# Conservation benefits of an interdisciplinary approach to marine mammal science

Health & Medicine

Marine mammal scientists tend to be rather wary of economists and may have a limited understanding of their role in marine science and conservation. This is likely due to the general belief that economists are " all about business and profits" rather than environmental conservation. Such misunderstanding is unfortunate because natural resource economics, a discipline that is somewhat more recognized in the context of terrestrial conservation, addresses the full valuation of wildlife (including marine mammals) to society ( Krutilla, 1967 ). Economists embrace complete accountability for the costs imposed on marine mammals and ecosystems by human activities, whether or not these values derive from direct exploitation or use. Such a comprehensive approach can improve policy design, stimulate public interest, facilitate better-informed decision-making, and provide stronger incentives for compliance with regulatory measures. A more concerted effort at dialogue and collaboration between marine mammal scientists and resource economists would strengthen the case for conservation and increase policy effectiveness as well as equity.

In addition to considering all costs and benefits to society, natural resource economists look for efficiencies in regulatory policy, such as approaches that incentivize environmentally beneficial decisions rather than force them through government top-down, " command and control." For example, in addition to technological fixes to carbon emissions, economists would also assess whether market-based approaches such as cap-and-trade systems or a carbon tax would yield higher net benefits. While there is a lively debate in the economics literature over the relative merits of the two market-based alternatives ( Goulder and Schein, 2013 ), both of these approaches provide

flexibility and incentive for innovation, as the firms figure out the technological fixes needed to operate profitably given the tax or the costs of acquiring emissions credits.

Natural resource economists also add to the quality of analyses of policy alternatives by including estimates of the non-market value of wild organisms and ecosystems to society. These estimates can be based on the non-consumptive uses (e. g., whale watching) and non-use values (e. g., existence and bequest values) 1 . In some cases, economic valuation analyses focus on population-level values as opposed to individual species values. For example, in a study on the value to Americans of improving the status of North Atlantic right whales, Wallmo and Lew (2012) estimate that households are willing to pay $71. 62 on average for removal of the species from the endangered species list. Estimating such values is a first step; incorporating them into the analyses of policy alternatives that inform decisions is the next, and sometimes more challenging, step in the process. Perhaps understandably, non-economists are often uncomfortable with the concept of putting a dollar value on a " charismatic megafauna" such as a whale through survey methods soliciting stated preferences. However, not all existence values are estimated through stated preferences, nor are all economic analyses predicated on existence value estimates.

Economics can also be a great asset in designing effective policy even when there is not a possibility of including values of marine mammals in the analysis. For example, if a regulation sets a limit on the number of animals affected by a given activity, a cost-effectiveness analysis would identify the

least-cost approach to satisfying this objective. This approach would “ release” financial resources for needed conservation measures elsewhere that would otherwise not be available.

Another pertinent point is that economists generally prefer private, negotiated solutions to adverse environmental impacts, rather than top-down, regulatory solutions. Such an approach can lower conservation costs, strengthen incentives to meet conservation objectives and compliance, and create an environment whereby innovative solutions are developed that might otherwise never occur. Negotiated solutions to externalities are particularly pertinent to cases in which the parties can be clearly identified and for which there are no public goods. Examples include the Morro Bay, California, groundfish fishery, in which an NGO purchased trawler permits and subsequently made the permits available for alternative gears having fewer adverse environmental impacts (and also achieving the NGO's objective of a smaller scale of operation) ( Gleason et al., 2013 ). Off central California in the approaches to the ports of Long Beach and Los Angeles, a voluntary, informal, non-binding agreement was negotiated among interested parties to achieve the goals of reducing ship speed and minimizing transit time in state waters using low emission fuel and therefore minimizing carbon emissions and the probability of marine mammal vessel strike injury and mortality 2 . It is interesting to note that to some extent, existing regulatory bodies such as the regional fishery management councils and marine mammal take reduction teams seek to establish this same approach of negotiation and dialogue in addressing environmental issues, admittedly with varying success.

Consider in turn the primary threats to the survival of marine mammals, notably fishery bycatch, climate change, and anthropogenic sound (shipping, energy exploration and development, military, construction) and what natural resource economists have to contribute to addressing each of these problems.

Bycatch (including entanglement in discarded or lost fishing gear) is the greatest direct threat to marine mammals, with estimates of annual mortality in excess of 650, 000 marine mammals globally ( Read et al., 2006 ). Economists approach bycatch as an unintended adverse impact of fishing for target species (i. e., a negative externality) that is not factored into the costs of fishing, and therefore not reflected in the price of seafood. Because the price of seafood is too low (it does not include the “ costs” of marine mammal mortality), fishing vessel operators, seafood marketers in the supply chain, and consumers are unaware of, and do not bear, the full costs of their activities and therefore over-produce and over-consume both targeted and bycaught species. Over the longer term, imposing these higher costs on fishing operations should create “ dynamic” incentives that induce technological change that reduces marine mammal bycatch. Traditional command-and-control bycatch measures could include mandatory modifications of gear or gear deployment (such as pingers on gillnets in the New England groundfish fishery), or time/area closures to reduce the overall level of bycatch in a fishery. In contrast, examples of incentivizing approaches championed by economists might include per-vessel allocations of tradable bycatch quotas or bycatch credits, resulting in trade among operators such that the vessels that are most efficient in reducing bycatch

end up doing most of the fishing—thus most efficiently reducing impact on marine mammals. In evaluating the various alternative regulatory and negotiated measures for mitigating marine mammal bycatch, economists would include not just the costs to fishery operations but also estimates of the benefits, to the ecosystem and to the public, of reductions in marine mammal mortality. An interesting example of an incentivized approach negotiated by an industry group in order to meet regulatory standards is found in one of the world's largest fisheries, notably the Alaska pollock fishery. The member companies in the At Sea Processors Association implemented their own " Chinook Salmon Incentive Plan and Agreement," which includes identification of " rolling hot spots" based on vessel reporting and features stricter provisions on fishing vessels with low performance in avoiding Chinook bycatch 3 .

Climate change is having profound and likely irreversible impacts on marine mammals through modification of habitat (particularly in the polar regions), such as reductions in sea ice and prey availability, altered pathogen survival and transmission, ocean acidification, and other ecosystem shifts. Mitigation of climate change requires measures that are pervasive and complex, with financial impacts on nearly all human activities and, if enacted, benefits to the entire global ecosystem and all species, including humans. As with fishing, and given the conclusion that climate change is driven largely by increasing carbon emissions [ International Panel on Climate Change (IPCC), 2014] , economists would argue that by ignoring the uncosted negative impacts (i. e., negative externalities) associated with carbon emissions, prices are too low—not just for energy products but for all goods and

services that use energy for production, transportation, and consumption. Incorporating the costs of these negative externalities into business decisions (via taxes or a cap and trade system) would result in higher costs and prices, and lower levels of production and consumption. Over the longer term, these higher costs would be expected to create “ dynamic” incentives that induce technological change that mitigates climate change and its impact on marine mammals—and the rest of marine and terrestrial ecosystems. In addition, while economists generally oppose subsidies (and taxes) as market-distorting interventions, when a “ good” is being produced that does not have a market value (e. g., cleaner air), there are economic arguments to be made for public funding of activities such as development and adoption of technological change that reduces energy consumption.

Marine mammals use sound for virtually everything they do, which includes communicating and interacting with conspecifics, avoiding predators, locating prey, and navigating in the marine environment ( Marine Mammal Commission, 2007) . In addition to the overall masking effects of an increase in ambient sound levels on communication, acute anthropogenic sounds at a high enough sound pressure level can result in temporary or permanent loss of hearing, physical injury, behavioral modification, and stress impacts on the health and survivability of marine mammals. Human activities such as shipping, offshore energy development (seismic surveys, pile-driving, drilling, etc.), and military operations generate potentially harmful underwater noise—at no cost to those carrying out the activities. Current command-and-control measures for addressing noise include mitigation efforts such as slow ramp-up of sound sources, use of trained observers to

monitor “ safety” zones around the sound sites, and shutting down the sound source when marine mammals are sighted nearby. In contrast, if the approach were to incorporate the true costs of these externalities into private sector decisions 4 on whether and how to conduct such activities, there would be higher costs and prices for the products and services (such as shipping fees and energy prices) and therefore lower levels of production. Again, over a longer time period, these higher costs (e. g., through a tax on noise emission) would provide incentives for technological change that reduces the impacts on marine mammals and other marine organisms from various underwater sound sources.

Marine mammal scientists and managers have much to gain by collaborating with their colleagues in natural resource economics. At the same time, economists need to focus on developing relatively simple and easily understood economic parameters that can be part of the information made available to policy makers and the public. Examples include measures of the non-market value of marine mammals or willingness to pay for population recovery, and the costs of the more common externalities, such as carbon emissions or noise. Full comparative analyses of alternative measures for mitigating impacts on marine mammals, including assignment of values to all direct and indirect costs and benefits, should help inform public debate and decision-makers and lead to more rational policies and greater incentives for compliance. The synergies from cross-disciplinary collaboration can enhance the quality and quantity of information available— to decision makers who have the responsibility for marine mammal conservation and to the public who must be part of the process. With so

many challenges in trying to address threats to marine mammals, an interdisciplinary effort is needed to save these animals and their marine environment, and ultimately, ourselves.

## Conflict of Interest Statement

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Footnotes

1. ^ Existence value refers to willingness of individuals to pay for the conservation of an environmental good, without being able to use or even see that good. The value can be based on altruism, intergenerational bequest value, or intrinsic worth ( Blomquist and Whitehead, 1995 ).

2. ^ In the case of Santa Barbara, shippers received partial compensation for the vessel speed reduction ( http://thinkprogress. org/climate/2014/08/05/3467453/ships-slow-down-to-protect-whales/ ) providing an interesting example of Payments for Ecosystem Services (PES).

3. ^ See description of the program at http://www. atsea. org/doc/Salmon%20Bycatch%20Poster%20FINAL. pdf

4. ^ Command and control policies are likely the most effective approach for the case of military exercises.

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