

# The Systemic Management Approach to Size Selectivity in Commercial Fisheries

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Commercial fisheries have a variety of ecological effects. They have been known to reduce stock biomasses to fractions of their virgin levels (Fig. 1), leading to reductions in mean age, age-at-maturity, and mean and maximum size (Figs. 2-3). Coincident with these changes, commercial catches shift to lower trophic levels (Fig. 4). Changes like these in the world's oceans emphasize the need for different forms of management to achieve sustainability.

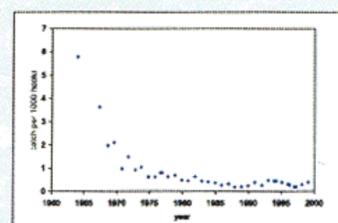


Fig. 1. Global trends in marine biomass (one of 13 similar examples).<sup>1</sup>

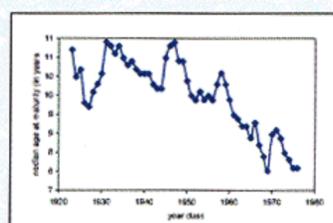


Fig. 2. Trend in median age-at-maturity for Atlantic cod in Lofoten, Norway.<sup>2</sup>

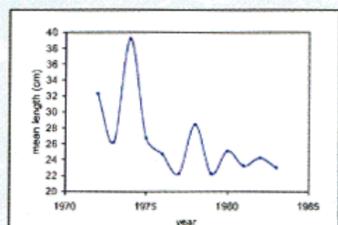


Fig. 3. Trend in mean length of Polish catch of Cape horse mackerel, Namibian Coast.<sup>3</sup>

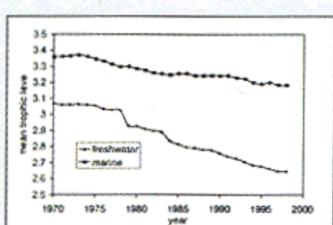


Fig. 4. Trend in mean trophic level exploited by commercial fisheries.<sup>4</sup>

Commercial fishing, as currently practiced in many of the world's oceans, is not sustainable in the long-term. In contrast, the ecosystems in which marine mammals have evolved exhibit predator-prey relationships with patterns that persist over evolutionary time scales. These systems exhibit emergent properties that reflect the effects of a wide range of variables at various spatial and temporal scales.

**Systemic Management**<sup>5</sup> argues that, because of their history and persistence, these systems provide useful information on alternative ways in which commercial fish stocks could be managed.

## OBJECTIVE

In this study we evaluated the consistency between fisheries and non-human mammalian predators to address the question: "What is the most sustainable size composition for commercial catches of fish?"

## METHODS

Prey size information for marine mammals was compiled from the literature. Body size information for prey consumed by marine mammals was found for 153 species of cephalopods, 17 species of crustaceans, and 244 species of fish from samples of scats, stomachs, and regurgitations of 20 species of cetaceans and 28 species of pinnipeds. The prey size selectivity of marine mammals was compared with the commercial catch only when commercial data were available for the same species from the same region and time period as the food habits studies.

## RESULTS

**Q1:** What are the general patterns of prey size selection among marine mammals as empirical examples of what is sustainable over evolutionary time scales?

**A1:** Food habits studies for everything from harbor seals to sperm whales show that the overwhelming majority of prey consumed by marine mammals average less than 20 cm in length (Fig. 5).

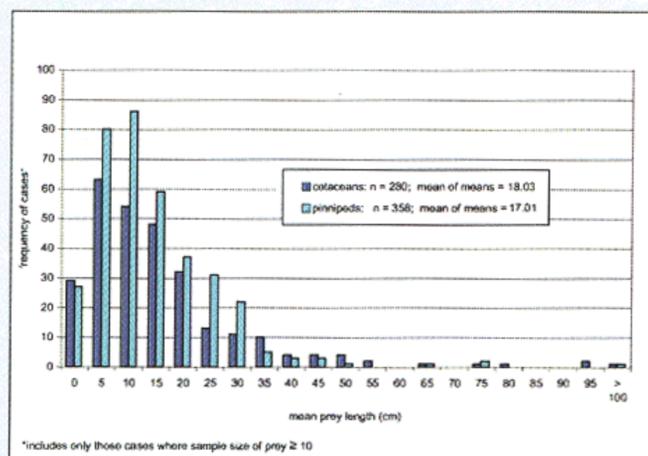


Fig. 5. Distribution of prey size means, by taxonomic group.

**Q2:** How does the size distribution of the commercial catch compare to the size distribution of prey consumed by marine mammals?

**A2.1:** The degree of overlap in size composition depends on the life-history characteristics and maximum size of the prey species. The full range of sizes of small-bodied fish and squid are found in both the diets of marine mammals and the catch of commercial fisheries. However, the larger individuals of longer-lived species (or species of larger overall size) are preferentially targeted by commercial fisheries (Fig. 6).

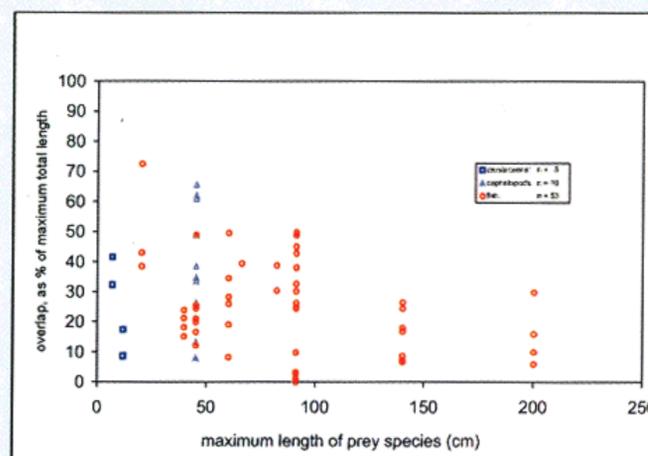


Fig. 6. Degree of overlap in size selectivity between marine mammals and commercial fisheries, as a function of maximum observed size of prey species.

**A2.2:** The difference in size selectivity between marine mammals and commercial fisheries is evident in the mean size of the take. For regionally (and temporally) specific comparisons among target species, commercial fisheries tend to remove larger individuals than marine mammals. As with the degree of overlap in Fig. 6, the magnitude of these differences tends to increase with increasing prey body size (Fig. 7).

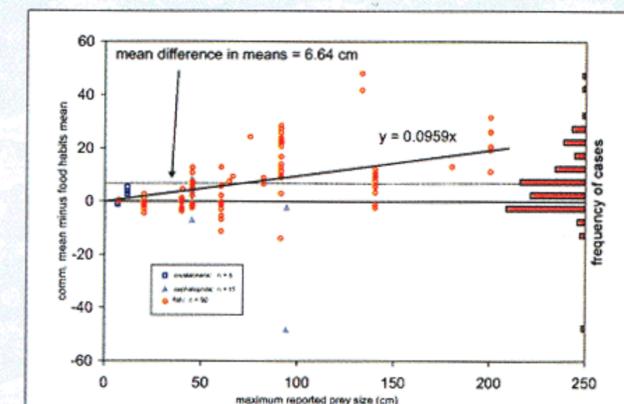


Fig. 7. Distribution of differences in mean size between marine mammal food habits and commercial fisheries, as a function of maximum observed size of prey species.

## CONCLUSIONS AND DISCUSSION

Marine mammals have a tendency to target prey items that average less than 20 cm in length while commercial fisheries take larger individuals, especially among larger bodied species. Because of this, most commercial fishing practices result in systemic effects that are different from those exerted by marine mammals. In applying the principles of **Systemic Management**, fishing effort would mimic the patterns seen in the feeding habits of marine mammals. This would reduce the mortality on the larger size classes (not necessarily to zero) and avoid the abnormal effects (especially the risks) of preferentially harvesting larger fish.

Changing commercial fishing practices to fit more closely with the patterns documented in the marine mammal food habits literature would, especially for larger bodied prey, require dramatic shifts in the targeted size composition. However, such changes are among those needed to account for the complexity of large systems and must be implemented simultaneously with other changes such as large reductions required in the total catch.<sup>5</sup>

Reduction in the size composition of commercial catches would, at a minimum:

1. increase competition between commercial fisheries and some marine mammal species — a step toward consistency in the competition observed in natural systems,
2. raise the question of sustainable harvest rates for large bodied prey if we persist with current selectivity (and the issue of marketability of small-bodied fish), and
3. force reconsideration of the driving economic factors associated with large-scale commercial fishing practices.

Many of the world's commercial fish stocks are clearly in serious trouble. Although sustainable harvests are typically the stated goal in fisheries management, previous practices have, in large part, failed to meet that goal. **Systemic Management** is based on directly relevant guiding information that produces recommendations for changing commercial harvest practices in such a way that long-term sustainability is an option.

## REFERENCES

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