

---

# INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Established by Convention between Canada, Japan  
and the United States for the Conservation of the  
Fisheries Resources of the North Pacific Ocean

## BULLETIN NUMBER 50

---

### PROCEEDINGS OF THE SYMPOSIUM ON APPLICATION OF STOCK ASSESSMENT TECHNIQUES TO GADIDS

Edited by: Loh-Lee Low

Symposium was held by the Standing  
Committee on Biology and Research  
at Seattle, Washington, U.S.A.,  
October 31 to November 1, 1989



INTERNATIONAL NORTH PACIFIC  
FISHERIES COMMISSION

---

OFFICERS FOR 1990

Chairman	Pierre Asselin (to February 1990) Kenjiro Nishimura (from March to October 1990) David Good (from October 1990)
Vice-Chairman	Kenjiro Nishimura
Secretary	Clement V. Tillion

COMMISSIONERS

CANADA

Pierre Asselin (to February 1990)  
David Good (from October 1990)  
Michael Z. Florian (to October 1990)  
Teunis Westbroek (from October 1990)  
Nancy S. Marshall  
John C. Davis

UNITED STATES

Clement V. Tillion  
Alec W. Brindle  
Steven Pennoyer  
Richard B. Lauber

JAPAN

Kenjiro Nishimura  
Atsushi Tokinoya (to October 1990)  
Minoru Tamba (from October 1990)  
Junzo Sasaki (to October 1990)  
Fumio Imanaga (from October 1990)  
Koji Imamura

---

SECRETARIAT

Bernard E. Skud, Executive Director  
Katsuma Hanafusa, Assistant Director



# ADDENDUM

## INPFC Bulletin 50

### "PROCEEDINGS OF THE SYMPOSIUM ON APPLICATION OF STOCK ASSESSMENT TECHNIQUES TO GADIDS"

The following Fig. 9 was missing from INPFC Bulletin 50. Please insert this figure after p. 134 of Bulletin 50.

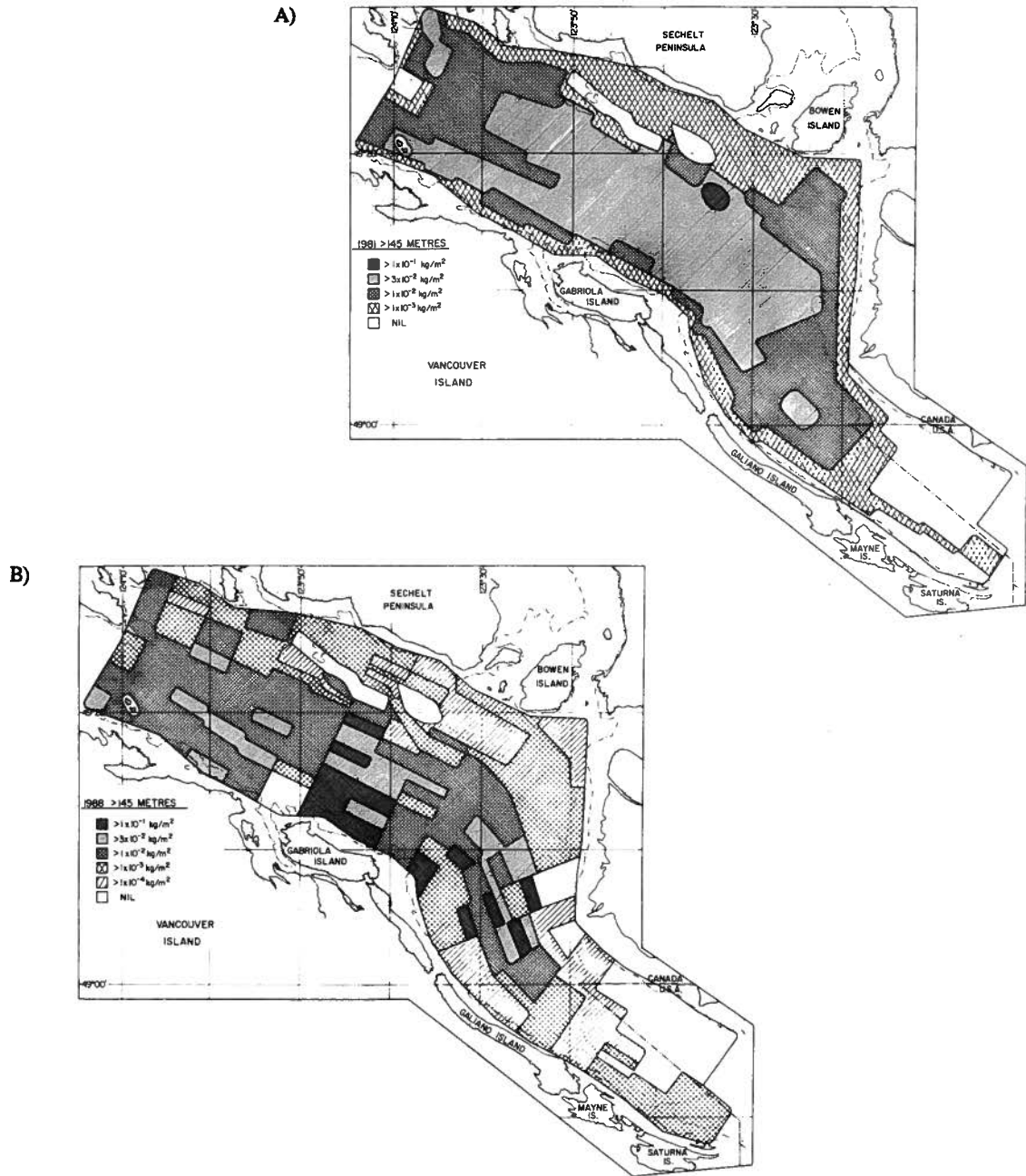


Fig. 9 Biomass surface density in the deep layer as determined from the hydroacoustic survey. A) 1981; B) 1988 survey.



## PREFACE

This Bulletin is a compilation of papers presented at an International Groundfish Symposium held in Seattle, Washington, October 31 to November 1, 1989, under the auspices of the International North Pacific Fisheries Commission. The topic of the symposium was "Application of Stock Assessment Techniques to Gadids".

The Symposium was the fifth such held by the Commission. It was organized by a symposium committee composed of the three senior scientist-members of the Standing Committee on Biology and Research and the Secretariat. The members were:

Loh-Lee Low  
National Marine Fisheries Service  
Seattle, Washington, U.S.A.

Richard J. Beamish  
Department of Fisheries and Oceans  
Nanaimo, British Columbia, Canada

Seiji Ohsumi  
Fishery Agency of Japan  
Shimizu, Japan

Bernard E. Skud  
INPFC Secretariat  
Vancouver, British Columbia, Canada

Research papers were presented by scientists of the three member nations of the Commission (Canada, Japan, and the United States) and by Poland. Draft copies of the papers were made available at the symposium. The drafts were sent out for peer technical review and the authors were given opportunities to make revisions before publication.

I wish to thank the following individuals for their technical review of selected papers: Richard G. Bakkala, William G. Clark, Jeremy S. Collic, Donald R. Gunderson, Ray Hilborn, Anne B. Hollowed, Daniel K. Kimura, Han-Lin Lai, Patricia A. Livingston, Richard D. Methot, Terrance J. Quinn II, Patrick J. Sullivan, Grant G. Thompson, Robert J. Trumble, and Vidar G. Wespestad.

Bulletins of the Commission are published separately in English and Japanese. I served as compiler and editor for the English version of this Bulletin. The Japanese version will be prepared later by the Secretariat.

*Loh-Lee Low*  
Chairman  
Organizing Committee





## TABLE OF CONTENTS

	<i>Page</i>
PREFACE .....	1
OPENING REMARKS .....	5
FIRST SESSION - RESOURCE SURVEY TECHNIQUES .....	7
DANIEL K. KIMURA and JULAINE L. LYONS. Choosing a Structure for the Production Ageing of Pacific Cod ( <i>Gadus macrocephalus</i> ) .....	9
RICHARD J. BEAMISH, GORDON A. MCFARLANE, and ALBERT V. TYLER. A Comparison of the Length Frequency and Fin-ray Methods of Estimating the Age of Pacific Cod .....	25
GORDON A. MCFARLANE and RICHARD J. BEAMISH. An Examination of Age Determination Structures of Walleye Pollock ( <i>Theragra chalcogramma</i> ) from Five Stocks in the Northeast Pacific Ocean .....	37
CRAIG S. ROSE and GARY E. WALTERS. Trawl Width Variation During Bottom Trawl Surveys: Causes and Consequences .....	57
JIMMIE J. TRAYNOR, WILLIAM A. KARP, MASAHIKO FURUSAWA, TAKASHI SASAKI, KAZUYUKI TESHIMA, TERRANCE M. SAMPLE, NEAL J. WILLIAMSON, and TAKU YOSHIMURA. Methodology and Biological Results from Surveys of Walleye Pollock ( <i>Theragra chalcogramma</i> ) in the Eastern Bering Sea and Aleutian Basin in 1988 .....	69
KIYOSHI WAKABAYASHI, KAZUTOSHI WATANABE, and YASUHIRO WATANABE. Assessments of Walleye Pollock Abundance of the Southeast Pacific Coast of Hokkaido, Based on Catch Statistics and Survey Data .....	101
WILLIAM SHAW, GORDON A. MCFARLANE, and ROBERT KIESER. Distribution and Abundance of the Pacific Hake ( <i>Merluccius productus</i> ) Spawning Stocks in the Strait of Georgia, British Columbia, Based on Trawl and Acoustic Surveys in 1981 and 1988 .....	121
LAURA J. RICHARDS and MARK W. SAUNDERS. Problems in Yield Allocation of Pacific Hake ( <i>Merluccius productus</i> ) .....	135
S.J. WESTRHEIM, J. FARGO, and R.P. FOUCHER. Stock Assessments of Individual Species in a Mixed-species Trawl Fishery: Some Hazards .....	145
SECOND SESSION - MATHEMATICAL MODELING AND ANALYTICAL TECHNIQUES ...	157
KEI-ICHI MITO, TAKASHI SASAKI and TAKU YOSHIMURA. Assessment of the Walleye Pollock Resource in the Eastern Bering Sea by Japanese scientists .....	159
KEI-ICHI MITO. Estimation of Consumption Number by Cannibalism of Pollock in the Eastern Bering Sea under Assumption of Multi-stocks .....	179
RAY HILBORN. Estimating the Parameters of Full Age-Structured Models from Catch and Abundance Data .....	207
GRANT G. THOMPSON and RICHARD G. BAKKALA. Assessment of the Eastern Bering Sea Pacific Cod Stock Using a Catch-at-Age Model and Trawl Survey .....	215
ALBERT V. TYLER. Estimation of Yield in a High Turn-over Stock of Groundfish: an Application to Pacific Cod on the West Coast of Canada .....	237
TERRANCE J. QUINN II and JEREMY S. COLLIE. Alternative Population Models for Eastern Bering Sea Pollock .....	243
RICHARD D. METHOT. Synthesis Model: An Adaptable Framework for Analysis of Diverse Stock Assessment Data .....	259
BERNARD A. MEGREY, ANNE B. HOLLOWED, and RICHARD D. METHOT. Integrated Analysis of Gulf of Alaska Walleye Pollock Catch-At-Age and Research Survey Data Using Two Different Stock Assessment Procedures .....	279
JAN HORBOWY and JERZY JANUSZ. Assessment of Walleye Pollock Biomass in the Aleutian Basin Based on Cohort Analysis and Polish Fisheries Data .....	303



## OPENING REMARKS

by  
**Warren S. Wooster**  
 Institute for Marine Studies  
 University of Washington  
 Seattle, WA 98185  
 U.S.A.

While INPFC looks chiefly at anadromous species and their conservation on the high seas, its interests go well beyond this group of species and the fishing activity of its members (Japan, Canada, USA), as this symposium clearly shows. There are other fish in the sea, and other countries that fish for them. The INPFC Convention foresees the eventual establishment of an organization with broader membership and dealing with non-anadromous species; and until that happens, it encourages the sort of information exchange that this symposium exemplifies.

There is probably no problem more central to fishery management than stock assessment, and none more intimidating to the outsider such as myself. But even an oceanographer can appreciate the need for a careful estimation of stock size as one of the basic elements in the management equation.

My own research in recent years has been concerned with recruitment in several species. In these studies, I have become convinced that while stock size clearly has some influence on recruitment, especially below some critical value, the predictive value of a stock recruitment curve for recruitment is generally low. There is also an accumulation of evidence that environmental change can have a strong influence on recruitment. This evidence includes observations on the impact of environmental events such as El Nino, of the synchronous occurrence of extreme year classes over large areas, and of large scale trends in abundance even in the absence of exploitation.

Given the nature of the agents affecting the abundance of fish stocks, it certainly looks as if any prediction of yield requires information on more than just stock size, including the abundance of interacting species (predators, prey, and competitors at different development stages) as functions of time and space, ocean circulation and mixing as they affect transport of eggs and larvae, primary and secondary productivity, etc., and the variable driving forces (primarily atmospheric) on short and long scales. At the same time, one needs the understanding whereby

such information can be combined in a useful model of the system.

The principal goal of such a broad approach is to understand the impact of environmental change on fish stocks and other marine organisms. That impact will be on distribution, availability, and abundance (production). In my view, prediction on an interannual scale is conceivable but unlikely, while prediction on longer time scales (decadal trends, regime shifts) should eventually be possible. From the fisheries point of view (which is not the only relevant view), the justification is to help in determining potential yield in face of environmental variability--how much can be removed without jeopardizing replacement. An additional non-trivial fishery justification is to help in determining the potential impact on fisheries of global warming and other kinds of climate change (e.g., how will the next Nino or sustained warming at high latitudes affect one or another fishery?).

The necessary information comes from a variety of sources both governmental and academic, not just fishery agencies but also those concerned with oceanography, including food web ecology, meteorology, and climatology. The evaluation and interpretation of such information requires the active participation of scientists from these multiple sources of information and research.

How does this relate to management? My own view is that the acquiring and evaluation of such information on a broad basis must be handled separately from its application in fishery management. Management is essentially a political activity operating under constraints imposed by biology, economics, social forces, law, etc. Its political nature, especially as it pertains to allocation of finite resources, makes it very difficult to get an objective assessment of information internally.

The difficulty of obtaining value-free scientific data is epitomized by the controversy over possible mixing of pollock stocks in the international area of the Aleutian Basin, the so-called donut hole. The

exercise of political taxonomy seems to have each country's scientists reaching different conclusions, usually those that support their country's political position. Is it really such a difficult scientific question? Perhaps at this late date, the only way to get an objective assessment of available data is to appoint a group of experts from countries not participants in the fishery. But in the future, I would hope that an independent scientific organization, to be discussed later, would offer a forum where scientific understanding was dominant, rather than its immediate application.

Another example is the driftnet controversy. The scientific question of the impact of the fishery on target and other marine organisms should be amenable to scientific investigation. Could the question be removed from the political arena and treated effectively by the collective action of scientists more interested in gaining understanding than in making a political point?

For more than a decade, consideration has been given to establishing an international scientific organization whose purpose was recently expressed as follows:

to advance scientific knowledge of the region [the northern North Pacific] with respect to the ocean environment and its interactions with land and atmosphere, its role in and response to global weather and climate change, its flora, fauna, and ecosystems, its uses and resources, and its response to human activities.

Functions of the organization informally known as Pacific ICES, or PICES, would include exchange, dissemination, and review of scientific information, data, and research programs; identification of critical research problems and methods appropriate for their solution; development and coordination of cooperative investigations; and evaluation and interpretation of available scientific data and information. It would be concerned with research (search for understanding)

and monitoring (keeping track of change) on topics such as ocean/atmosphere interaction, ocean circulation and mixing, food web ecology, fish and shellfish stocks, and environmental quality.

It is proposed that the organization PICES involve most aspects of ocean and fishery science except perhaps geology and geophysics. Among other things, such an organization could mobilize data and make assessments on stocks of international interest, if members and fishery management organizations so desired. This function is analogous to that of ICES which makes such assessments for many stocks for members, the EEC, and several regional fishery commissions.

As an aside, it is common in regional fishery management to have an artificial division among species groups, with separate organizations for different taxa. This seems to ignore the fact that these species and their harvesters interact with each other and with a common environment. There may be good political reasons to have species-specific management bodies, but the scientific reasons are not very convincing. A broader organization concerned with managing a variety of shared stocks, perhaps with subcommissions as necessary for separate fisheries, would seem more likely to produce useful results. Then among its other activities, a PICES could provide solid scientific support for such a broad-gage management organization.

The present position with the PICES proposal is as follows. Two intergovernmental discussions of the organization have been held, a draft convention has been drawn up, and a further drafting session involving representatives of Canada, China, Japan, USA, and USSR is scheduled for the week of 11 December in Seattle. If this session is successful, a plenary session for approving the convention and establishing the organization should take place early next year. Thus there is some hope that important scientific discussions such as that you are now holding will be convened in the future under the auspices of the new PICES (or whatever it is eventually called).