Sustainability, Ecosystems and Fishery Management

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Abstract

Fisheries management is experiencing a trend in which harvest rates are being reduced through increasing consideration of complexity. As recently as the late 1960s there was acceptance of fishing mortality equivalent to natural mortality (F = M). From this extreme, reductions in fishing mortality have been based on a variety of arguments, not the least of which is consideration of other species and ecosystems, especially those of the target resource species. In 1999, a National Research Council committee recommended further reductions as a means of dealing with ecosystem issues. Reductions in fishing mortality are the common element in the options being considered for the management of Bering Sea fisheries in view of potential effects of fishing on the endangered northern sea lion. Similar patterns are seen in the management of other fisheries such as the salmon of the Pacific Northwest, now protected under the Endangered Species Act.

One of the tenets of management requires that the complexity of nature be accounted for as a matter of principle. What is the end point of the declining trends in acceptable fishing mortality as more and more complexity is considered? In this poster we present empirical information for estimating such endpoints. More specifically, we present the central tendencies within limits to natural variation in predation/consumption rates observed for various marine mammal species as standards and reference points for fisheries management. Systemic management would apply this information to manage fisheries with harvests from individual resources species, groups of species, ecosystems, or the entire marine environment.

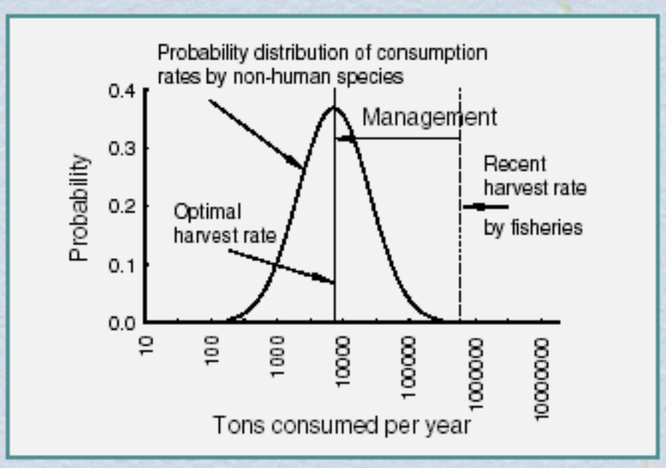
Limits of Conventional Management

Management historically has relied on models and theories about nature which are all subject to limitations. Primarily due to lack of scope, this has led to the over harvesting of resources and general degradation of the biosphere. Maximum sustainable yield (MSY) has a history in which fishing mortality rates as high as total natural mortality rates were used as a rule of thumb.[1] But models are always incomplete and do not account for the intangible, unimaginable, and complex matters of reality. Total allowable catches (TAC), potential biological removals (PBR), and optimum yields (OY) all suffer from such limitations and do not provide an adequate way to manage beyond the species level and certainly not at the level of the complete marine environment or the biosphere.

Tenets for Sustainable Management[2]

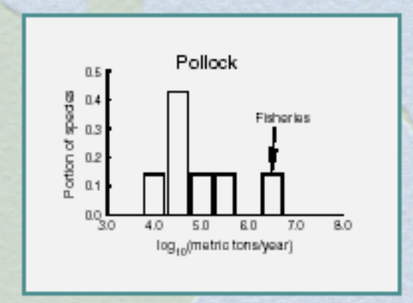
1) Manage consistently and simultaneously at the various levels of biological organization.
2) Account for complexity, including the unknowable.
3) Ensure that components and processes of systems are within their normal ranges of natural variation.
4) Avoid risk and exercise precaution to achieve sustainability.
5) Find and use guiding information.
6) Use science in research, monitoring and assessment, partly to produce guiding information.
7) Produce clearly defined and measurable goals and objectives.
8) Recognize that the impacts of our influence on other species and ecosystems are unavoidable.
9) Consider humans to be part of complex biological systems such as the biosphere and ecosystems.

Systemic Management in Theory and Practice

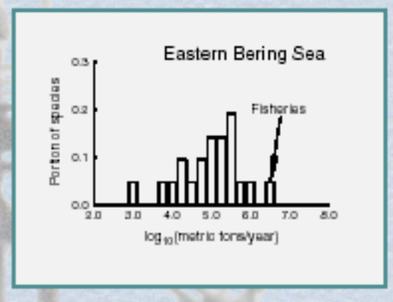


Systemic management[2] offers a way to account for complexity by using empirically proven examples of sustainability, which apply to a variety of management questions at all levels of biological organization. Systemic management focuses on what we can best control and change: human action, interactions, and impact on other species, ecosystems and the biosphere. Through systemic management human impact is managed to fall within the normal range of natural variation, illustrated by the consumption ("harvest") rates by other species over millenniums.

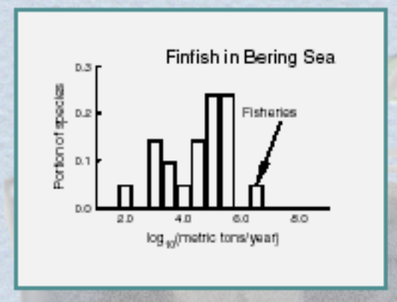
Example Applications



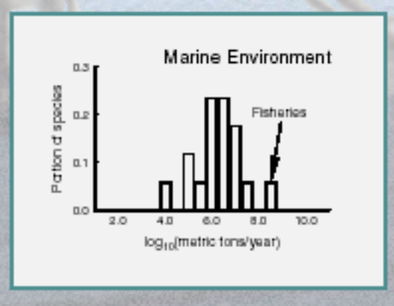
Single-species application: The commercial harvest of pollock *(Theragra chalcogramma)* in the Bering Sea in recent decades was about 50 times larger than the mean of consumption rates observed among marine mammal predators on this species as shown in the figure to the left. Systemic management would reduce this harvest by about 98% to fall in the middle (and 84% to reach the 95th percentile) of the normal range of natural variation of consumption rates observed within the natural system.



Multi-species application: The commercial harvest of finfish in the Bering Sea in recent decades was about 135 times larger than the mean of consumption rates observed among marine mammal predators on these species as shown in the figure to the right. Systemic management would reduce this harvest by over 99% to fall in the middle (and 55% to reach the 95th percentile) of the normal range of natural variation of consumption rates observed within the natural system.



Ecosystem application: The commercial harvest of biomass from the Bering Sea in recent decades was about 32 times larger than the mean of consumption rates observed among marine mammal in this ecosystem as shown in the figure to the left. Systemic management would reduce this harvest by over 96% to fall in the middle (and 49% to reach the 95th percentile) of the normal range of natural variation of consumption rates observed within the natural system.



Marine environment application: The commercial harvest of biomass from the entire marine environment in recent decades was about 154 times larger than the mean of consumption rates observed among marine mammal (17 species of near-human body size) as shown in the figure to the right. Systemic management would reduce this harvest by over 99% to fall in the middle (and 98% to reach the 95th percentile) of the normal range of natural variation of consumption rates observed within the natural system.

Challenges and Importance

The changes required to mimic empirical examples of sustainability are immense and will require years to implement. It is crucial to begin the changes now with management plans to ensure that the long-term objective of falling within the normal range of natural variation is met in order to minimize further damage to marine ecosystems and loss of critical resources. The responses of other species to management may result in different estimates of optimal sustainability and will require time to occur and to be measured.

References

[1](Alverson and Pereyra 1969), [2](Christensen et al. 1996, Mangel et al. 1996, Fowler et al. 1999)

Poster designed by Karna McKinney AFSC Graphics Unit 2001