Pelagic Reserves for Marine Top Predators: How Big and How Many?

By David Hyrenbach

While the concept of pelagic reserves may seem unreasonable due *to the vast movements of many whales, seabirds, and large predatory fishes (e.g., marlins, sharks, tunas), recent conceptual and technological advances have provided managers with the necessary tools to design and manage MPAs in oceanic systems and the open ocean beyond national territorial waters. In particular, advances in satellite-derived information, such as animal tracking and remote sensing imagery, are allowing scientists to define the habitats of protected species and to monitor oceanographic features and predator movements. Thus, it is becoming increasingly evident that pelagic reserves are not only feasible, but necessary to facilitate the long-term conservation of oceanic species and pelagic ecosystems.*

Marine protected areas are increasingly being used as tools for protecting valuable and sensitive ecological, cultural, and fishery resources throughout the world. Within this context, MPAs designed to conserve biodiversity can provide a wide range of protections for species, habitats, and ecosystems. For instance, no-take marine reserves, a type of highly protected MPA, often prohibit direct harvesting and indirect impacts on protected species and their habitats, while sanctuaries provide broader protections against more diffuse ecosystem-level impacts such as those involved in oil and gas extraction. In recent years, there has been mounting interest in the development of pelagic reserves—large MPAs designed to protect oceanic species and their habitats. In particular, marine ecologists have advocated the use of reserves to protect highly mobile marine mammals, birds, turtles, and sharks from incidental fisheries mortality and other impacts to their habitats. Because evidence suggests that top marine predators control populations of mid-level predators and hence help to structure marine food webs, the need to maintain their roles in marine ecosystems is critical.

LIFE HISTORY CONSIDERATIONS

Because MPAs have many different goals, their designs and management plans vary widely. Reserves designed to protect pelagic species and their oceanic habitats are based on design concepts driven by their biology and the associated oceanographic characteristics of their habitats. For example, managers need to understand critical life history aspects of the focal species: where and when they reproduce and feed; whether different life stages and sexes use distinct habitats; if they migrate seasonally between breeding and foraging grounds; and if they repeatedly use specific migratory pathways. Equipped with this information, managers can determine whether important life history processes are associated with habitats that can be mapped in time and space. Even though a given species may rely on specific features during certain seasons or ages, they may use widely distributed resources at other times. Thus, reserves may not be practical or effective throughout the entire life cycle of the species, but will only represent a feasible conservation option at those times and locations where the species concentrates in predictable features to breed or forage. These predictable aggregations provide excellent opportunities for the creation of reserves to protect these critical life history stages.

Sea turtles migrate long distances between their feeding grounds and places where they nest.

While reserves have long been used in coastal waters to protect benthic species and habitats, like coral reefs and mangroves, they are increasingly being considered to protect highly mobile species and oceanic habitats spurred by increasing evidence that these far-ranging species concentrate in predictable habitat features. Depending on the life history and habitats of the protected species, pelagic reserves can adopt four basic designs: hotspot reserves, reserve networks, basin-wide reserves, and ecosystem reserves.

HOTSPOT RESERVES

Wildlife reserves have long been used on land and at sea to protect relatively small areas of high biological value, because they harbor dense aggregations of protected species, sensitive or critical habitats, or areas of high biological diversity. For example, the eastern Pacific gray whale (*Eschrichtius robustus*) breeds off Baja California (Mexico) during the winter, spends the summer foraging in the Bering and Chukchi Seas, and migrates along coastal waters from Baja California to Alaska every fall and spring. A small (approximately 3,700 km^2) whale sanctuary encompassing two lagoons (Laguna Ojo de Liebre and Laguna San Ignacio) and the surrounding land was designated by the Mexican federal government in 1971 as a whale sanctuary to protect the gray whale calving grounds from development and associated threats, such as oil spills and coastal development. Research, recreation, tourism, and environmental education are the only permitted activities in the sanctuary, and whale watching is controlled.

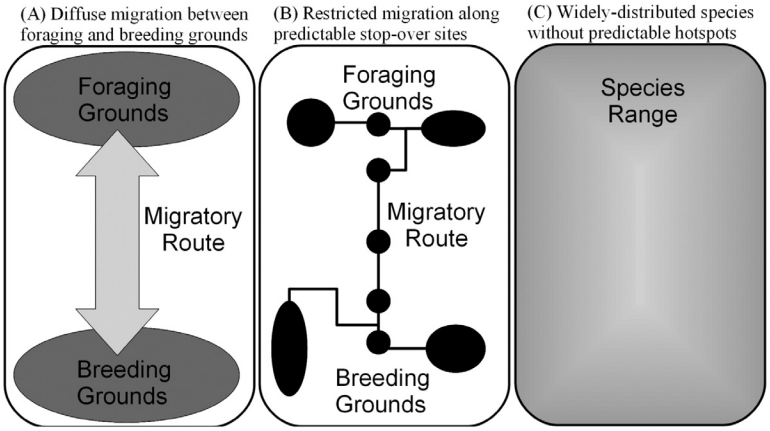

Figure 1. Diagram illustrating three different MPA scenarios: (A) two hotspot reserves protect key foraging and breeding grounds, connected by a diffuse migratory pathway; (B) a network of reserves protects stop-over sites along a fairly restricted migratory pathway, connecting predictable foraging and breeding grounds; and (C) a large seascape reserve encompasses the entire range of a widely distributed protected species. The shading indicates the abundance of the species, ranging from white (absence) to black (high density).

Species like the Pacific gray whale (*Eschrichtius Robustus*) have predictable migration patterns and could benefit from hotspot reserves.

Because gray whales have a fairly predictable oceanic migration, other sanctuaries could be created to protect this species during other parts of its life cycle. In particular, whale concentrations in their Alaskan summer-time foraging grounds could be mapped and protected. Potentially, other protective measures could also be used to mitigate human impacts along their migratory route between the breeding and foraging grounds [Figure 1(A)]. Due to the shared responsibility for the conservation of this species between Canada, Mexico, and the U.S., the Commission for Environmental Cooperation (CEC) selected the gray whale as a species of common conservation concern, a designation which involves identifying ecologically important areas for consideration as protected areas within the framework of the Bering to Baja Conservation initiative.

Even though MPAs are more difficult to design and to implement in the open ocean than in coastal areas, they could help to protect oceanic, highly mobile species like the fin whale (*Balaenoptera physalus*). Fin whales are found in all the world's oceans, but occasionally concentrate in dense aggregations susceptible to human impacts. The Pelagos Sanctuary for Mediterranean Marine Mammals was established in the Ligurian Sea (Western Mediterranean) in 1999 to protect a large local population of fin whales from accidental entanglement in drift nets, ship strikes, and pollution. This sanctuary covers an area of 87,492 km^2, and comprises the waters of three nations (France, Italy, Monaco) and 46,371 km^2 of high seas waters beyond areas under national jurisdiction. This MPA encompasses a persistent oceanographic front overlaying the continental shelf-break and upper slope (200-2000 m depth). These productive waters are believed to be the main feeding ground for fin whales in the Mediterranean basin, with an estimated 3,500 individuals using the area in summer. The sanctuary provides for enforcement of existing legislation by the three range nations to reduce a variety

of impacts. Discharge from dredges and power boat racing are both prohibited, and whale watching is regulated.

RESERVE NETWORKS

Because many cetaceans (whales, dolphins, and porpoises) engage in large seasonal migrations (over 1,000s of km), MPAs capable of encompassing their entire range would have to be very large, in some cases spanning entire ocean basins. Alternatively, multiple linked MPAs may be required to afford protection to these migratory species throughout their year-long cycle, by protecting their calving areas (winter), their foraging grounds (summer), and their seasonal migratory routes [Figure 1(B)], especially where they intersect with intense human activities such as shipping. Such a system of MPAs would require an integrated management plan involving multiple countries and protective measures in the high seas, beyond national jurisdiction, likely under the UN Convention on the Law of the Sea.

The International Union for the Conservation of Nature (IUCN) has defined MPA networks as "a collection of individual marine protected areas operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fulfill ecological aims more effectively and comprehensively than individual sites could alone. The network will also display social and economic benefits, though the latter may only become fully developed over long time frames as ecosystems recover" (WCPA/IUCN 2007). While reserve networks could be used to protect cetaceans throughout their migratory routes, network feasibility and design will ultimately depend on the predictability of species' foraging and breeding grounds, and the migratory routes connecting them. Thorough assessments will be required to guide these networks, because different threats have characteristic footprints that influence the ability of specific management actions to mitigate their impacts. In particular, the inability of reserves to mitigate large-scale human impacts with basin-wide footprints, such as climate change, noise pollution, and marine debris, emphasizes the need for a comprehensive approach to oceanic conservation, including the judicious use of MPAs with diverse objectives, designs, and management plans.

LARGE-SCALE RESERVES

In addition to reserves designed to protect cetacean hotspots from focused impacts, large seascape reserves may be required to protect widely distributed species from far-reaching threats over their entire ranges [Figure 1(C)]. For instance, vast expanses of the ocean beyond national jurisdiction have been set aside as international cetacean sanctuaries under the auspices of the International Whaling Commission (IWC), exclusively to protect large whale populations from commercial whaling. Currently, two such IWC sanctuaries exist: the 1979 Indian Ocean Sanctuary and the 1994 Southern Ocean Sanctuary. Together, these two sanctuaries cover the entire ranges of several Indian Ocean cetaceans that migrate seasonally from tropical breeding grounds to the Antarctic. The Indian Ocean and Southern Ocean Sanctuaries have been continued after scientific evaluations conducted every 10 years and are still in existence. While these sanctuaries do provide research and management benefits to large whale populations, their major limitation is the continued hunting of whales (largely Antarctic minke whales, *Balaenoptera bonaerensis*) by Japanese scientific permit whaling. This harvesting remains a major unresolved issue in the management of large whale populations and the monitoring of the Antarctic marine ecosystem.

Moreover, two proposals for the establishment of additional IWC sanctuaries in the South Pacific Ocean and the South Atlantic Ocean have so far failed to gain the required three-quarters majority at annual IWC meetings. Thus, large whale stocks in these two oceans are not currently protected from commercial whaling throughout their life cycle, since these populations exit the protected waters of the Southern Ocean Sanctuary (SOS) to breed in the tropics, or from scientific permit whaling. Despite the failure to agree to the establishment of new IWC sanctuaries, recent assessments of the two existing sanctuaries have stressed the need for broader management goals aimed at establishing a comprehensive ecosystem-based management of cetaceans within sanctuary waters.

ECOSYSTEM RESERVES

Even though reserve networks may be critical for protecting migrating species throughout their life cycle, they may not suffice to preserve the key ecological interactions and ecosystem processes supporting them. In recent years, scientists have called for the establishment of large ecosystem-level reserves to protect some of the last remaining stretches of ocean that have not been harmed by human activities such as overfishing and pollution. While most existing marine reserves have been created to protect endangered species and their habitats, these novel large scale, no-take reserves would be created preemptively to ensure that marine regions with high biodiversity or ecological value remain undisturbed. Basically, these ecosystem reserves would act as an insurance policy against future ecological degradation. Furthermore, these sites would facilitate long-term research opportunities as reference sites, critical for monitoring changes in marine ecosystems. The *Last Ocean* initiative, which advocates for the establishment of a basin-wide, no-take reserve to protect the diverse and productive Ross Sea near Antarctica, illustrates the concept of ecosystem-level MPAs in the open ocean.

CONCLUSIONS

MPAs are increasingly being used to protect cetaceans throughout the world, including pelagic species in oceanic habitats. As more pelagic reserves are established for biodiversity conservation, a more comprehensive approach for their design and management is emerging, built upon four principles: (i) all MPA designs must include clear goals and management plans that are periodically evaluated and revised, supported with adequate surveillance and enforcement; (ii) small hotspot reserves can

Pelagic MPAs can help conserve endangered species like the northern right whale *(Eubalaena glacialis)*.

be used to protect predictable breeding and foraging sites; (iii) reserve networks are needed to protect the entire life cycle of migratory species; and (iv) large seascape reserves are required to address broader ecosystem-level management considerations, including the long-term conservation and monitoring of ocean ecosystems.

Ultimately, marine reserve designs are driven by the natural history of the species to be protected and by the threats affecting them. For instance, while hotspot reserves can protect species with small ranges at a given life history stage from focused threats (e.g., incidental mortality from fisheries and ship strikes), large seascape reserves (often basin-wide) are needed to protect far-ranging species with seasonal migrations from widely distributed threats (e.g., commercial whaling). Nevertheless, reserves need not completely remove human impacts from the entire range of a species to be effective conservation tools; small decreases in mortality rates from entanglement and ship strikes can help reverse the population declines of protected whale species. Thus, fine-scale protective measures targeted at critical foraging and breeding sites can yield large conservation pay-offs, especially for species with small populations under pressure (e.g., the Pacific and Atlantic northern right whale, *Eubalaena glacialis*).

In those instances when cetaceans concentrate in predictable areas to breed (e.g., gray whales in Baja California) or to forage (e.g., fin whales in the Ligurian Sea), small reserves can protect these important habitats. These hotspot reserves can target productive habitat features associated with the sea floor (e.g., banks, seamounts, canyons, shelf-breaks) and with predictable locations where water flow causes high-localized productivity (e.g., upwelling plumes) or the concentration of weakly swimming zooplankton prey (e.g., convergence zones). Because these bathymetric (sea floor) and hydrographic (water movement) features vary in size and predictability, different reserve designs will be required to encompass top predator distributions in these habitats.

Existing cetacean MPAs (e.g., Pelagos and IWC Sanctuaries), ongoing initiatives for MPA networks spanning entire large marine ecosystems (e.g., Bering to Baja), and recent closures of high seas pockets in the Pacific Ocean to tuna fishing (Currie and Wowk 2009), underscore the potential use of international reserves in the conservation of pelagic species, including marine mammals, birds, turtles, and predatory fishes.

The *Last Ocean* initiative to establish a basin-wide, no-take reserve in the Ross Sea illustrates the advent of ecosystem-level MPAs on the international agenda. This reserve would protect marine top predators and the ecosystem processes they depend upon in perpetuity, by stopping the harvesting of marine resources—including scientific permit whaling—in this vast region of Antarctica. Already in October 2009, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) designated a similar ecosystem-level, high seas reserve south of the South Orkney Islands (South Atlantic Ocean). This reserve is intended to provide a scientific baseline for research, to increase resilience to climate change, and to conserve important predator foraging areas and representative examples of pelagic and benthic bioregions. Thus, a wide array of human activities, including fishing, ship discharges, dumping, and shipping, will be prohibited.

The future of pelagic conservation will involve the implementation and evaluation of fine-scale and basin-wide protections, including marine reserves designed to protect biological hotspots, bottlenecks in the migratory pathways of highly mobile species, vast seascapes encompassing the entire life cycle of protected species, and entire marine ecosystems. A diverse array of MPAs, both multiple-use and no-take, will be required, alongside other fisheries and conservation actions, to help protect and monitor far-ranging species and their oceanic habitats.

WEB LINKS

- Case Study 1- the Pelagos Sanctuary: **http://www.cetaceanhabitat.org/pelagos.php**
- Case Study 2- International Whaling Commission Sanctuaries: **http://www.iwcoffice.org/conservation/sanctuaries.htm**
- Case Study 3- The Bering to Baja Initiative: **http://www.cec.org/files/PDF/BIODIVERSITY/IMpaper_en.pdf**
- Case study 4- Ecosystem-level MPAs: **http://lastocean.com/story/overview/read/**

FOOD FOR THOUGHT

Visit the American Cetacean Society website (http://www.acsonline.org/factpack/) and compare the cetacean distribution maps. Read the species profiles and discuss

possible marine reserve designs for the different species. Consider the following:

- Do the species have large or small ranges?
- Are their breeding and foraging grounds together or separated?
- Do the species go on vast seasonal migrations? Hint: you may want to consider the following three species:
    - Gray whale: http://www.acsonline.org/factpack/graywhl.htm
    - Fin whale: http://www.acsonline.org/factpack/finwhl.htm
    - Franciscana dolphin: http://www.acsonline.org/factpack/Franciscana.htm

The number and size of MPAs varies throughout the world. Look for existing MPAs in your region on the interactive map and the regional lists. What parts of the world have the highest/lowest concentrations of MPAs? Where are the world's largest MPAs?

- Interactive map: http://www.mpaglobal.org/index.php?action=aboutus
- Regional lists: http://www.mpaglobal.org/index.php?action=summary_by_country

Effective MPAs need management plans devised by scientists together with local stakeholders. Management plans describe the specific conservation goals for the individual species and the entire ecosystem to be protected, the research and educational needs, the types of allowed and restricted uses, the management and enforcement regimes required, and the schedule for periodic monitoring and review of the MPA goals and performance. To learn more about the threats faced by cetaceans and the potential management actions to mitigate these threats, consult these MPA management plans at http://www.cetaceanhabitat.org/management_plans1.php.

Northeastern offshore spotted dolphins are believed to migrate inshore in the fall and winter months and offshore in the spring.

Read about the scientific rationale for creating ecosystem-level MPAs, and their importance for long-term conservation, resource management, and research at http://lastocean.com/.

FOR MORE RESOURCES

- Baja California to Bering Sea Ecosystem: **http://www.mcbi.org/what/b2bcd.htm**
- International Whaling Commission, Scientific Permit Whaling: **http://www.iwcoffice.org/conservation/permits.htm**

For more information on the design and implementation of the Pelagos Sanctuary, refer to NCEP module 498 ("The Pelagos Sanctuary for Mediterranean Marine Mammals"), available at http://ncep.amnh.org.

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REFERENCES

Currie, D., and K. Wowk. (2009). *Climate Change and Co_2 in the Oceans and Global Oceans Governance*, CCLR 4:387-399.

WCPA/IUCN. (2007). *Establishing Marine Protected Area Networks: A Guide for Developing National and Regional Capacity for Building MPA Networks*. Available at: http://www.medpan.org/_upload/893.pdf

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