunting platform to gain access to the seals. Limited access to food leads to mobilization of fat reserves and the release of hazardous substances stored in fat, which are transported by the blood circulation to vital organs such as liver and brain. High levels of contaminants have been associated with negative health effects (e.g. enzyme activation, hormonal disturbance and weakened immune systems) in polar bears in Svalbard (Norway), Greenland (Denmark), and Hudson Bay, Canada (Atkinsson et al 1996).

2.3 Special Conservation Status Issues

2.3.1 Sources of conservation information

International Whaling Commission: The conservation issues associated with large whales and, to a lesser extent, small cetaceans are addressed in the reports of the Scientific Committee of the International Whaling Commission. Besides directed hunting, these reports increasingly have addressed other topics of concern, including habitat degradation, ship strikes, climate change, fisheries by-catch, noise disturbance, and ecological interactions. The status of many of the great whales is summarized at www.iwc.int/status#species.

International Union for Conservation of Nature (IUCN): The IUCN Red List is an authoritative and regularly updated source of conservation information for all species and subspecies of marine mammals and for many threatened subpopulations. This information is easily accessible (www.redlist.org). The authority for listing determinations resides within the relevant Specialist Groups (SG) of the IUCN Species Survival Commission: the Pinniped SG, Cetacean SG, Sirenian SG, Otter SG and Polar Bear SG.

National and regional sources: In addition to the international sources of conservation information, some nations undertake research in support of management. Information obtained from such research is often available online. Major sources include Australia, Canada, New Zealand and the United States. The United States National Marine Fisheries Service and Fish and Wildlife Service provide updated Stock Assessment Reports on marine mammals under their respective jurisdictions (www.nmfs.noaa.gov/pr/sars; www.fws.gov/alaska/fisheries/mmm/stock/stock.htm). The United Sates Marine Mammal Commission also provides much information on marine mammal science and conservation (www.mmc.gov). In Canada, the Department of Fisheries and Oceans publishes information on population and ecosystem status (www.isdm-gdsi.gc.ca/csas-sccs). In addition, the Committee on the Status of Endangered Wildlife in Canada posts status reports on all marine mammal species of concern in Canada (www.sararegistry.gc.ca). Australia provides information on cetaceans, pinnipeds and dugongs that occur in areas within national jurisdiction (www.environment.gov.au/topics/marine/marine-species). New Zealand undertakes its own assessments (Hitchmough, 2010). In addition, a regional body in the North Atlantic, the North Atlantic Marine Mammal Commission, provides information on marine mammals in that region (www.nammco.no).

2.3.2. Potential value of management methods

Regulation of directed and indirect takes: The most obvious approach to management of human activities that result in the killing of marine mammals is to control directed (i.e. deliberate) takes. Numerous examples demonstrate the effectiveness of this approach, such as the strong recoveries of some severely depleted populations following protection from whaling, sealing, or other forms of deliberate exploitation. The status of marine mammal populations, especially in relation to the effects of directed takes, is usually measured in terms of the size of populations relative to historical levels. The likelihood of population recovery after takes are controlled depends on the survival of a viable nucleus of individuals in the population at the time of protection. Furthermore, suitable habitat, including food resources, needs to exist to support recovery.

In some cases, especially when a population has been reduced to low levels, it is also necessary to manage sources of incidental (i.e. unintentional) mortality, injury, and disturbance due to other human activities. This can include requiring the use of less wasteful fishing practices and less by-catch-prone fishing gear and the regulation of ship traffic to reduce the incidence of vessel strikes. Techniques to reduce by-catch include the use of acoustic deterrents, gear modifications, time-area closures, and gear switching, for example, from gillnets to hook-and-line or traps/pots (i.e., Knowlton and Kraus, 2001; Read et al., 2006). Some of these approaches have been the subject of considerable research (www.bycatch.org). Other anthropogenic threats may also need to be addressed, including reduction of noise from anthropogenic sources, and reduction of contamination by toxic substances (including oil) and of marine debris (including discarded or derelict fishing gear, and plastics of all sorts) (see chapter 25. The effects of tourism, for example whale and pinniped watching, in modifying behaviour through close approach, particularly to breeding and nursery areas, may also need to be addressed (Higham et al., 2014). In any event, successful marine mammal management requires selecting and implementing suitable methods of enforcement.

Marine Protected Areas: Protecting marine mammals in specific areas (e.g., feeding, breeding, and resting areas) can sometimes be effective for addressing certain threats (Gormley et al., 2012). Understanding the life history of the species, the degree of localization of the threats and the needs and interests of local human populations is critical to the design of area management. Effective protection depends on devising plans that consider local community needs, as well as establishing effective control and monitoring. Furthermore, marine mammals tend to be highly mobile, and some species migrate across multiple ecosystems and even entire ocean basins, so protection may be needed in more than one area. There is considerable interest in spatial management to protect and conserve marine mammals through the establishment of parks, reserves and sanctuaries (e.g., Reeves, 2000; Marsh and Morales-Vela, 2012; and see www.icmmpa.org).

3. Key pressures linked to trends

3.1. Direct Removals

There are various types of directed takes, including commercial harvests, scientific sampling, captive display, and subsistence. Some of these are under management while others are unauthorized and unmanaged. The nature of direct removals varies among major marine mammal groups.

There is a very long-standing, but relatively small (811 whales over four centuries), capture of northern bottle-nosed whales in the Faeroe Islands (Denmark), recorded from at least the sixteenth century (Bloch et al., 1996). Coastal dolphins continue to be taken not only in the Solomon Islands (Oremus et al., 2013), but also in a large-scale drive fishery in Japan. Dolphins are hunted with harpoons in various countries for human consumption or for bait, especially in shark fisheries (IWC, 2013b). The consumption of by-catch as well as deliberately taken cetaceans and sirenians is a growing concern in Africa, Asia, and some parts of Latin America (Clapham and Van Waerebeek, 2007). In the Arctic, narwhals and belugas continue to be hunted by aboriginal people in Canada, Greenland (Denmark), the Russian Federation and the United States. Marine mammals are also harassed and sometimes deliberately killed around aquaculture facilities in many parts of the world.

Whales are taken by several States for commercial, aboriginal and scientific purposes. The nature and regulation of these takes are described by the International Whaling Commission (www.iwc.int). Cetaceans occasionally strand on the shore in large groups: so-called mass strandings. The cause of this behaviour is poorly understood, but it has occurred for millions of years (Pyenson et al., 2014). Unless a population has been depleted by other causes, mass strandings are unlikely to be a major threat in themselves.

Pinnipeds – including walruses and numerous seal species – are hunted in large parts of the Arctic and sub-Arctic, primarily for subsistence. A few commercial hunts for pinnipeds continue, including those for Cape fur seals in Namibia, harp and hooded seals in Canada, and harp seals in Norway and the Russian Federation. Because pinnipeds often interact directly with fishing operations, sometimes fishermen and aquaculturists exert pressure to limit or reduce pinniped populations by commercial hunting or culling.

For manatees and dugongs, commercial hunting no longer occurs, but harvesting for meat and for dugong tusks continues in many areas. Although often illegal, there is little enforcement in most areas. The largest aboriginal hunts of dugongs persist in Australia and the western Pacific (Dobbs et al., 2012). In Australia, both Aboriginal and Torres Strait Islander people continue their traditional subsistence hunting of dugongs, but commercial hunting of dugong is prohibited.

3.2. Fisheries Interactions

While the effects of fisheries on marine mammals from entanglement and by-catch are well known (see section 2.3.2.1), the effects of marine mammals on fish

populations and the effects of fisheries on the prey base of marine mammals are less clear. The diet of most marine mammals includes fish and the possibility is often raised that some marine mammals are competing with fisheries or impeding the recovery of depleted fish stocks. Although some cetaceans, such as sperm whales, killer whales, pilot whales, and false killer whales, are known to depredate fishing operations, the significance of such depredation on fish populations and fish catches is not always clear.

Similarly, the effects of pinniped predation on valuable fish populations remain uncertain. For example, in the north-eastern Pacific sea lions feed on small populations of endangered salmon during spawning migration in rivers, especially in connection with dams (NMFS 1999). On the other hand, the significance of some other interactions is less clear (NMFS, 1999). Cape fur seals prey on two commercially fished species of hake off the west coast of South Africa (Punt et al., 1995) and grey seals prey on cod populations off the east coast of Canada (Fisheries and Oceans Canada, 2010). Population modelling studies of these fishery interactions suggest that seal culls are likely to have small if any effects on fish catch rates. Indeed, the effect of Cape fur seal predation may be overshadowed by predation of one hake species on the other. This suggests the need for further ecosystem-level research to clarify complex foraging relationships and interactions before conclusions are drawn, as discussed in section 4.1. (Yodzis, 2001; Gerber et al., 2009; Morisette et al., 2010). The biological and economic significance of marine mammal interactions varies with the fisheries and fish species involved. The areas of conflict are geographically limited and fishery interactions do not appear to be a global problem (Kaschner and Pauly, 2004).

3.3. Habitat Alterations

3.3.1 Disturbance

Many human activities generate underwater noise, including ship movements, military exercises involving the use of sonar or explosives, offshore oil and gas exploration and pile driving associated with construction of renewable energy facilities. Potential effects of such noise on marine mammals include direct acoustic injury, interference with foraging and communication, and food-web disruption. Disturbances are more likely to be significant for populations that have also been affected by other factors, such as harvesting or bycatch. Among the effects of disturbance that have been confirmed are the tendency of some whales to modify their movement patterns to avoid fixed-point noise sources, as for bowhead whales near an offshore oil production facility (McDonald et al., 2012), and the mortality of deep-diving cetaceans exposed to naval sonar (Cox et al., 2006; Fahlman et al., 2014; Ketten, 2014).

Offshore oil and gas development creates unique problems related to oil spills, whether at drill sites or during shipping. For depleted species, the additional mortality from ship strikes have been shown to be significant and vessel speed controls are demonstrably effective at reducing such strikes, as for right whales in the western North Atlantic (Laist et al., 2001; Laist et al., 2014).

3.3.2. Coastal and riverine development

Development in coastal and freshwater areas affects marine mammals in a variety of ways. Residential and urban development can make pinniped haul-out habitat inaccessible or hazardous. However, some species have shown remarkable adaptability to human-modified beach environments. For example, in the United States, California sea lions regularly haul out on piers and even on moored yachts in San Francisco. Although monk seals are extremely sensitive to disturbance in some areas, in Hawaii they sometimes rest and even nurse pups on crowded bathing beaches. In such cases, the animals seem capable of co-existing with the human presence as long as they are not molested.

Coastal habitats used by whales and dolphins make them vulnerable to increasingly intensive aquaculture operations of many types (Hucke-Gaete et al., 2013). A well-studied case is salmon farming in southern Chile, which operates in concentrated areas using open-cage net pens, moorings and anchoring, external supplementary feeding (rich in nutrients) and a significant quantity of chemical products (antimicrobials and pesticides) (Buschmann et al., 1996). However, there are differences globally in fish-farm design and operation, so general conclusions are difficult.

The construction of dams, barrages, and other structures in rivers and estuaries has led to fragmentation of dolphin and manatee populations in Asia and South America, making such populations more vulnerable to various threat factors, including entrapment in canals and mortality in flood-control gates. Runoff from agricultural fields, livestock feedlots, factories, and city streets contributes to chemical and biological contamination of freshwater, estuarine and coastal food webs, with often uncertain but likely negative effects on marine mammal health. For example, sea otter deaths in California (United States), have been linked to protozoan parasites known to breed in domestic cats (Johnson et al., 2009) and toxoplasmosis has been identified in Hector's dolphins (Roe et al. 2013).

3.3.3. Climate change

Climate change, both natural and human-induced, has the potential to affect the spatial distribution, reproductive success, foraging, and health of marine mammals (Leaper et al., 2006; Burek et al., 2008). The direction of such effects, negative or positive, is likely to be variable, with some species suffering from the loss of habitat and others able to take advantage of new habitat. MacLeod (2009) predicted that the ranges of most cetacean species (88 per cent) would be affected by changes in water temperature resulting from global climate change. This author predicted that the effects would be unfavourable for about half (47 per cent) of cetacean species. Little is known about the ability of most marine mammals to adapt to rapid environmental change. For example ice seals and polar bears, which are dependent on sea ice (Ferguson, et al. 2006), may be especially vulnerable to predicted climate change effects on ice habitat. Foraging habitat of right whales, which are dependent on small zooplankton, may change with increasing water temperature (Torres et al., 2013). Other species with more generalized diets and the ability to thrive in multiple types of habitat, such as bottlenose dolphins, may be more resilient (e.g., Heide-Jørgensen, 2009; Salvadeo et al., 2010). The overall effects of sea-level rise have been studied for northern elephant seals (Funayama et al., 2012) and Hawaiian monk seals (Baker, Littman and Johnston, 2006).

4. Major ecosystem services provided by marine mammals

4.1. Services to the ecosystem

Marine mammals can affect their ecosystems in several ways. Some species, such as sea otters, dugongs and walruses, structure their foraging habitat (e.g. Estes and Duggins, 1995). Depletion of these animals can result in major habitat changes; for example, kelp beds thrive when sea urchins are suppressed by sea otter predation. Other species, such as killer whales and leopard seals, play key roles as high-order predators, and their absence can affect prey resources of other marine mammal, bird or fish populations (Estes et al., 1998; Williams et al., 2004). Additionally, some species, such as sperm whales and blue whales, may have a large effect on nutrient recycling, with nutrient transport from deep ocean feeding areas to the surface (Lavery et al., 2010; Lavery et al., 2014). These ecosystem-level effects are understood for only a few species, but they can be critical for maintaining diverse and productive ecosystems (Bowen, 1997; Roman and McCarthy, 2010).

4.2. Direct services to humans including economic and livelihood services

The economic value of products obtained from marine mammals – meat, oil, ivory, fur, and many others – has been large, and this has contributed to these animals' extreme depletion and in a few instances led to their extinction (Steller's sea cow, Caribbean monk seal). Many groups of people continue to benefit from hunting marine mammals, including in some instances from selling products in international markets (e.g., narwhal and walrus ivory and seal skins). Aboriginal people in the Arctic and sub-Arctic continue to consume products from cetaceans and pinnipeds on a regular basis. Local people in Amazonia, northern Australia, and West Africa continue to harvest sirenians for food. In Nunavut and the Northwest Territories in Canada, regulated polar bear sport hunts provide income to Inuit who serve as guides and are required to use dog teams and sleds to pursue the animals.

In contrast, many people benefit from non-consumptive or low-consumptive uses of marine mammals, especially through whale-, dolphin-, and seal-watching tourism (see chapter 27). In addition, many people enjoy seeing marine mammals in the wild on their own. However, such activities can negatively affect small localized populations, for example bottlenose dolphins in Shark Bay, Australia (Bejder et al. 2006). Additionally, public display of captive marine mammals can make people more aware and appreciative of them, but it is extremely controversial, in part because the capture of marine mammals from the wild for display in captivity could threaten small wild populations (Fisher and Reeves, 2005).

5. Conservation responses and factors for sustainability

Like most large animals, marine mammals have limited capacity to reproduce and increase their numbers. Therefore, factors that can result in either low recruitment (e.g. impairment of reproduction by chemical contaminants such as organochlorines in food webs; (Dierauf and Gulland, 2001) or human-induced mortality rates higher than replacement (e.g. hunting or by-catch) need to be addressed to achieve conservation goals. Harmful algal blooms, ocean acidification, and expansion of hypoxia zones are among the most intractable factors affecting marine mammal populations. Conservation requires understanding of the organisms and their habitat requirements, and a balancing of human needs and desires with the natural productivity and the carrying capacity of the environment. The identification of key limiting factors is a first step toward developing management measures that can help populations to recover.

For the most part, population recoveries are regarded as successes, although in some cases they have led to unanticipated conflicts. One such conflict is with fishermen who have become accustomed to low levels of marine mammal abundance. For example, the recovery of numbers and range of sea otters has increased competition with fisheries for high-value molluscs in Alaska (United States) and the eastern North Pacific. Similarly, as mentioned above, sea lions prey on endangered fish, such as salmon and sturgeon, and recovering grey seals in Europe have had negative effects on seabird nesting habitat. Growing pinniped populations have also led to increased interactions with recreational fishers, vessel owners, and marina managers.

The conservation of marine mammals, like conservation more generally, should be understood as a dynamic and continuing process. Consequences of management actions need to be anticipated and unforeseen consequences addressed as they arise. Especially in the case of animals like marine mammals, that are widely distributed and rarely occur within the jurisdiction of only one State, multilateral approaches are essential. For example, the global ban on large-scale pelagic drift net fishing on the high seas imposed by the United Nations in 1994 was a major step in limiting the by-catch of several marine mammal (and seabird) species that were especially vulnerable to entanglement. Other international instruments, such as Convention on the International Trade in Endangered Species (CITES) and the International Convention for the Regulation of Whaling, have helped limit the damage caused by over-exploitation of the great whales.

With a broad understanding of the many aspects of both conservation and use of marine mammals and their roles in marine ecosystems, it should be possible to address at least some of the issues arising from human interactions.

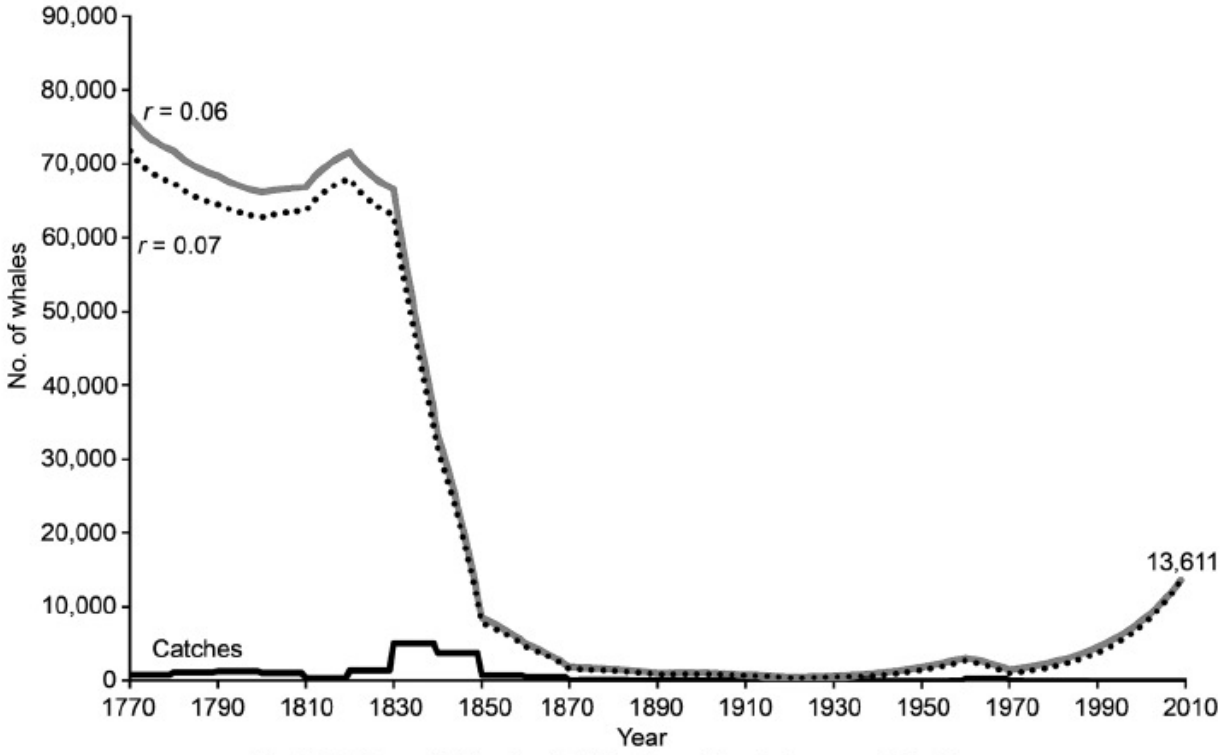

Figure 1. Catches (solid dark line) and estimated population size for southern right whales from 1770 to 2010, assuming a maximum annual net rate of increase of 6 per cent (grey line) and 7 percent (dotted line), culminating in an estimated population size of 13,600 in 2010 (IWC, 2013a).

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