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Foreword

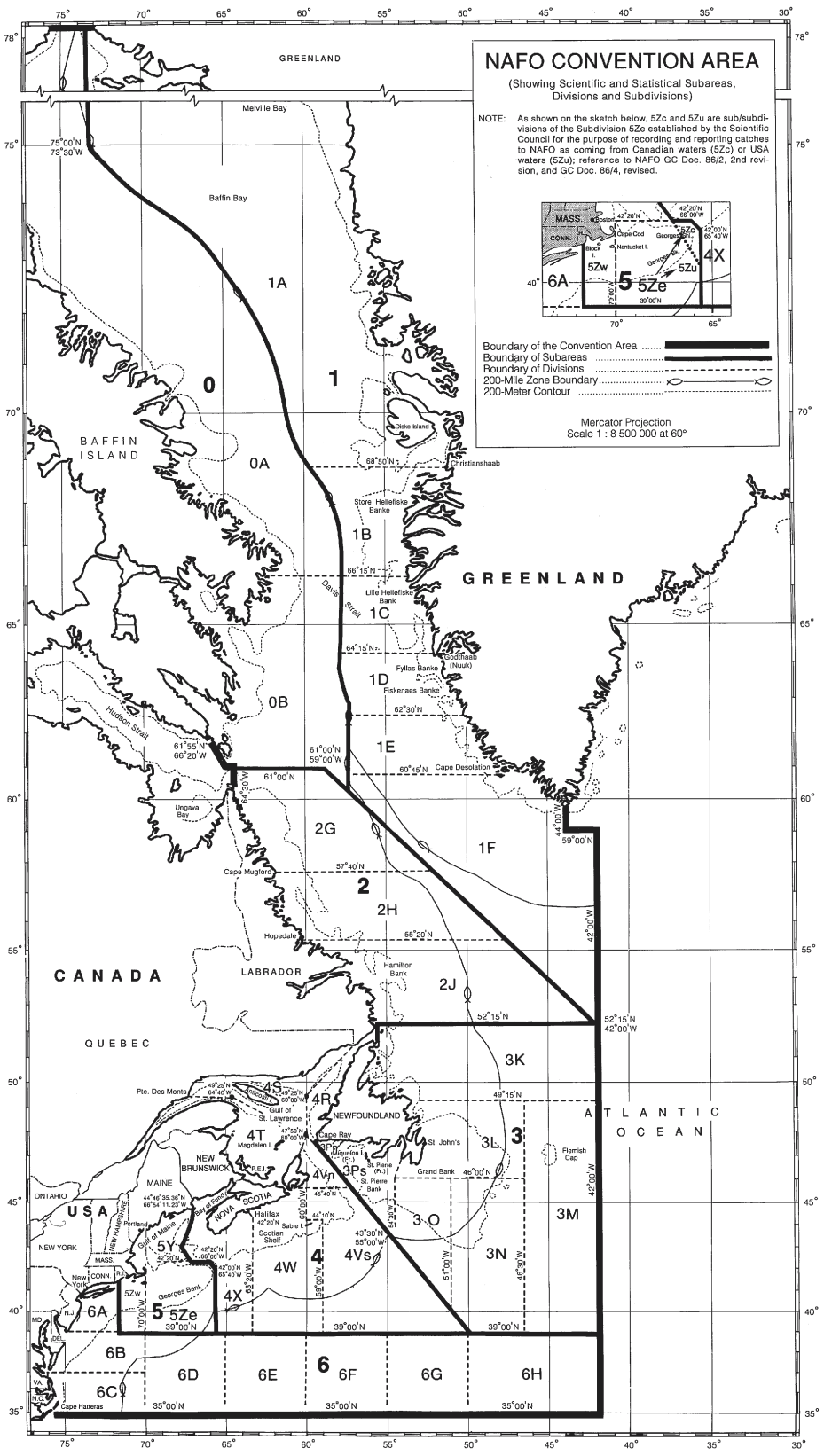
In accordance with its mandate to disseminate information on fisheries research to the scientific community, the Scientific Council of NAFO publishes the *Journal of Northwest Atlantic Fishery Science*, which contains peer-reviewed primary papers and notes on original research, and *NAFO Scientific Council Studies*, which contains review 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 NAFO publications. In 1990, two Contracting Parties of NAFO, Canada and Union of Soviet Socialist Republics (Russian Federation since 1991) held a symposium of topical interest to NAFO on Capelin in the Northwest Atlantic. In accordance with the decision of the Scientific Council of June 1990 (NAFO Sci. Coun. Rep., 1990), this volume of the *Journal of Northwest Atlantic Fishery Science* contains papers presented at the bilateral symposium of 27–29 November 1990, in St. John's, Newfoundland.

The symposium was jointly organized by J. E. Carscadden from the Department of Fisheries and Oceans, Newfoundland Region, St. John's, Newfoundland, Canada, and A. Chumakov, from the Knipovich Polar Research Institute (PINRO), Murmansk, Russia. Scientists from these two institutes have been meeting annually (and sometimes more often), since Canada extended its fisheries jurisdiction, with the aim of fostering a better understanding of fisheries research undertaken by both institutes. This symposium modelled after similar meetings between PINRO and Norwegian Institute of Marine Research scientists, was restricted to papers addressing aspects of the biology of the capelin. A total of 23 papers were presented and approximately 40 researchers attended the sessions, including nine from Russia. The attendance by so many Russian scientists was particularly noteworthy, with some of them voluntarily participating in a research vessel survey in the Northwest Atlantic for several weeks in order to attend the symposium during a port call.

In accordance with the decision of the Scientific Council, J. E. Carscadden was invited to select the appropriate papers for publication in this issue, and 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. However, all oral presentations stimulated vigorous discussion and the final publication numbers in this Journal do not diminish the overall success of the symposium.

30 October 1994

Tissa Amaratunga
Assistant Executive Secretary


NAFO CONVENTION AREA
(Showing Scientific and Statistical Subareas, Divisions and Subdivisions)
NOTE: As shown on the sketch below, 5Zc and 5Zu are sub/subdivisions of the Subdivision 5Ze established by the Scientific Council for the purpose of recording and reporting catches to NAFO as coming from Canadian waters (5Zc) or USA waters (5Zu); reference to NAFO GC Doc. 86/2, 2nd revision, and GC Doc. 86/4, revised.
Boundary of the Convention Area
Boundary of Subareas
Boundary of Divisions
200-Mile Zone Boundary
200-Meter Contour
Mercator Projection
Scale 1 : 8 500 000 at 60°
GREENLAND
Melville Bay
Baffin Bay
BAFFIN ISLAND
Davis Strait
Hudson Strait
Ungava Bay
CANADA
LABRADOR
QUEBEC
NEWFOUNDLAND
Gulf of St. Lawrence
Cape Ray
St. John's
Grand Bank
Flemish Cap
ATLANTIC OCEAN
Hamilton Bank
Cape Mugford
Hopedale
Cape Desolation
Fyllas Banke
Fiskenaes Banke
Lille Hellefiske Bank
Store Hellefiske Banke
Godthaab (Nuuk)
Christianshaab
Disko Island
Cape Hatteras
Halifax
Sable I.
Scotian Shelf
Georges Bank
Gulf of Maine
Cape Cod
Nantucket I.
Block I.
MASS.
CONN.
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MAINE
NOVA SCOTIA
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ONTARIO
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4R
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4Vn
4Vs
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Scientific publications by ICNAF and NAFO have been in existence since ICNAF began in 1949 with the *ICNAF Special Publication Series* dealing with Proceedings of scientific symposia. The *ICNAF Research Bulletin* was started in 1964 to provide a means of publishing results of scientific research relevant to the Commission. The *ICNAF Research Bulletin* was terminated in September 1979 after the issue of Number 14. The primary scientific publication of NAFO began with the first issue of the *Journal of Northwest Atlantic Fishery Science* in December 1980.

Editorial Policy

The Journal provides an international forum for the primary publication of original research papers on fisheries science in the Northwest Atlantic, with emphasis on environmental, biological, ecological and fishery aspects of the living marine resources and ecosystems. While the Journal is intended to be regional in scope, papers of general applicability, and methodological and review papers, irrespective of region, are considered. Space is available for notes and letters to the editor to facilitate scientific discussion of published papers. All papers are peer-reviewed to determine their suitability for primary publication. Associate Editors arrange for the peer-reviews and ensure that the papers accepted for publication meet the high standards required for the Journal. Manuscripts approved for publication are accepted with the understanding that they are not copyrighted, published or submitted elsewhere except in abstract form. There are no page charges.

Editorial Board

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Report of the Canada–USSR Capelin Symposium

J. E. Carscadden (Co-convener)

Introduction

The Canada-USSR Capelin Symposium on "The Biology of Capelin in the Northwest Atlantic" was held at the Battery Hotel in St. John's, Newfoundland, Canada, during 27–29 November 1990. The title of the Symposium was very broad and except for two overview papers, there was no attempt made by the convenors to solicit papers on specific topics. In total, 23 oral presentations were made (a list of contributions follows this report) and contributors were encouraged to submit manuscripts for publication in this Journal. The Symposium was attended by about 40 researchers from Canada and USSR.

Capelin (*Mallotus villosus*) have been important as a commercial species since the early-1970s and a substantial proportion of the research since then has been conducted as a result of this increased commercial interest. Capelin are also important as a forage species and there has been considerable interest in the potential conflict between man as a predator on capelin and non-human predators, many of which are important commercial species. In spite of the commercial interest in capelin, only one paper offered an analysis of the interacting effects of fishing and population dynamics of capelin. However, papers were presented on a wide range of subjects pertaining to the biology of capelin and many of the subjects were directly relevant to management of a capelin fishery. In the following report, summaries of two overview papers are presented and the remaining summaries are arranged generally according to the capelin life stage beginning with adults and proceeding to early life history.

Specific Topics

One overview paper centred mainly on the capelin fishery in the Northwest Atlantic and the other on the physical environment. The former paper by Carscadden and Miller presented a brief history of the fishery in the area – a fishery that expanded rapidly beginning in the early-1970s. The fishery during the 1970s was largely conducted by the offshore midwater trawls and purse seines. This fishery declined during the late-1970s and was replaced by an inshore Canadian fishery centred on mature fish. This fishery continued during the 1980s but at a catch level that did not exceed about one-third of the peak catches of the 1970s offshore fishery.

The overview paper on the physical environment described the Northwest Atlantic to be dominated by the cold, south-flowing Labrador Current. This environmental overview paper by Mertz and Helbig included a discussion of this physical feature as well as the effect of wind on near-shore waters and its potential to affect the release of larval capelin from beach sediments.

Stock structure of capelin has been a topic of several studies in recent years but new mt DNA analyses have only recently been applied. As part of a worldwide study of capelin populations, Dodson and co-authors reported that mt DNA analyses did not separate putative stocks in the Northwest Atlantic although capelin in this area could be discriminated from other capelin in the North Atlantic.

Bakanev and Chumakov presented an analysis of population trends between 1972 and 1989 and related these trends to the level of fishing activity during this period. As previously noted, this was the only paper that attempted to address the effects of fishing on the population abundance of capelin.

Four papers addressed various aspects of capelin biology that were directly relevant to its role as a forage species. Nakashima and Kennedy described seasonal variations in body biochemistry. These data are not only useful for the fishing industry (e.g. oil content for fish meal) but also are of interest to scientists who are engaged in bioenergetics and modelling.

Cod are a major predator of capelin. A question that is often addressed is the effect of fluctuating capelin stocks on the well-being of cod, often measured by cod growth. Fahrig et al. addressed this question for cod in the Northwest Atlantic for a time series of 15 years and found no relationship between cod growth and capelin biomass. This was similar to results from a study from the early-1980s using a shorter time series.

Results from three feeding studies were also presented, two on feeding by predators on capelin and one on feeding by capelin. The two capelin predator studies presented data on Greenland halibut (*Reinhardtius hippoglossoides*), an important capelin predator that has received less attention than cod, probably because historically it has been less commercially important.

Albikovskaya and Gerasimova presented capelin consumption estimates for cod and Greenland halibut for Div. 3KL based on quantitative collections during the spring periods of 1988 and 1989, augmented by visual observations of feeding by these predators between 1980 and 1989. Bowering and Lilly presented feeding data on Greenland halibut from Div. 2J and 3K during the autumn periods of the early-1980s. Capelin was found to be an important prey item for Greenland halibut especially for medium sized individuals (20–69 cm) occurring on the continental shelf and upper slopes off southern Labrador and northeastern Newfoundland.

There have been relatively few publications on feeding by capelin. Gerasimova presented the results of a study conducted in Div. 3LNO during April and May 1987–90. Immature capelin fed mainly on copepods. Mature capelin also fed on copepods as well as euphausiids (*Thysanoessa raschii*). Feeding on this euphausiid by capelin and cod (results from another study) suggest that it is widespread and important in the food chain. Where feeding on euphausiids by mature capelin was poor, they compensated in part by increasing the predation on juvenile capelin and sandeel.

Maturing capelin undertake extensive migrations during the spring from offshore banks to the inshore spawning beaches and the movement of adult capelin during this phase of the life cycle was the subject of three presentations. Rose *et al*. combined results from acoustic surveys, tagging, oceanographic sampling and fishing to test hypotheses that capelin migrate northward through the Avalon Channel to spawning sites on the Northeast Newfoundland coast, that this migration occurs along fronts associated with the inshore branch of the Labrador Current, and that capelin tend to occupy waters having subzero temperatures during migration. Schneider also used acoustic data on capelin coupled with oceanographic events to test hypotheses relating capelin movement to upwelling events in the Avalon Channel. He found that water mass replacement due to coastal upwelling could be predicted to occur as the balance between buoyancy and Coriolar forces. Capelin abundance occurred as a cross-shore gradient and this was related to upwelling, and the gradient in capelin abundance decayed after an episode of winds that favoured upwelling. Horne also used acoustic techniques to study adult capelin distribution in Conception Bay, Newfoundland. He reported that the patchiness of cross-shore distributions of capelin was not greater than longshore distributions, contrary to an observation that had been made for phytoplankton, zooplankton and seabirds.

Capelin in Newfoundland spawn extensively on gravel beaches, and two papers presented preliminary results of studies of spawning and larval existence and beach characteristics. Beaches vary widely in their characteristics (size of sediment, orientation, etc.) and different beaches appear to support different levels of spawning activity. Nakashima and Taggart presented preliminary data examining the relationships between sediment size, orientation (direction) and spawning intensity. Capelin larvae live in beaches for periods of up to seven days before they enter the pelagic environment. The development of the offshore oil industry in the Newfoundland area and the resulting potential for oil spills and fouling of capelin spawning beaches prompted the study by Morrisson *et al*. They used laboratory and field experiments to investigate the effects of oiling on the physical beach environment and larval emergence.

Nine papers were on various aspects of larval ecology and recruitment. This interest in the early life history reflects the importance of this phase of the life history to its population dynamics. Capelin are a short-lived species characterized by early maturity (as early as 2 years but more often 3 or 4 years of age) and variable recruitment. Thus, a knowledge of factors influencing survival and subsequent recruitment is necessary to provide fishery management advice. The first three papers by Taggart, Chambers *et al*., and Litvak and Leggett were contributions from a group of researchers from McGill University, Montreal, who have been studying the ecology of capelin eggs and larvae at their study site in Bryant's Cove, Conception Bay, Newfoundland, since 1978. These papers addressed various questions regarding larval mortality (Taggart), the effect of environment on age at hatching (Chambers *et al*.), and predation on capelin larvae of different sizes and ages (Litvak and Leggett) under experimental conditions.

Once the larvae leave the beach environment and enter the pelagic environment, they apparently leave the nearshore waters within a few weeks to reside on the offshore banks until they mature. During this period the larvae and juveniles have been extensively studied and such studies formed the basis for the next four papers. Anderson and Penney presented results from a limited sampling experiment for capelin larvae in one coastal embayment, Conception Bay, while Dalley sampled over 5 years 1982–86, with several surveys per year in another major capelin spawning bay, Trinity Bay. Dalley's more extensive sampling permitted him to compare relative abundance and sizes of larvae from this bay. Both studies occurred in the July and August periods. USSR scientists, since 1983, have been monitoring the offshore larval capelin later in the year (November, most years), in an attempt to determine whether estimates of 0-group capelin provide an early indication of year-class strength.

V. Bakanev provided details of this program. Canadian scientists (Carscadden, Nakashima and Miller) have been estimating recruitment at age two using broad-scale acoustic surveys in offshore waters. These estimates of year-class strength of juveniles, were compared with estimates of the same year-classes of mature fish inshore which were derived from catch rates and acoustic estimates of abundance.

K. T. Frank combined the observations that both vertebral counts and recruitment are influenced by the environment, and he presented analyses to indicate that vertebral count variations could reflect recruitment variation.

In a previous publication, Leggett, Frank and Carscadden had established a relationship between capelin recruitment during the late-1960s and 1970s and the frequency of onshore winds and surface water temperatures during the first 6 months of larval existence. At this meeting the same authors compared predictions of year-class strengths from this relationship to measures of year-class strength for the 1980s.

This symposium was not designed to address specific questions relating to capelin biology or management. It was a format to bring together Canadian and USSR scientists working on capelin and environmental conditions, many of whom were meeting for the first time, to discuss existing and new research ideas in a semi-formal setting. As a result, no written records of the presentations (unless later submitted) or discussions were kept. Consequently, the foregoing summary reflects my interpretation only and apologies are extended if there are any errors. Some of the summaries of individual papers mention only the general topic or approach rather than present specific conclusions. This is intentional since many papers presented new ideas or preliminary results, some of which have not been published.

Acknowledgements

The convenors thank the authors and participants for a successful Symposium. The editor thanks the authors and reviewers for their patience, noting the process took longer than expected partly because of the difficulties in dealing with the mail system between Canada and Russia. Special thanks are offered to M. Hynes who helped with the Symposium and the editing. The following individuals reviewed the papers: J. Anderson, W. Brodie, E. Dalley, K. Drinkwater, K. Frank, G. Lilly, J. Loder, G. Mertz, D. Miller, B. Nakashima, P. Pepin, G. Rose, D. Schneider, P. Shelton, R. Stephenson, C. Taggart and G. Winters.

List of Presentations

Brief introduction to capelin in the Northwest Atlantic – J. Carscadden and D. Miller

Revisiting Newfoundland Capelin (*Mallotus villosus*) Recruitment: Is There a Wind Effect? – G. Mertz, J. A. Helbig, and E. Colbourne

Phylogeographic structure of capelin in the Northwest Atlantic as demonstrated by mt DNA analysis – J. J. Dodson, F. Colambini, L. Bernatchez, and J. Carscadden

Spawning stock composition and fecundity of Newfoundland capelin – V. S. Bakanev and A. K. Chumakov

Seasonal variation and proximate body content of capelin in the Newfoundland area – B. Nakashima and K. Kennedy

Effect of capelin on cod growth – L. Fahrig, P. Shelton, and R. Millar

Estimate of capelin consumption by cod and Greenland halibut in Divisions 3KL in the spring/summer period – L. K. Albikovskaya and O. V. Gerasimova

Greenland halibut (*Reinhardtius hippoglossoides*) off Southern Labrador and Northeastern Newfoundland (Northwest Atlantic) feed primarily on capelin (*Mallotus villosus*) – W. R. Bowering and G. R. Lilly

Peculiarities of Spring Feeding by Capelin (*Mallotus villosus*) on the Grand Bank in 1987–90 – O. V. Gerasimova

Spatial distribution of migratory capelin (*Mallotus villosus*) relative to the inshore branch of the Labrador Current – G. A. Rose, B. Nakashima, J. Helbig, and E. Colbourne

Distribution of Capelin (*Mallotus villosus*) in Relation to Coastal Upwelling in the Avalon Channel – D. C. Schneider

Spatial Variance of Capelin (*Mallotus villosus*) in Coastal Newfoundland Waters – J. K. Horne

Predicting spawning densities of capelin from beach characteristics – B. Nakashima and C. Taggart

Wave-driven sediment disturbance and oiling effects on capelin spawning beaches: implications for larval emergence – M. C. Morrisson, C. Taggart, and B. Nakashima

Mortality and condition of larvae in a controlled mesocosm – C. Taggart

Predicting age at hatching of capelin in variable environments – R. C. Chambers, G. L. Maillet, and W. C. Leggett

The impact of size and age of capelin larvae on their vulnerability to predation – M. Litvak and W. C. Leggett

Seasonal occurrence of capelin, Mallotus villosus, in the nearshore waters of Conception Bay, Newfoundland – J. T. Anderson and R. Penney

Inter- and intra-annual distribution, abundance and size composition of larval capelin, *Mallotus villosus*, in Trinity Bay, Newfoundland, 1982–86 – E. L. Dalley

Capelin year-class strength estimate according to ichthyoplankton survey data – V. S. Bakanev

An Evaluation of Trends in Abundance of Capelin (*Mallotus villosus*) from Acoustics, Aerial Surveys and Catch Rates in NAFO Divison 3L, 1982–89 – J. Carscadden, B. Nakashima and D. S. Miller

Predicting recruitment variation from year-class specific vertebral counts: an analysis of the potential and a plan for verification – K. T. Frank

Predicting capelin recruitment in the 1980s from environmental variables – J. E. Carscadden, K. T. Frank, and W. C. Leggett