Size in the seas: A new perspective raises questions, but does it yield answers?

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In the natural sciences several separate lines of research on the biological implications of how big an organism is (or can reach) have been pursued over the past decades. Each line of research has been a source of insights in its own right. Recently, however research has begun to merge these separate lines of research, and to explore their implications for conservation and sustainable use of aquatic ecosystems. The insights arising from their convergence and integration are just beginning to be realised. Likewise we are in only the early stages of understanding the implications of size-based processed for marine policy and management of living marine resources. The talk will review major lines of research on size-based processes briefly, but focus primarily on the recent work to integrate and apply these lines of research.

At the scale of individuals, there has been significant work on how most aspects of physiology and many aspects of behaviour scale with size. At the scale of populations, there is rich theory, with significant empirical support, for how many key life history processes, such as survival, maturation, fecundity, etc all scale with size. At the scale of communities and ecosystems, consistent patterns of distribution of sizes of individuals across species were noted several decades ago. These patterns led first to identification of the log-linear size spectrum as a general property of marine ecosystems, and subsequently development of a theory for these patterns based in ecological energetics. Illustrations of how "size" is an important and useful concept at each of these scales will be provided, as will be the types of equations used to represent these patterns and processes at each scale.

The real integration comes when these equations for processes at different scales are combined at the community and ecosystem scale. Size gives a single and consistent currency that allows physiological and behavioural processes at the individual level, life history theory at the population scale, and species interactions at the community scale to begin to form the analytical basis for theory and modelling of how ecosystem work, and how they respond to human uses and management actions. The talk will focus on efforts by a team of researchers to undertake such analyses, develop such models, and commence their application to questions about marine policy and management.

In developing size-based concepts and models for how ecosystems work, it turned out to be necessary to address all the classic problems of species based approaches to population and community dynamics; such as density dependence, "stock"-recruitment relationships, environmental forcing, and life history trade-offs. However it also turned out to be *possible* as well as necessary address all these classic problems. Moreover the size-based approaches often turned out to be less data-hungry than species-based approaches, while being a rich source of insights into how marine systems work and respond to pressures.

This research has reached stages where it is becoming possible to ask management questions of size-based data sets and models. There is excitement about their potential for investigating indirect effects of fishing on communities and ecosystems, and resilience of systems to forcing, whether environmental or due to human pressures. Some results have already been tied to real-world observations; others will be presented to illustrate the new types of answers that size-based approaches may provide to long-standing management questions, and the new types of questions that can be asked within size-based frameworks perhaps more readily that in species-based ones.

These more applied aspects of size-based approaches are still in early stages. Excitement about research results is not the same as validation that all the results are correct. The talk will end with some specific challenges to the scientific community for efforts to push the boundaries of these size-based approaches, and to test the robustness of their results. The marine policy and management community is in need of powerful and robust science tools for supporting an ecosystem approach to management. We urgently need to understand how far size-based approaches can go in providing such support.

Biography

Jake Rice, B. Sc. (Cornell 1970; Conservation) Ph. D. (Toronto 1974; Ornithology)

Currently National Senior Advisor – Ecosystem Sciences, for Department of Fisheries and Oceans, Ottawa, Canada. From 1996 – Sept 2007 was Director, Peer Review and Science Advice for DFO. Previous positions with DFO included Division Chief, Marine Fish at Pacific Biological Station (1990–1996), and Division Chief, Groundfish (1998–1990) and Section Head, Marine Ecology (1992–1998), at the Northwest Atlantic Fisheries Centre. Also held faculty positions at Memorial University of Newfoundland (Biology) and Arizona State University (Environmental Studies), and was Guest Professor of the Royal Danish Academy of Sciences from July 1996 to March 1997.

Major research interests include metrics of marine ecosystem status and change (particularly size-based metrics); operationalisational of the ecosystem approach to management of human activities in the sea; approaches to improving the application of science to policy and the cycle of science assessments and management decisions in fisheries; use of non-parametric density estimation methods to address uncertainty in fisheries problems; and during academic period avian community structure and habitat use in desert riparian ecosystems, seabird behavioural ecology, and ecological and behavioural basis for interspecific territoriality.

Publications: 71 Papers in primary scientific journals and book chapters; 89 papers in the technical literature of fisheries and marine science

Key Committee and Advisory Appointments

- Chaired or co-chaired more than a dozen major Working Groups or committees for DFO, including WGs to develop 20 year science vision for DFO, 5 year ecosystem science plan for DFO, the Ecosystem Objectives WG and Ecosystem Indicators WG.
- Chaired ICES WGs on Multispecies Assessments, Ecosystem Effects of Fishing, Regional Ecosystem Descriptions, Fisheries Management in Marine Protected Areas, and Fishery-Seabird Interactions. Also served on Advisory Committee on fisheries Management for 8 years, Advisory Committee on Ecosystems for 7 years (continuing) and as Chief Scientist of ICES from 2002–2005.
- Served on NOAA Science Advisory Board for 8 years.
- Many Expert Groups for FAO, IOC, MSC, CBD, and many other IGOs.