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# Report of Special Session

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## Introduction

The Special Session on "Changes in Biomass, Production and Species Composition of the Fish Populations in the Northwest Atlantic Over the Last 30 Years, and Their Possible Causes", was held at the Centre des Conferences Albert Borschette, Brussels, Belgium, during 6-8 September 1989. A total of 18 presentations were made: 16 papers (SCR Doc. 89/62, 89/72 and 89/74 to 89/87) and two oral presentations. The Session was attended by scientists from Canada, Cuba, Denmark (Greenland), European Economic Community, German Democratic Republic, United States of America and Union of Soviet Socialist Republics.

## Specific Topics

The response of fish populations to sustained perturbations such as harvesting or pollution and habitat degradation is dependent on the regulatory mechanisms (i.e. compensatory responses) characteristic of each population. The nature and relative importance of the compensatory mechanisms governs the stability and resilience of populations to natural and man-made disturbances. Species with little or no compensatory capacity will be particularly vulnerable to exploitation or other perturbations. The principal objective of the Special Session was to explore the available information on responses of fish populations in the Northwest Atlantic to exploitation and variability in the biotic and abiotic environment. The deliberations of the group were centred around stabilizing factors in fish populations and their dynamic ecological setting. These problems were examined from both a single species and a multiple species perspective.

A total of eight presentations dealt specifically with the effects of exploitation on the abundance of individual species or groups of species. Seven papers provided information principally on environmental effects on fish populations and two presentations involved biotic interactions (primarily predator-prey dynamics). An overview paper provided a general framework for discussion of the role of anthropogenic and natural factors on exploited populations.

Dramatic shifts in the biomass levels and species composition were documented for several systems throughout the NAFO Convention Area. The nature of these changes and their possible causes are described in the following discussion which reflects both the presentations made during the session and comments made during the final discussion period.

### Exploitation effects

The role of exploitation on the structure of marine fish communities was examined in several papers. Biomass declines under increasing exploitation rates with the arrival of distant water fleets were documented for Georges Bank, Southwest Nova Scotia, Gulf of St. Lawrence, Newfoundland, and the Grand Banks. Recovery of biomass levels in these areas was noted following implementation of extended jurisdiction although on Georges Bank, the biomass of commercially desirable species has since continued to decline. Comparisons of biomass levels inside and outside of the two hundred mile limit on the Grand Bank also show a reduction in abundance under exploitation. Exploitation effects were implicated in the declines of a diverse array of species.

Changes in relative species composition were also apparent for the Georges Bank, Grand Bank, and Flemish Cap based on analyses of changes in fish assemblages, aggregate biomass, or abundance of selected groups of species. Analyses of species assemblages indicate the composition and spatial configuration of the groups tends to remain relatively constant but that the abundance levels of the component species and the assemblage as a whole can vary widely. Structural changes in the Georges Bank system, with a current domination by elasmobranches is a particularly striking example of a change in relative species composition. These changes appear to be related to selective harvesting of marketable species.

The nature of the changes expected in each system may be highly dependent on its underlying structure. For example, a system characterized by low diversity may exhibit qualitatively different responses than higher diversity systems to a reduction or deletion of one or more species (e.g. replacement effects may not be observed). If a stock is reduced to a critical level in a productive system, it may continue to exist in the system at a low level. Conversely, in a system characterized by low productivity, the species may be forced to local extinction.

Although considerable evidence for changes in biomass levels was provided, the question of overall changes in productivity was not addressed. In

particular, the role of changes in growth rates was not explored. This component of production can conceivably exert considerable influence in overall production rates in the system. It is recommended that more detailed analyses of the changes in growth and its importance in the productivity of these systems be undertaken. With respect to the importance of recruitment to production rates, a distinction between changes in base levels of recruitment should be distinguished from short term fluctuations.

### Biotic interactions

The role of intraspecific interactions was described for several stocks. Cannibalism was shown to be a potentially important factor in the regulation of silver hake and herring stocks. In addition, density-dependent survival rates of herring eggs in egg beds were described. Interspecific interactions between cod and several species were also suggested in an exploratory correlation analysis.

The possibility of interactive effects between predation and environmental effects on growth were noted. If growth rates decline under sub-optimal environmental conditions, the larvae may be vulnerable to predation stress for a longer period of time, resulting in increased mortality rates. Thus, subtle interactions between abiotic and biotic factors can be important.

It was noted that a critical lack of information exists for the earliest life stages. Specifically, time series of abundance estimates for the egg and larval stages are not generally available. It is therefore not possible to partition the sources of variability in pre-recruit survival into specific developmental periods.

Comparisons between Northeast and Northwest Atlantic systems can be instructive, however, the general exploitation on smaller sizes and a broader diversity of component species in the Northeast Atlantic prohibit direct comparisons of system response to exploitation and predation effects in these two systems.

Changes in the relative abundance of predators can alter pathways of energy flow in systems in indirect ways. For example, the depletion or removal of a predator can result in a change in benthic-pelagic coupling, disrupting energy transfer among certain components of the system.

The apparent dominance of elasmobranches in the Georges Bank region in recent years may signal a fundamental change in the system. These species are important piscivores and may exert considerable predation pressure on commercially desirable species. If current selective harvesting patterns are maintained, the synergistic effects of exploitation and predation may result in continued low biomass levels of harvestable species.

### Environmental effects

The importance of identifying the relevant spatial and temporal scales for integration of biological and physical processes was discussed. In particular, the linkage between physical processes and their potential effects on biological systems is crucial to the correct selection of scales in time and space.

Specification of the underlying mechanisms (or hypothesized mechanisms) relating environmental factors to growth and survival of fish at different life stages is critical to advancing from empirical relationships based on correlational studies to a full understanding of environmental effects on fish populations.

The potential implications of global climate change on fish populations were discussed. Clear evidence of warming trends have been obtained from water temperature records for West Greenland. Sustained trends of this type are likely to have much different implications for fish populations than short-term variability. These changes may fundamentally alter the production characteristics of boreal-temperate systems which are expected to be more strongly impacted by global warming than lower latitudes.

It was noted that collaboration between physical oceanographers and fishery ecologists on the effects of small-scale variability in oceanographic processes on larval fish survival and growth has been very fruitful.

## Conclusions

Clear evidence of changes in biomass levels and relative species compositions in response to exploitation has been obtained in the Northwest Atlantic during the last three decades. The observed response of fish populations to disturbances such as fishing has immediate implications for fishery management. These observations can also provide insights into basic ecological processes and structuring mechanisms in marine ecosystems. The broad spatial and temporal scales over which fisheries operate represent major perturbations to these systems. The relative strength of the perturbation can be measured and the responses of systems to these disturbances can be determined. Basic ecological questions such as the possible existence of alternate stable states in system configurations can be addressed by measuring changes in the structure of fish communities with changes in exploitation rates and patterns.

Exploitation can dramatically alter the biomass levels in marine systems. This effect was unequivocally shown in a number of systems considered during the Special Session and for a broad range of species or species groups. Interesting comparisons between lower diversity, higher latitude systems can be instructive. The effects of exploitation on productivity of these systems, however, is less clear because the relevant comparisons have not often been attempted.

Changes in fish populations under exploitation are embedded in a complex physical setting and it may not always be possible to clearly distinguish between the effects of harvesting and environmental effects in the short term. Accordingly, it is crucial that consistent time series of relevant biological, physical and fishery-related information be maintained and that these sources of information be synthesized into an overview of system response to the factors affecting the component species.

## Acknowledgements

The papers presented during the Special Session provided valuable case studies of the importance of exploitation, environmental factors, and biotic interactions on marine systems. It was recommended that papers presented be considered for publication collectively in an issue of the *Journal of* the *Northwest Atlantic Fishery Science*, as appropriate.

Due to a number of unforeseen factors, the editorial process for this volume was substantially delayed. I would like to express my apologies to the authors and participants in the special session for this delay. The contributions of the participants both in terms of formal presentations and lively discussion are gratefully acknowledged. I would especially like to thank T. Amaratunga (Technical Editor), R. G. Halliday (Associate Editor, Vertebrate Fisheries Biology), Sv. Aa. Horsted (Associate Editor, Vertebrate Fisheries Biology) and STACPUB Chairman, H. Lassen for their editorial assistance in completing the volume.

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