Study identifies priority regions for conservation of iconic large marine animals

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Protecting marine vertebrates at sea is one of the greatest challenges in conservation.

A team of researchers, and from the Universities of Exeter, Plymouth and Southampton and Plymouth Marine Laboratory (PML), has brought together several decades of scientific literature about animals that are known to be associated with ocean fronts in different parts of the global ocean, and why. The findings, published in the *Journal of Applied Ecology*, show that oceanic fronts - areas where nutrients are drawn together resulting in foraging hotspots - should be priority regions for conservation efforts.

Large marine vertebrates such as seabirds, turtles, sharks, seals and whales are under severe threat from human activity in the oceans, with many populations undergoing dramatic declines. These animals are

flagships for conservation and fulfil critical ecological functions, such as stabilising food webs, nutrient cycling and maintaining biodiversity. Yet despite this they are currently afforded minimal protection, particularly in the open ocean where they spend the majority of their lives. As human demands on marine resources continue to grow, threats have intensified and conservation solutions are now a matter of urgency. Protection of coastal sites form the backbone of current marine conservation strategies but many animals live far from land and range over great distances, hampering conservation efforts.

Dr Stephen Votier from the ESI at the University of Exeter's Penryn Campus in Cornwall said:

"Protecting marine vertebrates at sea is one of the greatest challenges in conservation. It is like trying to conserve a moving target, and a target that is largely out of sight. Thus far we have tended to focus on where these animals are located, but our review provides answers to the why. Oceanic fronts are discontinuities in the sea that provide excellent foraging conditions, and are in turn important hotspots for a wide range of marine vertebrates. Unlocking the key to protected areas for marine vertebrates is therefore all about understanding the underlying oceanography."

Securing the future of large marine vertebrates may come from increasing our understanding of how and where they feed at sea. Food can be tough to find in the open ocean but oceanic fronts, areas where nutrients are drawn together, can produce foraging hotspots. Fronts encourage phytoplankton growth, which in turn supports zooplankton, fishes and ultimately, large predators including sharks, turtles and albatrosses. Therefore if we know the whereabouts of fronts, we may be better able to protect these threatened, iconic animals.

Ocean fronts show at the surface as sharp changes in temperature,

salinity, density or colour and so can be automatically detected using satellites. Also areas in which fronts form frequently or persist for longer amounts of time are known to be particularly important habitats for marine vertebrates, and can be mapped via satellite in near real-time. Satellite observations together with studies of the behaviour of marine vertebrates via tracking and other survey techniques is developing a valuable knowledge base to help form protection strategies.

The review also clearly demonstrates that it is not only the charismatic, large marine animals that are attracted to fronts, they are also highly attractive to fisheries operations, and hence potential for competition and incidental capture of marine vertebrates ('by catch') is high. Frontal zones therefore represent tractable conservation areas, where we can focus measures to reduce threats.

The review team sees great potential in using the combined knowledge for conservation and management:

"We now have the opportunity to integrate satellite science, spatial ecology, oceanography and fisheries management to improve marine biodiversity conservation. This could inform conservation planning through mapping and real-time monitoring of hotspots of human threat to marine vertebrates," said lead author Kylie Scales, concluding that: "We need this integration if we are to balance human activity and biodiversity conservation in the vast and dynamic oceans. We know many of these enigmatic animals use fronts, and we can map the locations of these fronts in near real-time, anywhere in the global ocean. So front maps could be used as part of a range of tools to identify, monitor and manage at-sea conservation areas, informing the design of Marine Protected Area (MPA) networks and supporting development of dynamic ocean management."

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