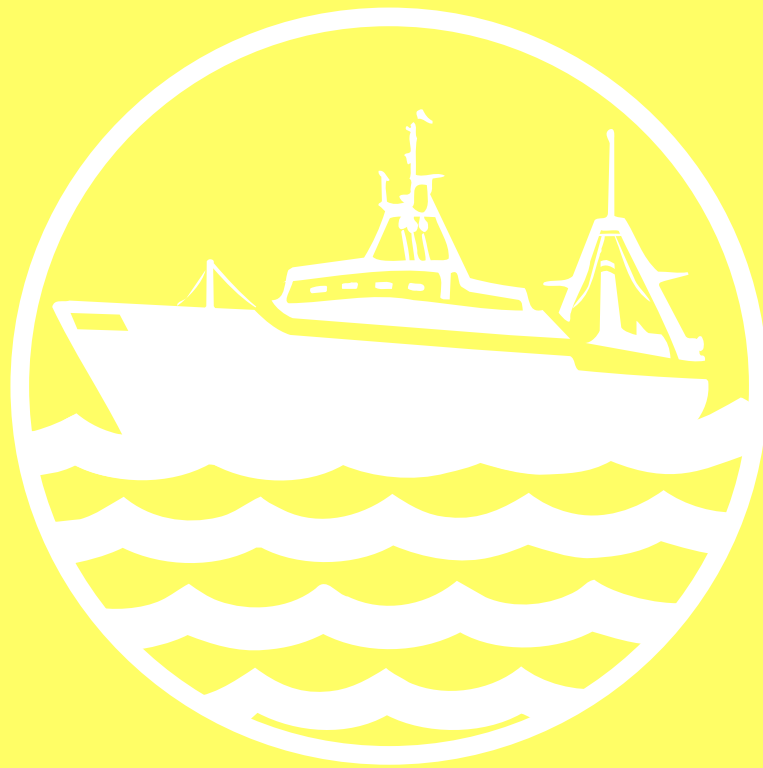


# Journal of Northwest Atlantic Fishery Science



Volume 19  
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Northwest Atlantic Fisheries Organization  
Dartmouth, Canada



# Journal of Northwest Atlantic Fishery Science



Volume 19

Gear Selectivity/Technical Interactions  
in Mixed Species Fisheries

Symposium, 13–15 September 1993

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## Foreword

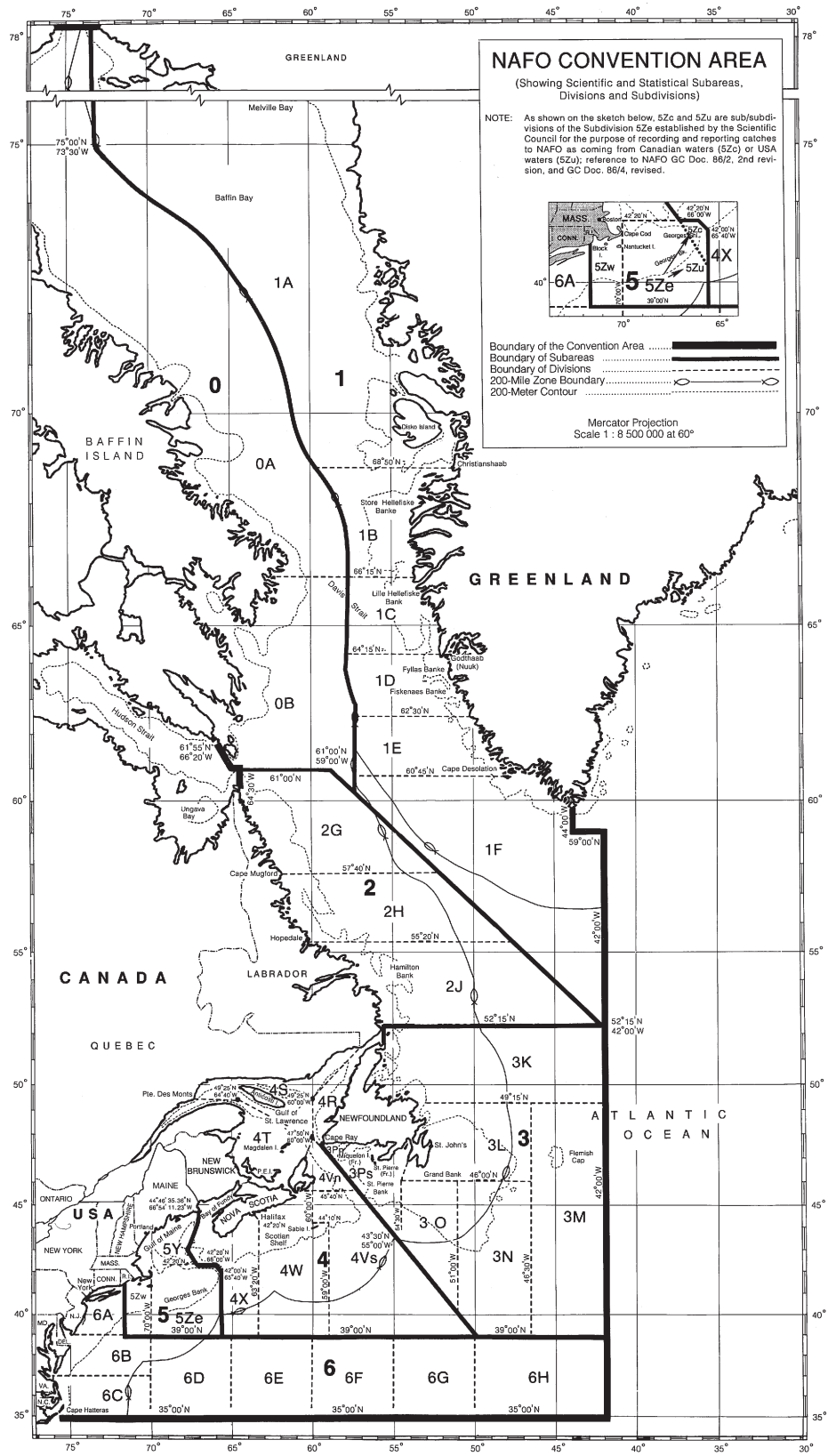
In accordance with its mandate to disseminate information on fisheries research to the scientific community, the Scientific Council of NAFO publishes the *Journal of Northwest Atlantic Fishery Science*, which contains peer-reviewed primary papers and notes on original research, and *NAFO Scientific Council Studies*, which contains papers of topical interest and importance. Each year since 1981, the Scientific Council has held a Special Session on a topic of particular interest, and many of the contributions to those sessions have been published in either of these NAFO publications. In 1993, the Scientific Council held this Special Session as a symposium of topical interest to NAFO. In accordance with the decision of the Scientific Council of September 1993 (*NAFO Sci. Coun. Rep.*, 1993), this volume of the *Journal of Northwest Atlantic Fishery Science* contains papers presented at the symposium of 1993 held at the Holiday Inn, Dartmouth, Nova Scotia.

The symposium was jointly convened by S. A. Murawski from the National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, USA and P. A. M. Stewart from the Department of Agriculture and Fisheries for Scotland, Marine Laboratory, Aberdeen, Scotland, UK. A total of 25 papers along with videos and posters were presented of which 12 papers were submitted by the authors for consideration for publication in this issue.

In accordance with the decision of the Scientific Council, S. A. Murawski and P. A. M. Stewart were invited to undertake the normal Journal editorial process. A relatively small proportion of the papers presented at this symposium appears in this issue. While several authors chose to publish the work elsewhere, some papers represented work in progress and were not comprehensive enough to warrant publication at the time and a few that were submitted did not meet the Journal standards. While the Scientific Council had intended to complete this publication sooner, delays experienced by some authors and some personal delays experienced by one editor precluded this. However, the quality of the oral presentations, the stimulating discussions at the symposium, and the comprehensive coverage achieved in this publication does not diminish the timeliness and importance of the proceedings.

September 1996

Tissa Amaratunga  
Assistant Executive Secretary



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# Report of the Symposium

S. A. Murawski and P. A. M. Stewart

The Symposium was held immediately after the Annual Meeting of the Scientific Council, 7–10 September 1993, and the following report was prepared by the co-conveners for the Scientific Council.

## Introduction

The Symposium on "Gear selectivity/technical interactions in mixed species fisheries", with S. A. Murawski (USA) and P. A. M. Stewart (United Kingdom) as co-conveners, was held at the Holiday Inn, Dartmouth, Nova Scotia, Canada, during 13–15 September 1993. Twenty-five papers were presented (see List of Meeting Documents: SCR Docs are available at NAFO Secretariat) and, additionally, four posters and two video presentations were displayed. The Symposium was organized into six thematic paper sessions: 1) Components of mixed fishery systems (S. Murawski, USA, Chair), 2) Influencing the selection pattern of fishing gear (P. A. M. Stewart, UK, Chair), 3) Interactions among competing gears (A. Sinclair, Canada, Chair), 4) Mixed species/multifishery effects (S. Murawski, USA, Chair), 5) Fleet dynamics in technical interactions (J. DeAlteris, USA, Chair), and 6) Gillnet selection studies (A. Bjordal, Norway, Chair). A final panel discussion consisted of brief presentations by the session chairmen, reviewing information presented at the six sessions, and their views on the content of the Symposium and future directions of research in the theme areas. The Symposium was opened and closed by H.-P. Cornus (Germany), Chairman of Standing Committee on Fishery Science (STACFIS). A total of 70 participants registered for the Symposium, representing 15 countries (Brazil, Canada, Chile, Denmark, Finland, France, Germany, Greenland, Japan, Norway, Portugal, Russian Federation, Spain, UK, USA).

The concept of this Symposium was rather revolutionary – to bring together experts in various scientific disciplines to address a common problem. The subject of technological interactions in mixed fisheries has many dimensions. Gear technologists, stock assessment experts, economists and social scientists view the nature of problems associated with mixed fishery harvesting, and their potential mitigation, from vastly differing points of view. The goals of the Symposium were 1) to summarize the current state of fisheries research on the topics of gear selectivity and technical interactions 2) to propose new directions for future research, and 3) to establish dialogue among experts from the various disciplines that may facilitate more integrative approaches to these problems. Based on the diversity of contributions and the summaries presented by the session chairmen, the goals of the Symposium were accomplished.

## Thematic Contributions

The subjects considered in the papers, posters and videos presented spanned the diversity of issues intended in the announcement of the meeting and call for papers. Following is a brief summary of the contributions, by theme session:

**Components of mixed fishery systems.** Four papers and a poster presentation on this subject emphasized the evolution of data and analytic tools for revealing the structural elements contributing to mixed fishery systems. Seasonal components of the Gulf of St. Lawrence fisheries are dominated by the cyclical distribution patterns of species taken in single- and mixed-species fisheries. New computer-assisted methods for visualization of this complexity were demonstrated. The identification of fishery tactics and factors associated with by-catch and discard rates were evaluated in two papers that utilized tow-by-tow sea sampling data from otter trawl fisheries off the northeast USA. Options for the management of the transboundary Greenland-Iceland cod stock were considered, given the rates of migration and bioeconomics of fleets and fisheries of Chile were found to be dependent upon relative fishery success among industrial and artisanal components.

**Influencing the selection pattern of fishing gears.** Effects of gear modifications on the selective properties of fishing gears were considered in six papers and one video presentation. Two papers considered the analysis of data from 'trouser trawl' gear, used to evaluate selection properties of a mesh alternative, relative to a control mesh. The choice of empirical *versus* structural modelling of selection properties of gears focused on the goodness-of-fit alternative models and the underlying reasons for choosing one approach over the other. Use of a sorting grate for herring in the Baltic resulted in some mortalities of animals passing through the grate and not retained by the gear. Implications of discard mortalities for witch flounder yields were evaluated in a poster. The size compositions of catches sampled at sea, using

different mesh sizes and shapes used in the fishery were compared to experimental gear selection studies for these gears. Results in some cases conflicted. The selection properties of otter trawl gear for redfish were reviewed, in relation to the total catch and size composition, based on experimental fishing results. A video designed to explain principles of gear selectivity and measurement methods to managers and industry was presented.

**Interactions among competing gears.** Relative selection properties of fishing gears deployed to target various species were reviewed in four papers. The selection properties of various gears in some cases given clear differences in size/age retention, whereas when fisheries are more complex, selection attributable to the gear properties becomes more ambiguous. Choice of the 'optimal' gear to exploit a particular species must take into account not only biological goals such as protecting pre-spawning individuals, but the inherent trade-offs between species when species mixtures are taken. A modelling paper presented a framework within which the properties of gear selection (steepness of the curve and its placement) can be used to evaluate effects on yields and spawning stock biomass-per-recruit.

**Mixed species/multifishery effects.** Four papers and one poster emphasized the effects of interactions among species and fisheries on yields and values of complex fishery systems. Two presentations considered the short-term survivorship of roundfishes and flounders discarded from otter trawl fisheries off the northeastern USA. The impact of discards of young fish on standard assessment calculations (Fs, yields and spawning biomass), was considered for both retrospective analyses and in forecasts. The impact of survivorship of herring passing through the meshes of a herring trawl on yield projections assuming different mesh sizes was considered. Factors that influence decisions by skippers to target specific fishing grounds were evaluated in a probabilistic outcome framework.

**Fleet dynamics in technical interactions.** The interactions among multi-purpose fishing fleets with respect to fishery yields and associated economic and social considerations were considered in five papers. Choice of management units is a complex intersection of gear, species mix and targeting behaviour of fishermen. The use of standard predator-prey models for describing the targeting behaviour of multi-purpose fleets was reviewed. The impact of mixed-species harvesting on the fishing mortality of species was considered as an exercise in computing the partial fishing mortality rates due to each fleet. Optimization of the Greenlandic shrimp fishery was considered, particularly emphasizing the differential revenue of the product based on individual animal sizes. The evaluation of gear alternatives for Canadian shrimp fisheries were considered in a combined video and paper presentation.

**Gillnet selection studies.** Two papers evaluated various properties of gillnet selectivity, and predictions of selection based on theoretical aspects of fish length-girth and mesh size. Theoretical selection curves generally performed well in predicting percent retention, better than for mobile fishing gear.

### Summary of Findings

The management of fishery resources, world-wide, is complicated by a general trend in increased fishing pressure, combined with the rapid pace of technological innovation in fishing gear, and competition for fishery resources among gears, fleets and nations. Managers are increasingly asking scientists of various disciplines questions such as: What is the 'best' age or size at which to exploit species x? What is the 'best' gear to exploit a particular fishery? What is the relationship between fishing effort and yield? What are the economic and social consequences of particular management actions that we are contemplating? More often than not, managers have addressed these and similar questions to the technical disciplines individually rather than collectively. Not surprisingly, the answers to the questions have been ambiguous and in some cases conflicting.

It is clear that a multi-disciplinary approach to the provision of management advice is necessary when complex fishery interactions occur. Tentative results presented at the Symposium emphasize the difficulty of management actions based solely on benefits to be derived from gear-based solutions. The actual benefits of improving selectivity of particular target species may be substantially reduced by a variety of operational factors, including mixed catches of non-target animals. Survivorship of sorted animals, either in the sea or on deck, may significantly alter our perceptions of the benefits expected from a proposed technological solution. Likewise, gear changes may have substantial economic and social consequences for mixed fleets. Choice of the 'best' way to harvest a particular species or species group is a complex decision involving the impacts of yields and spawning potentials of the resource, and the economic effi-

ciency of the gears and fleets. Optimization of total yields or revenues for multi-fleet or multi-national fisheries may result in substantial social consequences which must be considered.

Participation in the Symposium by representatives of the Canadian fishing industry and domestic management bodies provided a focal point for deliberations, and a message to the scientists. The serious management problems of the day require the choice between management options that, in some cases, will have important societal and ecological consequences. These choices need to be made based on forecasts that incorporate the complexity inherent in the real world. Participants generally felt that they had new insights into the questions, approaches and findings provided by the various disciplines represented, and a better appreciation of how these various elements fit together into an integrated assessment of the biological and fishery consequences of management alternatives.

The consensus of the participants was the desire to publish appropriate papers from the Symposium in the *Journal of Northwest Atlantic Fishery Science*. The authors wishing to publish their papers were requested to submit their papers to the co-conveners, who will serve as editors of this issue.

The co-conveners expressed their thanks to the Secretariat for providing the excellent facility and technical accommodations for the conduct of the Symposium and for their outstanding cooperation in assisting with the preparation of papers and presentations.

## List of Presentations

### Session 1: Components of Mixed Fishery Systems

Chair: Steve Murawski (USA)

Seasonal components in technological interactions in Gulf of St. Lawrence shrimp and groundfish fisheries – A. Sinclair

\*Factors influencing technological interactions in Mid-Atlantic Bight groundfish fisheries – W. L. Gabriel.

\*Optimal management of the Iceland-Greenland transboundary cod stock – S. Christensen and H. Lassen

\*Factors influencing by-catch and discard rates: analyses from multispecies/multifishery sea sampling – S. A. Murawski

### Session 2: Influencing the Selection Pattern of Fishing Gears

Chair: Peter Stewart (Scotland)

Effect of mesh size/type on size distribution and catch rates for 1991 Scotian Shelf groundfish fisheries – M. Showell

\*Analysis of subsampled catches from trouser trawl size selectivities studies – N. G. Cadigan and W. M. Hickey

Combining selectivities from multiple trouser trawl tows – D. L. Boulos, N. G. Cadigan, and W. M. Hickey

Impacts of increased codend mesh size on the catches and fishery of herring in the northern Baltic Sea – uncertainties from the ecosystem and markets – S. Kuikka, P. Suuronen, and R. Parmanne

Possibilities to increase the size-selectivity of a herring trawl by using a rigid sorting grid – P. Suuronen, E. Lehtonen, and V. Tschernij

\*Models of codend selection – R. J. Fryer and J. G. Shepherd

### Session 3. Interactions Among Competing Gears

Chair: Allen Sinclair (Canada)

\*Performance and biological implications of a multi-gear fishery for Greenland halibut (*Reinhardtius hippoglossoides*) – K. Nedreaas, A. Vold Soldal, and Å. Bjørndal

\*Effect of size selection within and between fishing gear types of the yield and spawning stocks biomass per recruit and catch per unit effort for a cohort of an idealized groundfish – J. DeAlteris and R. Riedel

Effects of methods selectivity on the yield and standing stock of cod: a trawl-longline comparison – Å. Bjørndal and T. Levastu

Observations on the size composition of haddock and whiting catches taken by the different fishing methods used in the Scottish North Sea demersal fisheries – P. A. M. Stewart and A. W. Newton

\*Comparative fishing for cod and haddock with commercial and longline at two different levels – A. Engås, S. Løkkeborg, A. V. Soldal, and E. Ona

### Session 4: Mixed Species/Multifishery Effects

Chair: Steve Murawski (USA)

\*Estimating discards using selectivity data: the effects of mesh size changes in the mixed demersal fisheries in the Irish Sea – J. Casey

Why skippers skip grounds: a probabilistic decision model for whether a skipper continues fishing on the same or change to some other ground, based on data from the West Greenland shrimp fishery – T. K. Hassager and H. Lassen

Estimating of foregone yield associated with the discarding of witch flounder in the Gulf of Maine northern shrimp fishery – S. Wigley

Finfish by-catch mortality in the Gulf of Maine northern shrimp fishery – S. R. Hokenson and M. R. Ross

Selectivity of bottom trawls during the fishery for redfish on the Flemish Cap Bank – K. V. Gorchjinsky, S. F. Lisovsky, and M. K. Sadokhin

### Session 5: Fleet Dynamics in Technical Interactions

Chair: Joe DeAlteris (USA)

\*Management regions, statistical areas and fishing grounds: criteria for dividing up the sea (Work in Progress) – P. M. Clay

Estimating fleet specific F given catch quotas – A. Sinclair

\*On management of varying shrimp stock in the Davis Strait – S. Christensen

Dynamic models of technological interaction: man as a prudent predator – S. A. Murawski

A Canadian northern shrimp selectivity program 1993 – D. Balfour

### Session 6: Gill Net Selection Studies

Chair: Åsmund Bjørndal (Norway)

Characteristics of the fish's body affecting gillnet selectivity – E. G. Reis and M. G. Pawson

Gill-net selectivity of bass and white croaker using commercial catch data – E. G. Reis and M. G. Pawson

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\* Revised and published in this volume.