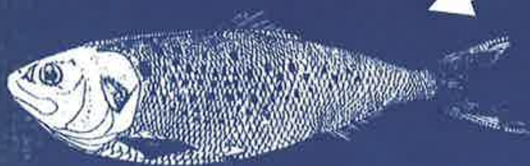

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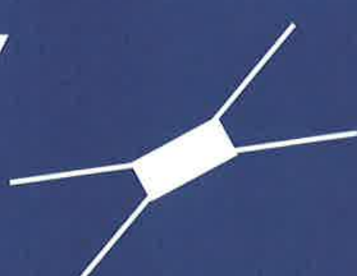
Multispecies Fisheries

Research and Management Problems

A Personal View
by
John Pope

An Excerpt from: *Prospects for Multispecies Fisheries Management in Chesapeake Bay*

STAC Publication 98-002a



About the Scientific and Technical Advisory Committee

The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Chesapeake Bay Program on measures to restore and protect the Chesapeake Bay. As an advisory committee, STAC reports quarterly to the Implementation Committee and annually to the Executive Council.

STAC members come primarily from universities, research institutions, and federal agencies. Members are selected on the basis of their disciplines, perspectives, and information resources needed by the Program.

STAC publications focus on issues of importance to the Chesapeake Bay Program. This publication was supported by the U.S. Environmental Protection Agency through cooperative agreement CB-993584-01 with the Chesapeake Research Consortium, Inc.

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Layout and Editing:
Caryn Boscoe and Kate Abrey

Publication Date:
August 1998

To receive additional copies of this publication, contact the Chesapeake Research Consortium (410-798-1283) and request the publication by title and number or contact their website: http://www.chesapeake.org/crc/crc.html

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A Personal View of the Workshop on Multispecies Fisheries Research and Management Problems

An Excerpt from:

Prospects for Multispecies Fisheries Management in Chesapeake Bay

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STAC Publication 98-002a

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Introduction

Neils Daan pointed out that you cannot manage ecosystems, you can only manage what humans do to them. In the case of Chesapeake Bay, humans clearly affect the ecosystem by adding nutrients and by fishing. Orientation papers by Ed Houde and Tom Miller bought out these concerns.

Hydrological models of nutrient inputs in the Chesapeake Bay watershed seem well developed. Such models can be coupled to phytoplankton production but as production moves to higher trophic levels, the problems of understanding, modeling and managing increase because we are increasingly dealing with critters with minds and agendas of their own. Moreover, they interact with each other and are directly or indirectly subject to fishing pressure. In short, we are moving from physical/chemical problems and into biological and fisheries problems.

Traditionally fisheries models have concentrated on the biology of each species in isolation and proposed appropriate ways to fish each species. Where fishing has been the major source of change in fish stocks, this single species approach has been reasonably successful in pointing out the major fisheries management problems. From a management perspective such an approach leads to relatively straightforward management decisions. Given combinations of size of first capture and exploitation rate can be seen as being good or bad, with respect to objectives about yield maximization. The management problem is also relatively capable of being communicated to fishermen and to the public. It can be expressed in terms of certain sizes of capture being good or bad or in terms of certain rates of harvest being excessive. Unfortunately, these relatively comfortable single species management tools do not always reflect fisheries or biological reality. When this is the case they may need to be replaced by multispecies approaches. The rest of this note is about what these might be.

Interactions between fishermen and the ecosystem

Comfortable single species management tools do not reflect fisheries or biological reality. This is because, in addition to the direct effects of fishing mortality, other interactions occur between both sets of players. The workshop presentations have made it clear that multi-species interactions are of two types:

- Technical interactions are of obvious interest to fishery managers because they involve different user groups who have different interests in the various fish stocks. Managers clearly need to know enough about technical interactions to be able to allocate the resource appropriately between the various user groups. Indeed, as part of allocation arguments, managers will often hear "whines" about the "misdeeds" of other user groups. Since these problems are of clear concern to managers, data are needed that are appropriate to this problem. Appropriate data are those that describe what species the various user groups catch, the size selectivity of their gear and perhaps where they fish in the Bay. Such data allow the construction of relatively simple, "who does what, and with which, unto whom" models, which, when coupled to the single species models of the relevant species, will help illustrate the allocation alternatives

- Biological interactions are less obvious to managers and also potentially more difficult to manage. Biological interactions between species may involve species for which little common utilization occurs. Hence, to consider them may involve allocation problems between users who previously appeared to operate independently of each other. In the case of Chesapeake Bay examples might be interactions between menhaden and striped bass or interactions between oysters and crabs. These examples indicate that considering biological interactions may involve wider and perhaps more difficult tradeoffs than managers are used to handling. However, if real biological interactions exist, then single species management plans aimed to simultaneously maximize the yield of all species will be rooted in unrealistic expectations.

A previous Prime Minister of the UK, Harold Macmillan, said "that politicians have a duty to point out where their constituents aims are unrealistic, For example, to point out that zero inflation and 10% annual pay rises for everyone are not compatible". On occasion fisheries managers also have to act as opinion leaders. It is their duty to point out to their stakeholders when their aims are unrealistic. A general example is that fishermen cannot expect all their sons to carry on the business and at the same time to use the most modern gear and best electronic kit on their vessels; increases in efficiency imply reductions in participants. A possible example, in the context of Chesapeake Bay, is that it may be incompatible to expect the yields of those species, which have displayed opposite trends through time, to be simultaneously maximized. Similarly, it is possible that the Bay cannot be restored to near pristine conditions and still have the fish yield at current levels. It is usually best for leaders to face up to such realities and tackle them, rather than to ignore them and to foster unrealistic expectations that cannot be satisfied. Thus, if they seem likely to exist, then it is best that biological interactions are studied, quantified and bought into management decisions.

Multispecies models to aid management

Given that multispecies interactions have to be addressed, there is a need for suitable models to provide advice. There is also a need for models that help scientists to visualize the problems, even if they are not directly applicable to management. Management models of biological interactions need to tackle two main problems. These are:

- Predatory interactions amongst the higher trophic levels; contributions by Jake Rice, Ann Hallowed and Jeremy Collie have described some appropriate models.

- The effects of changes in the nutrient base and the production of phyto-plankton and zooplankton, particularly in so far as they provide food to higher trophic levels; Bob Ulanowicz describes one such model and Danny Pauly and Villy Christensen are in the market with an analogous approach.

A problem with all such models is that predation acts by size. The size, age or stage detail needed to satisfy the predation models is typically far more than could be chosen for the food production models. Nutrient and production models tend to be framed in terms of the biomasses of major species or species groups. Combining both types of models would probably result in something that was so complicated that it could neither be fitted to data nor understood. Hence, both types of models are needed. Presently it is best to use the type of model that is most appropriate to a particular question rather than to seek a general model, which will solve all problems.

The bulk biomass type of model provides an interesting integration of both processes. Jeremy Collie showed an example of such a model. These models are interesting because they might address both predation and food competition interactions. However, there is a drawback. It is that the number of model terms potentially increases as something like n^2, where n is the number of species. Thus a four species model might have 16 parameters to estimate. It is not realistic to expect that all 16 could be estimated from available time-series of data. In fisheries, biomass or catch rate data time-series are typically quite short (20 or 30 years) but even a hundred-year sequence would hardly suffice to estimate 16 interaction terms. Jeremy Collie got over this problem by a judicious elimination of many of the potential interactions but the potential to do this may not always exist. Moreover, it is not clear to me if nutrients could be easily entered in such a model. Despite these problems, clearly such models can provide a useful overview for the effects of a few major interactions. As well as being a way of directly fitting data, such models do have a further useful role. They may be fitted to the outputs from more complex models to provide a relatively simple summary that can be helpful for providing management advice and exploring management tradeoffs.

Typically species interaction models need extra data in order to fit the extra terms. Predation is one of the easier effects to study because of the availability of the "smoking gun" of stomach contents data, but all species interaction models need their own appropriate data.

Models to aid scientific understanding

As well as developing models that help managers to handle biological interactions, there may also be a need for models, which help scientists to better understand multi-species problems. Size spectrum models seem to have some potential for helping scientists to visualize the problem simply. In the North Sea, the size spectrum of the finfish has been found to be a very conservative feature of the system and one that appears to react simply to changes in exploitation. For example, comparisons between the size spectrum of finfish in 1904 and in 1991 (see figure) shows how the relative numbers of the larger sizes of fish have been eroded over the past century. They also are useful for making comparisons between systems.

Finfish size spectra are of course only the tip of the iceberg of the size spectra of all species. The Sheldon Sutcliffe/Platt and Denman hypothesis postulates that in non-seasonal systems, size spectra contain equal biomass per size octave. In many systems, including Chesapeake Bay, it is likely that such spectra are seasonally perturbed. Pope et al. (1994) have speculated that the Sheldon Sutcliffe/Platt and Denman hypothesis might also be true when size spectra are integrated over a year. It seems likely that studies and comparisons of size spectra of phyto and zooplankton may indicate disruptions and changes caused by changing nutrient inputs. Moreover, size provides an alternative "taxonomy" to species and perhaps, when augmented with the dimension of species guilds, one which might make a useful basis for a network analysis of Chesapeake Bay.

Problems with the wider ecosystems effects of fisheries

The wider ecosystem effects of fisheries can cause an extension to the problem of species interactions. In the North Sea and a number of other areas the ecosystem effects of fishing on parts of the ecosystem which have no direct economic value has become an issue. Examples of such problems are beam trawls designed to catch flatfish, which also kill benthos, discarded fish and fish offal which feed populations of scavenging seabirds, cod and flatfish gill nets, which also catch cetaceans. Any effects of fisheries on the wider Chesapeake Bay ecosystem will add to the factors that its managers will have to consider. Clearly this will be difficult but an ecosystem approach to management will demand nothing less.

Reference

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