ECOLOGY-

How migrating marine megafauna tracks with conservation

Evidence-based conservation to guide actions for protecting the ocean's most iconic species

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Despite growing global commitments to protect ocean biodiversity, conservation falls short in safeguarding the species most vital to ocean health. On page xxxx of this issue, Sequeira et al. (1) report an extensive dataset representing 15,000 tracked marine megafauna and show that less than 8% of the area used by tracked individuals overlaps with designated marine protected areas. By identifying specific, predictable areas that remain largely outside existing conservation frameworks, the authors propose Important Marine Megafauna Areas. As policymakers rally behind ambitious targets including the 30×30 goal—to protect 30% of the ocean by 2030—and the United Nations High Seas Treaty, the findings of Sequeira et al. offer an empirical foundation to align conservation efforts with the movements and needs of highly migratory marine species.

Sequeira et al. systematically combined data from many disparate sources covering 11 million geopositions from nearly 16,000 animals across 121 species to get a global picture of the ocean space used by highly mobile marine megafauna—from whales to sharks to seabirds—revealing that 63% of the area they occupy predominantly functions as critical migratory corridors or residence areas. The data synthesis points to the tremendous potential of marine animal tracking data to inform conservation planning on an unprecedented scale. The study also highlights a persistent gap between data collection and its applications in policy. The authors adopted a retrospective approach, mapping species movements to infer conservation priorities, particularly through marine protected areas, where human activities are managed or restricted to conserve marine ecosystems, biodiversity, and cultural resources. This strategy reflects a broader trend in conservation science in which efforts often begin with gathering data rather than posing management-driven questions. As the world faces substantial biodiversity challenges, future work should build on clearly defined conservation goals that are informed by rigorous science that links management actions to conservation outcomes. This could involve, for example, designing networks of marine protected areas or other interventions that protect species during life history stages that are most critical to the growth rates of populations and long-term viability of the species (2,3). Further still, aligning conservation goals to the technical, political, or economic feasibility of available management actions (*4*) can help prioritize and focus data collection to design interventions that most effectively address those objectives.

Although the focus of Sequeira et al. on marine protected areas is understandable given the prominence of this management strategy in policy making, this emphasis can unintentionally oversimplify the diverse threats facing marine megafauna. Marine protected areas are a vital part of the conservation toolkit, but as Sequeira et al. indicate, they are not a panacea - especially for wide-ranging species that regularly traverse multiple government jurisdictions, such as gray whales, which migrate through regions governed by 3 countries (*5*). Effective conservation must account for the timing, location, and nature of interactions between these animals and threats such as bycatch, ship strikes, ocean noise, plastic pollution, and whaling (*6*). These problems are often addressed in fragmented ways that fail to capture the cumulative impacts that marine species face throughout their migratory journeys.

One illustrative example is whaling—one of the few ocean threats regulated at the global level. Although still a controversial topic, whaling now contributes relatively little to overall human-caused mortality compared to other, less-regulated threats. Yet, the majority of public discourse on whale conservation focuses on whaling activities. By framing whaling within a broader context of cumulative impacts, the conservation dialogue shifts to where the real problems are occurring, thereby focusing efforts on solutions that will maximize conservation impacts. Such an approach is equally relevant for other marine species that migrate over long distances, such as sea turtles, seabirds, and pelagic sharks.

The goal of the 30×30 initiative has galvanized international momentum, yet its impact depends on clearly articulated outcomes. Rather than asking what percentage of habitat should be protected, the community might instead ask what level or kind of protection is needed to reduce extinction risk or to maintain the ecological roles of marine megafauna. Further, which life stages or activities (e.g., migration or residency areas) should be targeted? Conservation goals should be grounded in these kinds of measurable outcomes.

To realize such results, conservation planning must evolve to integrate diverse datasets and assess the relative importance of different threats for each species or group—as well as incorporate information on how likely management actions are to achieve targeted changes (7). This approach would enable more strategic allocation of resources (8) and allow conservation efforts to focus on the most pressing drivers of decline. The Important Marine Megafauna Areas framework introduced by Sequeira et al. is a major step towards identifying key spatial overlaps between different species and human activities, also opening the door for more comprehensive analyses.

Mobility and migration data remain one of the neglected traits of macroecological studies, with a few exceptions that have been limited to the terrestrial realm. Yet, those terrestrial examples have provided key insights into the effects of human activities on animal performance (9), ecological processes (*9*), and biodiversity trends (10). The role of mobility and migration in the marine realm is likely more important for the ecology and evolution of species than on land, because movement is energetically less costly through water than through air (*11*). Connecting information on the functional and life history traits of marine species with the rich tracking dataset from Sequeira et al.

provides a timely opportunity to investigate how marine megafauna are responding to anthropogenic threats.

Beyond identifying marine regions of high biodiversity or movement, determining how species interact with environmental and human threats should help identify feasible management actions. For example, how frequently do migratory species encounter bycatch hotspots, and which mitigation measures are most effective? Other questions surround the effectiveness of mitigation measures and their expected economic or socio-political costs. Another concern is the impacts of noise pollution and how those compare to, and intersect with, the effects of fisheries on marine megafauna. Adopting a threat-based framework (*12*) rooted in systematic decision making not only informs where marine protected areas might be most critical but also informs complementary interventions—such as modifying fishing gear or implementing vessel speed reductions—that extend beyond protected zones.

Transparency around the intentions and outcomes of large-scale data initiatives is crucial. Long-term monitoring has often paved the way for unanticipated discoveries. However, without clearly defined goals prior to accessing such a rich resource, there is a risk of becoming sidetracked by exploratory analyses that may lead to less robust or spurious findings. Substantial investment has gone into global marine animal tracking and understanding what conservation gains have or could result is key. By ensuring that future efforts are targeted at areas or threats that cost-effectively improve species outcomes, rich datasets can be leveraged for tangible species protection, in addition to describing movement patterns.

The findings of Sequeira et al. provide a forward-looking change in marine conservation. Data must serve decision-making, not just documentation. Conservation strategies should be rooted in clearly defined goals, informed by threats, and measured by their past or expected success in reducing harm to vulnerable species. Although the Important Marine Megafauna Areas framework offers a compelling spatial lens, its value will be maximized when drawing upon knowledge of individual species' traits and life histories (*13, 14*), and combining this knowledge with a diverse suite of management tools that reflect the complexity of governing marine ecosystems (*15*).

The future success of marine megafauna conservation will depend on implementing targeted, scalable strategies that transcend political boundaries and address multiple stressors (*16*). With the work of Sequeira et al. as a foundation, it is time to embrace outcome-oriented, evidence-based conservation—not just to meet targets, but to make a measurable difference for the ocean and its most iconic species.

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