St. Andrews Biological Station Activity Report 1990-1993

B. D. Chang (Editor)

Biological Station
St. Andrews, N. B. E0G 2X0

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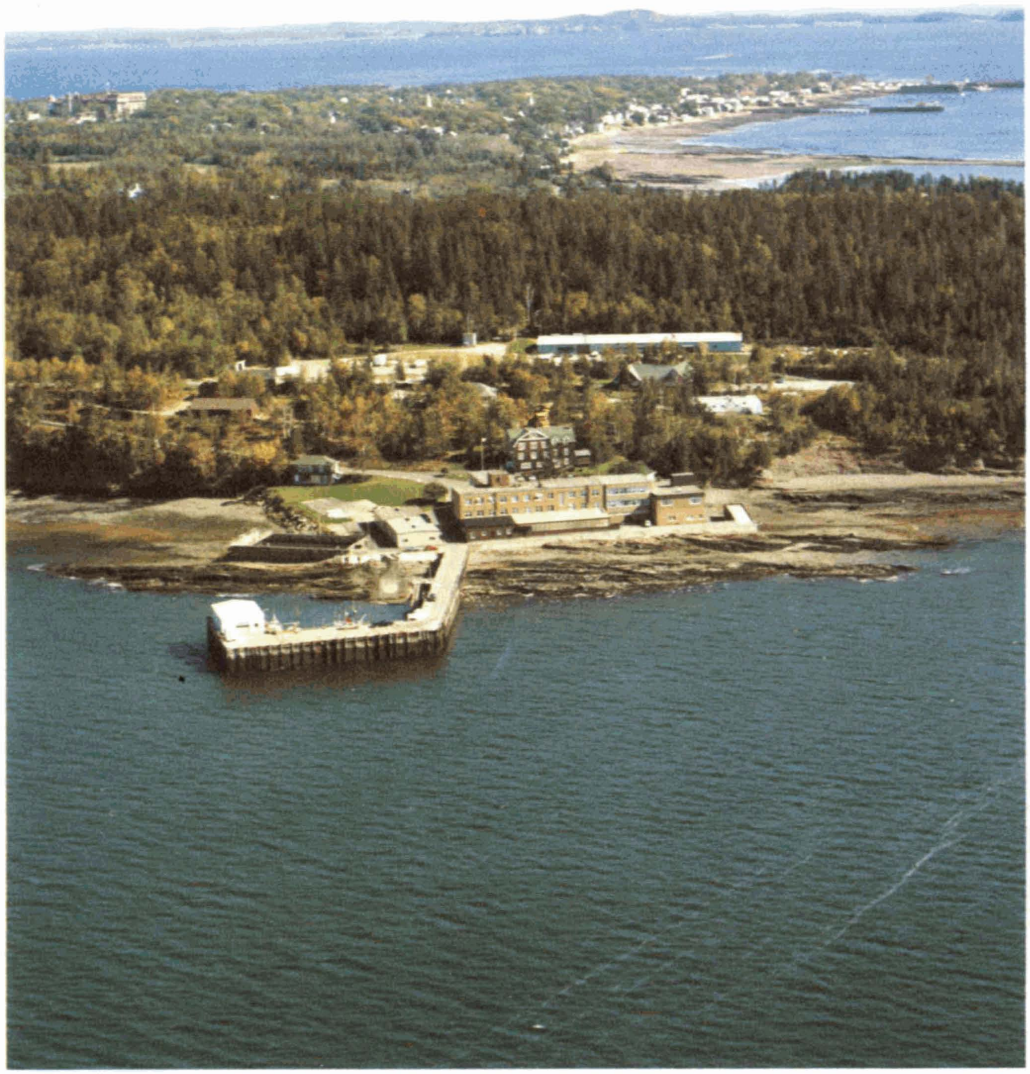
Biological Station

St. Andrews, New Brunswick, Canada



BIOLOGICAL STATION
FISHERIES AND MARINE SERVICE
ST. ANDREWS, NEW BRUNSWICK, CANADA

The antecedents of the present St. Andrews Biological Station go back to 1898, when approval was given to construct a portable floating laboratory, resembling a pullman car – it was built on a scow and moved from place to place for 2-year periods. A continuing land base was established at St. Andrews in 1908. Begun by university professors and their students as a summer operation, the St. Andrews Biological Station is Canada's oldest laboratory for research in marine biology. In the course of the Station's development, permanent, non-university, year-round staff gradually took over. However, university students continue to provide an integral part of summer research programs. Graduate students have long used the Station's facilities and the guidance of the scientific staff in completing degree requirements. Post-doctoral fellowships also bring a variety of scientific talent.

The Biological Station at St. Andrews is one of eight major fisheries management research centres in Canada. Strong ties are maintained with many Federal and Provincial agencies, while international cooperation is exercised through such agencies as the International Council for the Exploration of the Sea (ICES) and the International Commission for the Northwest Atlantic Fisheries (ICNAF). In the 7 decades of its existence, the St. Andrews Biological Station has made major contributions in its fields of fisheries research and proudly enjoys international acclaim.

Modern laboratories and offices are housed in several buildings on a 23-acre site adjacent to beautiful Passamaquoddy Bay in the Bay of Fundy, within easy reach of the continental shelf area. Major vessels that probe the Maritime waters are the E.E. PRINCE (130 ft), the PANDALUS (50 ft), and the J.L. HART (65 ft). Two summers' work with research submarines has confirmed that submersibles form an integral requirement of the fleet for studying performance of fishing gear and behaviour of aquatic organisms in their natural habitats.

Much of the research is conducted in programs which are primarily species-oriented, since one of the first responsibilities is to understand the various fisheries. Included are life history, population, and behaviour studies leading to a sound scientific basis for conservation and management of commercially important species of fish – including lobsters, spider crabs, clams, scallops, salmon, cod, haddock, flatfishes, tuna, swordfish, and herring. In these species-oriented programs, a good deal of research, while related to the resource, is of a fundamental nature: e.g., metabolic studies, physiology of crustacean moulting, sound perception by cod, and the feeding behaviour of salmon. Other programs are of a more obviously applied nature, such as the search for new fishing grounds, and attempts to improve fishing methods and gear.

Cutting across taxonomic boundaries are studies on fish genetics, diseases, physiology, behaviour, and the effects of water pollution on fisheries. The behaviour program, organized in 1968, investigates the relation of the behaviour of fish to fishing gear performance and fishing strategy.

The Station has considerable expertise in SCUBA diving, with a number of the staff serving as qualified divers, as well as in the application of photography, television, and electronic sensing to submarine work. A marine technology program is involved in the development of a bottom referencing underwater towed instrument vehicle (BRUTIV) designed to assist in regional fish stock assessment programs.

In 1976, the research programs at the Station were integrated more closely with those other programs conducted within the Maritimes Region. Within the regional Resource Branch are four major divisions, each with components based at St. Andrews. Marine Fish Division with headquarters in Dartmouth, N.S., is responsible for assessments of vertebrate fisheries stocks under management by quota and for recommendations on management strategies. There is also a considerable amount of what might be termed basic fisheries research. The Invertebrate and Plants Division, headquartered in Halifax, is similarly responsible for basic biological research and management advice on invertebrate fisheries. The St. Andrews component deals principally with research on lobsters, scallops, and crabs. The Freshwater and Anadromous Division, headquartered in Halifax, discharges similar functions for freshwater fisheries. The Fisheries and Environmental Sciences Division is headquartered at the St. Andrews Biological Station, and Dr. R. H. Cook, the Station's Director fulfills the additional role of Division Chief. The principal programs of the division located at St. Andrews are Fisheries Environmental Research with responsibilities to resolve a wide variety of fisheries-related envionmental problems such as pesticides and pulpmills; and the Applied Physiology Research program responsible for scientific investigations into the growth and maturation of lobster, salmonids, marine fish, and the development of aqua-culture techniques.

The Station itself provides necessary support services to all Division components located at the St. Andrews site, together with technical services, such as the library, computer, workshops, etc., needed to support the scientific programs.

The Biological Station enjoys a close association with the Huntsman Marine Laboratory – a multi-university centre for marine research and education (Executive Director, Dr. W. B. Scott) and the International Atlantic Salmon Foundation (Executive Director, Dr. W. M. Carter) which has recently established the North American Salmon Research Centre close by.

A number of visiting professors, post-graduate students and post-doctoral fellows work with Station scientists in all aspects of field and laboratory studies.

Considering the direct involvement of the Biological Station associated with Canada's extended jurisdiction, the exciting research expected in the fields of population dynamics, behavioural sciences, along with continued excellence in the fields of fisheries biology, physical oceanography, pollution, and physiology, the future of the Biological Station at St. Andrews, N.B., is bright indeed!

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ACTIVITY REPORT 1990-1993

edited by

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ABSTRACT

Chang, B.D. (Editor). 1994. St. Andrews Biological Station Activity Report 1990-1993.
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This report presents a summary of research activities at the St. Andrews Biological Station from 1990 to 1993. In addition, the report includes lists of staff, publications, seminars and workshops, and missions on which staff participated during this period.

RÉSUMÉ

Chang, B.D. (Editor). 1994. St. Andrews Biological Station Activity Report 1990-1993.
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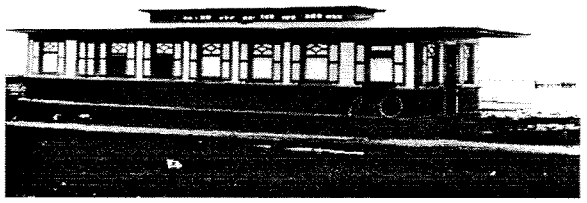
Ce rapport présente un sommaire des activités de recherches scientifiques à la Station biologique de St. Andrews entre les années 1990 à 1993. En plus, le rapport contient quelques listes d'employés, de publications, de colloques et d'ateliers, ainsi que de missions auxquelles certains employés de la Station ont participés pendant cette période.

INTRODUCTION

This report provides an overview of activities at the St. Andrews Biological Station from 1990 to 1993. Included are brief descriptions of projects, with highlights of activities during this period. Also included are lists of staff, publications, and seminars held at the Biological Station during this period. Previous recent overviews can be found in Canadian Manuscript Reports of Fisheries and Aquatic Sciences Nos. 2054 (February 1990) and 1948 (September 1987).

The history of marine biological research in Canada began at St. Andrews. This is where Canada's first marine biological station began operations in 1899-1900. This station was a small, portable laboratory that resembled a Pullman railway car. This station was subsequently operated at other sites in Atlantic Canada. A few years later, when the Biological Board of Canada decided that a permanent biological station was needed on the Atlantic coast, St. Andrews was chosen as the the site. St. Andrews was chosen primarily because of its location adjacent to a diverse biological and physical environment in Passamaquoddy Bay and the Bay of Fundy and its proximity to important commercial fisheries for herring, groundfish and invertebrate species.



Canada's first biological station
St. Andrews 1899-1900

The St. Andrews Biological Station (originally called the Atlantic Biological Station) began operations in 1908 at a 1.4 hectare site at Brandy Cove, near the mouth of the St. Croix River. The original facilities included a main laboratory building, a residence building, and a small wharf. Staff during that first year consisted of the Resident Director, Dr. D.P. Penhallow, eight other scientists, all of whom were affiliated with universities in Ontario and Québec, and a small group of support staff. In the early years, the Station was open only during the summer field season, generally from May to September. It was not until 1928 that the Station was operated year-round.

The Biological Station facilities have now expanded to cover 9.3 hectares. One of the original buildings is still in use, but it now forms part of a modern complex that includes laboratories, offices, a conference centre, computer facilities, a library, and a wharf for research vessels. The staff in 1993 consisted of over 80 full-time employees. In 1992, Dr. Wendy Watson-Wright was appointed as Station Director, replacing Dr. Robert H. Cook, who had held that position for almost 15 years. The Biological Station celebrated its 85th anniversary in 1993 . Various activities were organized to commemorate this anniversary, most notably an open house held on 22-23 June 1993.

The St. Andrews Biological Station is a component of the Science Sector in the Scotia-Fundy Region of the Department of Fisheries and Oceans (DFO). It is one of a network of research facilities operated by DFO across the country. Current activities at the Biological Station fall within four categories:

- stock assessments and research on commercially harvested marine finfish and invertebrates
- aquaculture research
- aquatic environmental studies
- support services

These activities are carried out in support of the Department's goals of conservation, development, and sustained economic utilization of Canada's fisheries resources.

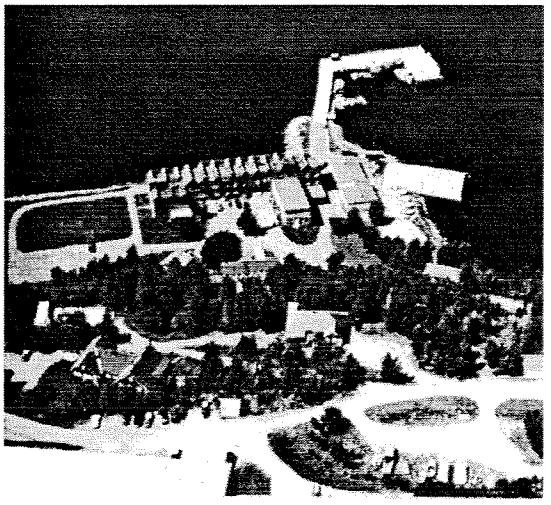
In addition to cooperating with other fisheries research centres in the Scotia-Fundy Region and in the rest of Canada, the Biological Station maintains strong ties with many Federal and Provincial agencies and with the fishing and aquaculture industries. National and international cooperation is exercised through agencies such as the Fisheries Resource Conservation Council (FRCC), the International Council for the Exploration of the Sea (ICES), the Northwest Atlantic Fisheries Organization (NAFO), and the International Commission for the Conservation of Atlantic Tunas (ICCAT).

The Biological Station collaborates closely with other institutions within an active scientific community in the St. Andrews area. The Station is a founding member of the Huntsman Marine Science Centre (HMSC), a multi-university organization dedicated to marine research and education, which is located adjacent to the Biological Station. Collaborative projects with HMSC include the Atlantic Reference Centre (ARC), which houses a museum collection containing over 200,000 specimens representing the marine and freshwater fauna of Atlantic Canada, and the St. Andrews Aquarium/Museum, which is open to the public during the summer and attracts about 30,000 visitors each year.

Other collaborative projects include the Salmon Genetics Research Program, which is operated by the Atlantic Salmon Federation at its research facilities located just outside of St. Andrews, and the Atlantic Salmon Demonstration and Development Farm, which is operated by the New Brunswick Salmon Growers' Association at Lime Kiln Bay, about 20 km due east of St. Andrews.

The Biological Station plays an important role in the education of future marine scientists and technicians. The Station provides research facilities and supervision for graduate students. In addition, practical experience in research techniques is provided for students in the aquaculture training course of the St. Andrews campus of the New Brunswick Community College, as well as for visiting students from universities and local high schools.

These reasons for choosing St. Andrews as the site of Atlantic Canada's first biological station continue to make St. Andrews an ideal location for conducting fisheries research. Furthermore, the southwestern New Brunswick area is now the most important salmon aquaculture area in Atlantic Canada. The Station's facilities, especially its access to high quality seawater and freshwater, allow our scientists to conduct aquatic research not possible at other research institutions on this coast. These factors, together with the Station's dedicated and qualified staff, should allow the St. Andrews Biological Station to continue its tradition of conducting science in support of Atlantic Canada's fisheries well into the future.

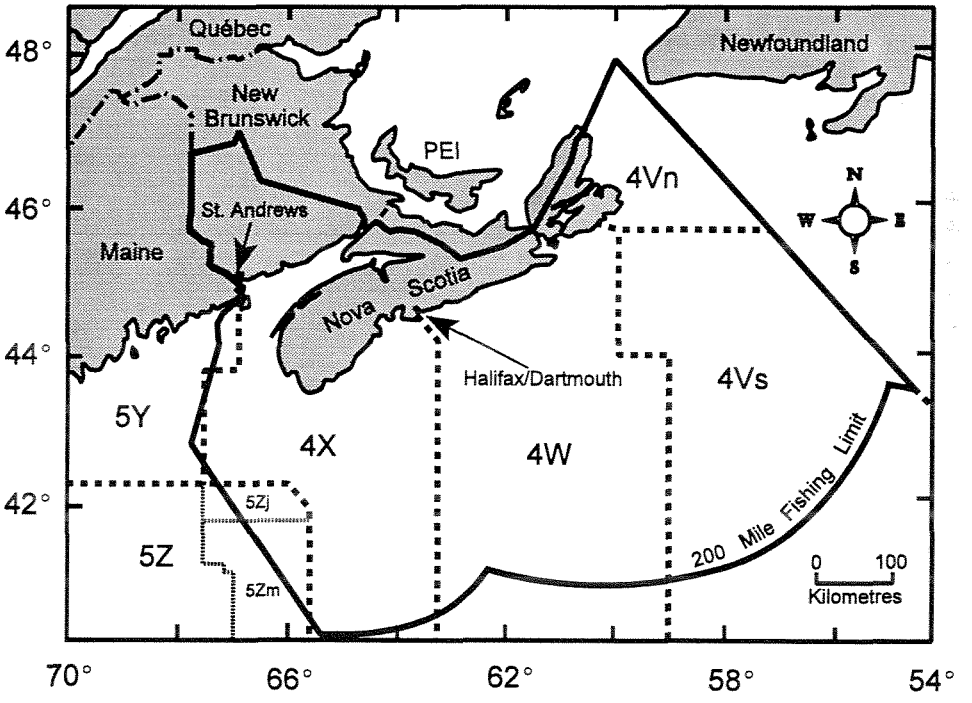


HARVEST FISHERIES ASSESSMENTS AND RESEARCH

The largest component of the scientific activities at the Biological Station is associated with the assessment of commercially harvested fisheries in the Bay of Fundy and other parts of the Scotia-Fundy Region and Atlantic Zone of Canada. A stock assessment can be defined as the scientific activity conducted to determine the size and potential yield of a fish stock. The two main sources of data used in assessments are the commercial fisheries and scientific surveys. In addition, research is conducted in order to improve the quality of assessments. The fisheries studied by Biological Station scientists fall into three categories:

- groundfish - haddock, cod, pollock, flatfish
- pelagic finfish - herring, tuna, swordfish
- invertebrates - lobster, scallop, soft-shell clam, underutilized species

The scientific advice provided by Biological Station researchers is presented to an internal DFO review committee, formally known until December 1992 as the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC). Since 1993, this scientific advice has also been forwarded to the Fisheries Resource Conservation Council (FRCC), a partnership among government, the scientific community, and industry. The FRCC is responsible for making formal public recommendations to the Minister of Fisheries and Oceans on Total Allowable Catches (TACs) and conservation measures for the Atlantic fishery, as well as advising the Minister on scientific research and assessment priorities and methodologies.



Map of DFO's Scotia-Fundy Region, showing Northwest Atlantic Fisheries Organization (NAFO) statistical areas for which the Region is responsible.

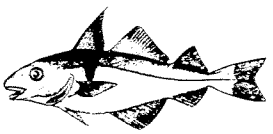
GROUNDFISH FISHERIES

The Biological Station is responsible for providing the scientific basis for the management advice on groundfish populations. The chief stocks for which the Station is responsible are Browns Bank/Bay of Fundy (NAFO Division 4X) cod, eastern Georges Bank (Unit Area 5Zjm) cod, eastern Georges Bank (Unit Area 5Zjm) haddock, and Scotian Shelf pollock. Assessment personnel participate in industry/management meetings as required to explain or elaborate assessment advice and advise on alternate management plans.

Research is conducted on biology, population dynamics, oceanography, and assessment methodology in order to improve the quality of advice. Staff are participating and contributing to studies aimed at resolving three Atlantic wide fisheries issues: improving the accuracy and precision of stock assessments; understanding the impact of changes in oceanographic conditions to fisheries; and enhancing our knowledge of the recruitment process.

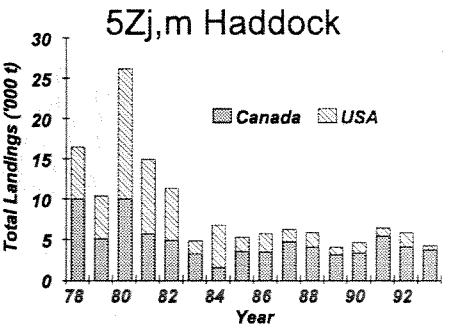
1990-93 Activities

Haddock Assessments and Associated Research (Division 5Z)

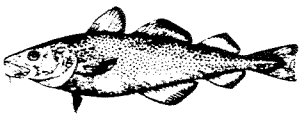


Staff: S. Gavaris (Project Leader), L.A.M. Van Eeckhaute, M.B. Strong

Annual assessments were conducted for haddock (*Melanogrammus aeglefinus*) stocks in NAFO Division 5Z (Georges Bank), as required for management of the fishery. Analysis of information from surveys and the commercial fishery showed a continuing decline in abundance of this stock to the lowest levels observed, coupled with very high exploitation rates. A transboundary yield model was developed, which showed that haddock on Georges Bank was principally distributed in Canadian waters and migration to USA waters was limited. This provided considerable scope for the achievement of management objectives through unilateral Canada action. Length-at-age based methods were applied for deriving age composition for this stock, but were found to be unsuccessful due to the growth rate of this stock and the overlap in the distributions of length at age. USA survey indices for haddock (and cod) were adjusted for vessel/gear changes with information made available by USA scientists.

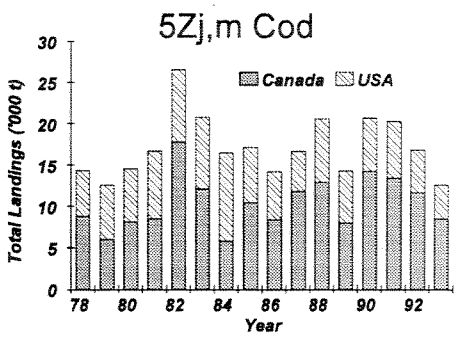


Cod Assessments and Associated Research (Division 5Z)



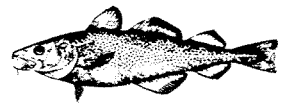
Staff: J.J. Hunt (Project Leader), M.-I. Buzeta, F.H. Page, E.A. Trippel

Annual assessments were conducted for the cod (*Gadus morhua*) stock in NAFO Division 5Z (Georges Bank), as required for management of the fishery. Analysis suggested that the biomass of this cod stock continued to decline and may be at its lowest observed level. Studies were completed on growth rates and maturation of 5Z cod and on the effect of migration on yield. The transboundary nature of this stock and the implications of unilateral harvest controls by Canada were examined.

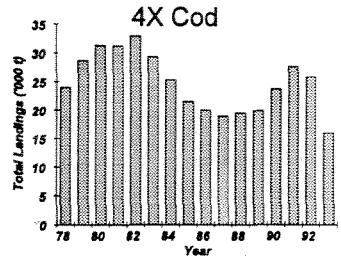


Cod Assessments and Associated Research (Division 4X)

Staff: E.A. Trippel, S. Gavaris (Project Leaders), D.S. Clark, P.D. Perley, L.L. Brown, H.M. Sampson, F.H. Page, C.W. Nelson, M.B. Strong



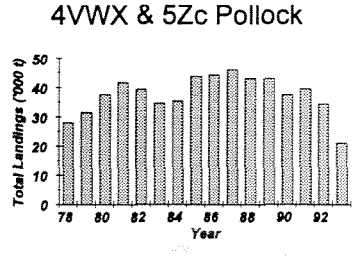
Annual assessments were conducted for the cod (*Gadus morhua*) stock in NAFO Division 4X, incorporating information from surveys and the commercial fishery. The analysis showed a continuing decline in abundance of this stock to near the lowest historic levels. Analysis of commercial catch rates indicated high fishing effort. Samples of ovaries were collected to assess maturity state and estimate maturity ogives, which will be compared to data from the 1950s and 1985. Cod broodstock were kept at the Station, for use in evaluating the effect of age, reproductive experience, and condition of spawners on regularity in egg batch production, total number of egg batches, egg number per batch, egg size, fertilization success, larval quality and survival.



Pollock Assessments and Associated Research

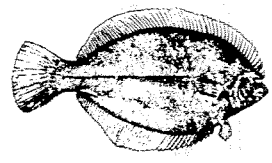
Staff: J.D. Neilson, E.A. Trippel (Project Leaders), P.D. Perley, H.M. Sampson, L.L. Brown, S. Gavaris, T.D. Iles

Assessments were conducted for pollock (*Pollachius virens*) stocks in Divisions 4VWX and Subdivision 5Zc (the Canadian portion of 5Z), as required for fisheries management purposes. Adult pollock stocks on the Scotian Shelf were depleted, but there were signs of promising year-classes recruiting for 1994/95. Commercial catch data for pollock were analyzed and corroborated estimates of high fishing mortality. General trends showed considerable increase in fishing effort by Canadian fleets since 1977.

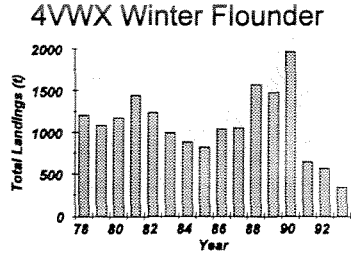


Winter Flounder Assessment and Associated Research

Staff: F.H. Page (Project Leader), K.R.J. Losier, M.-I. Buzeta, J.D. Neilson



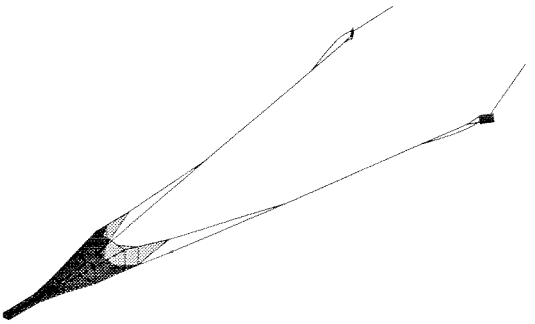
Winter flounder (*Pseudopleuronectes americanus*) stocks in NAFO Divisions 4VWX and 5Z were assessed as required for management of the fishery. A collaborative project was initiated with the University of New Brunswick and industry, in which industry participants gathered basic biological information on the winter flounder resource in the southwest Nova Scotia area. In 1993, the mandate for this stock assessment was transferred to the Marine Fish Division, Bedford Institute of Oceanography, as part of a program reorganization.



Groundfish Trawl Surveys

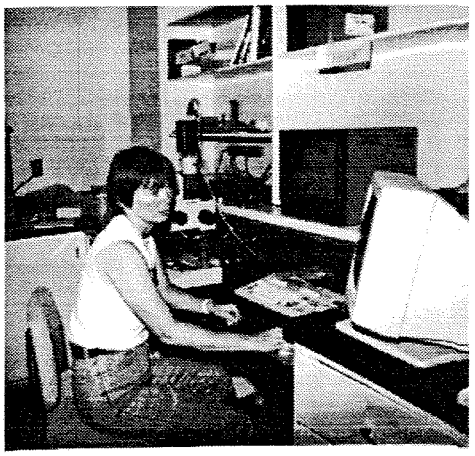
Staff: J.J. Hunt (Project Leader), M.B. Strong, L.L. Brown, J.R. Gale, S. Gavaris, C.W. Nelson, D.S. Clark

Annual random stratified surveys were conducted on the Scotian Shelf, Georges Bank, and in the Bay of Fundy using standardized bottom trawl gear to provide information on the abundance, distribution, and biology of finfish and invertebrate species. Results are used in assessments and to provide support for other surveys designed to address specific research questions conducted at various times. Research was conducted with the aim of improving survey methodology and design in order to provide more accurate and precise abundance estimates for the assessment of groundfish species. The reliability of survey results was improved by gaining further understanding of trawl configuration variation through remote monitoring with Scanmar technology. A study which adjusted survey tow swept area for bottom depth indicated that this factor did not have a major impact on assessment results.



Groundfish Age Determination

Staff: J.J. Hunt (Project Leader), C.W. Nelson, L.L. Brown, M.B. Strong, H.M. Sampson, P.D. Perley, M.-I. Buzeta, L.A.M. Van Eeckhaute



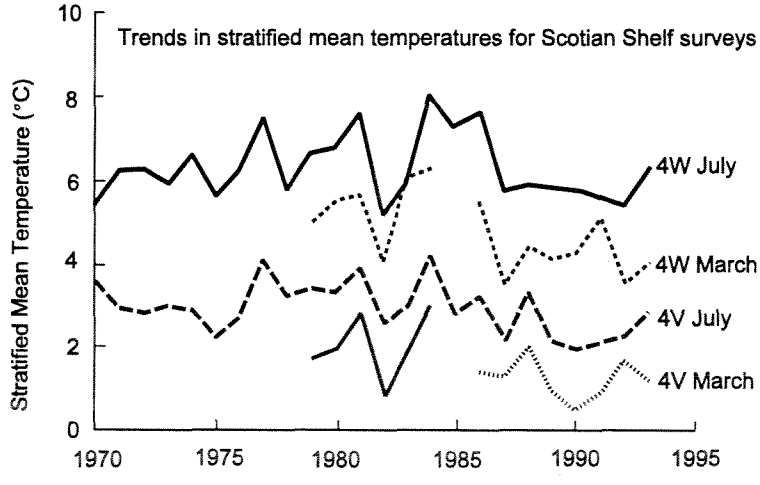
The objectives of this project were to provide accurate estimates of age composition for use in stock assessments and other biological studies of cod, haddock, and pollock. Age of groundfish was determined through interpretation of otoliths or other structures. Research was conducted on validation methodology and growth. The precision of ageing was monitored through quarterly re-ageing evaluations to ensure that results had minimal error and did not give biased estimates of stock status. However, age estimates of haddock for 1983-92 were found to be biased and will require revision. Exchanges were conducted with USA age readers to ensure consistency between the countries. A video image library of annotated otoliths has been compiled and will be the basis for ensuring ageing precision and population estimates. Investigations were conducted on stock specific otolith characteristics, in order to enhance ageing precision, as well as for potential application to stock identification.

Oceanography and Fish Distribution

Staff: F.H. Page (Project Leader), K.R.J. Losier

This project examined the influences of oceanographic variables and processes on the structure and dynamics of fish populations and aimed to quantify the impact of these influences on indices of fish abundance, commercial catch characteristics, stock structure and recruitment. It explored methods to detect and predict oceanographic influences on the estimated distribution and abundance of commercial fish populations so natural influences could be distinguished from human influence. It included the exploration of new sampling techniques such as remote sensing, monitoring by research surveys, modelling and making use of commercial operations. The results could be used to help predict fishing patterns, help modify research survey indices of abundance, and consequently assessments of population size, and help predict recruitment success which could have application in setting management advice.

Analysis was completed on summer water temperatures and 4VW cod catches and the relation between age specific bottom trawl cod catches and water depth, temperature and salinity. A major analysis of the association between bottom trawl catches of cod and haddock and near-bottom water depth, temperature, and salinity was begun in October 1993. Staff participated in the GLOBEC Scotian Shelf/Gulf of Maine Modelling Project.



Oceanographic Data Handling

Staff: F.H. Page (Project Leader), K.R.J. Losier, H.M. Sampson

The activities within this project were aimed primarily at the provision, maintenance and development of databases for standard oceanographic data collected by programs of the Biological Station and the Marine Fish Division of the Bedford Institute of Oceanography. The responsibilities and direction of the project were shared between the Marine Fish Division and St. Andrews. The project was the only ongoing monitoring program for offshore oceanographic conditions within the Scotia-Fundy region. The data were used in physical and fisheries related research programs, both regionally and internationally (e.g. GLOBEC) and provided the basis for investigating groundfish fisheries-oceanographic interactions. A review of oceanographic conditions within Scotia-Fundy Region was produced, based primarily on temperature and salinity conditions measured during the groundfish and pelagic surveys. Monitoring results indicated a trend toward colder conditions in the eastern range of the Region.

PELAGIC FISHERIES

The pelagic finfish studied by Station scientists include the herring and large pelagics such as tuna and swordfish. The herring fishery is one of the oldest commercial fisheries in Atlantic Canada and is currently the largest fishery, by volume, in the Scotia-Fundy Region. Assessments are conducted for herring in areas 4Vn (Sydney Bight), 4WX (Bay of Fundy and Scotian Shelf) and 5Z (Georges Bank).

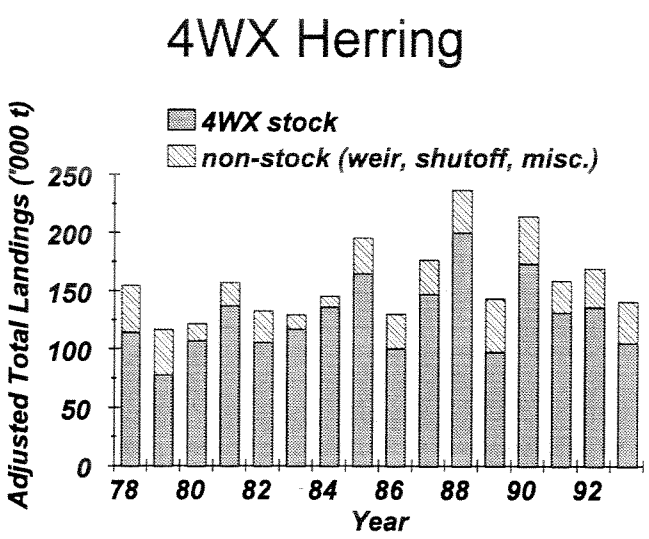
Research surveys, sampling of the commercial catch, and purse seine logbook analyses are conducted in support of assessment activities. Research on biology, population dynamics, and assessment methodology is undertaken to improve the accuracy and precision of management advice. Project personnel participate in industry and management meetings, as required, to explain or elaborate on assessments and research findings, and to advise on management strategies.

1990-93 Activities

Herring Assessments and Associated Research (Subarea 4)

Staff: R.L. Stephenson (Project Leader), M.J. Power, J.B. Sochasky, F.J. Fife, G.D. Melvin

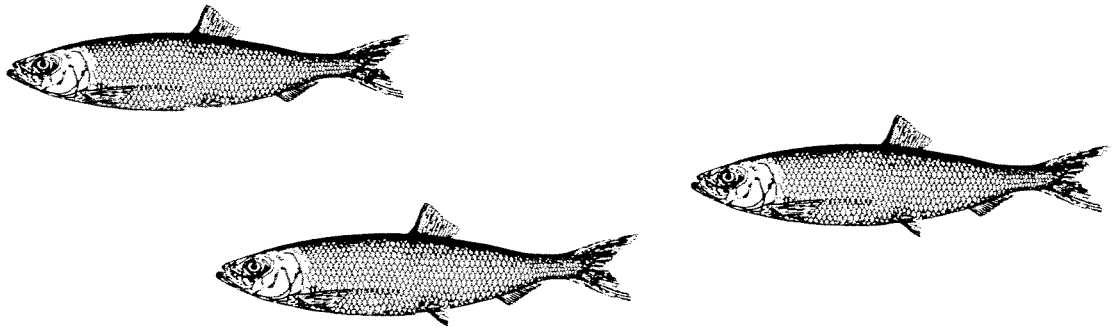
Assessments of Atlantic herring (*Clupea harengus harengus*) stocks were conducted, as required, to provide biological basis for advice on management of fisheries in NAFO Divisions 4WX (Bay of Fundy and Scotian Shelf) and 4Vn (Sydney Bight). A Bay of Fundy/Gulf of Maine larval herring survey, which was used as a basis for an index of abundance, was conducted annually in autumn; 1993 was the 22nd year for this survey. Larval abundance in recent years indicated higher spawning activity relative to the 1970s and early 1980s. Data collected from commercial catches formed the basis of the evaluation of stock status. Studies were also conducted on the ecology of herring, particularly aspects of stock structure, as a basis for improvements to assessments and advice. Advances were made in catch reconstruction to account for misreporting, based on interviews with purse seine captains and back calculation from production data. A review of assessment methodology and management was conducted in collaboration with Dr. Dan Lane (University of Ottawa). This included evaluation of the performance of the 10-year herring management plan and the Individual Transferable Quota (ITQ) system. Collaboration continued with Dr. Lane on the development of a 4WX herring fishery model.



Herring Assessments and Associated Research (Subarea 5)

Staff: G.D. Melvin (Project Leader), F.J. Fife

Research into aspects of herring (*Clupea harengus harengus*) biology was conducted in support of assessment of Georges Bank (5Z) stock status as required for management. Georges Bank once supported the largest herring fishery in the Western Atlantic. The fishery collapsed in 1977 due to overfishing and poor recruitment. Annual fall larval/adult herring surveys have been conducted to study the recovery of this stock. A collaborative survey with industry used commercial vessels to document herring spawning on the northeast peak of Georges Bank. Long-term research was initiated in 1991 on density dependent factors such as fecundity and growth, which may reflect changes in stock abundance, and on harvest strategies. During the summer of 1993, a DFO/industry tagging program was launched to investigate herring distribution and migrations. No fish were collected, as the fish were too deep, but it is hoped to continue the program in 1994. The 1993 update on the recovery and status of Georges bank herring reported the highest larval abundance index since 1987. This resulted in advice which would allow reopening of a commercial fishery for this potentially large herring resource.



Pelagic Acoustics Surveys

Staff: U. Buerkle (Project Leader), J.D. Trynor

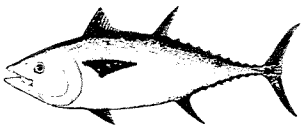
The objectives of this project were to develop and apply acoustic methods for estimating distribution and abundance of fish (particularly pelagic) populations to improve the basis for fisheries management. Research was undertaken to modify and improve acoustic systems for finfish abundance estimates. Acoustics surveys were conducted annually in Chedabucto Bay (4X and 4W) and Georges Bank (5Z) to estimate herring abundance and the results were used in stock assessments. The program evaluated acoustics hardware and software, examined problems of acoustic survey design, and evaluated the feasibility of using acoustics for groundfish. This project was scheduled to terminate in March 1994.

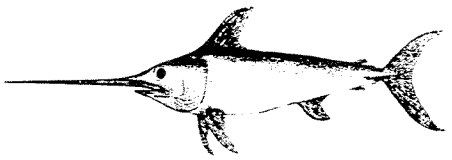
Large Pelagics Assessment and Associated Research

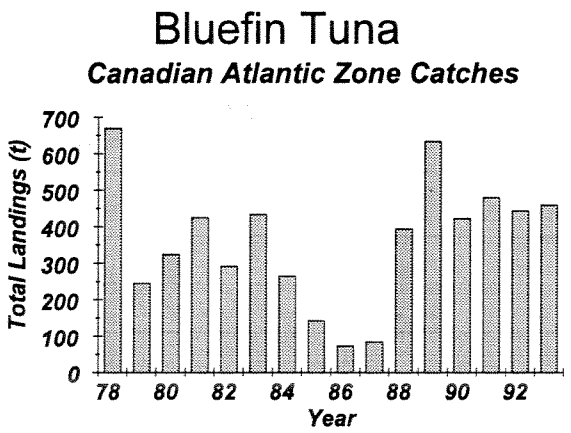
Staff: J.M. Porter (Project Leader), C.A. Dickson (to June 1993), H.H. Stone (from August 1993)

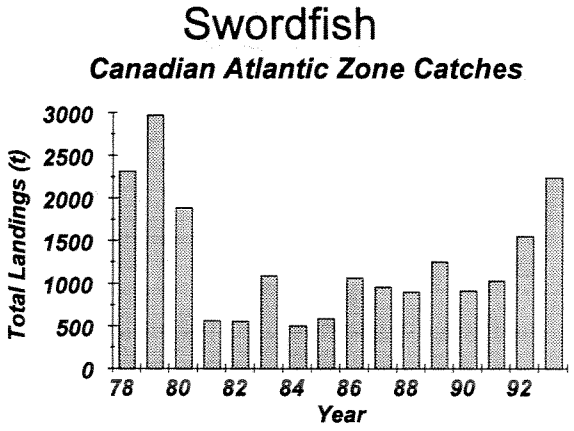
The Biological Station reinitiated work on large pelagic fishes in 1989, after a long period of dormancy. Research and assessment-related activities for large pelagic species, with a focus on swordfish (*Xiphias gladius*) and tunas (*Thunnus* spp.) in the Atlantic Zone, were undertaken with the primary objective of improving management advice. Data were collected from industry and from survey cruises. Staff participated in the International Commission for

the Conservation of Atlantic Tunas (ICCAT) assessment process, and provided advice to zonal industry/management meetings. ICCAT workshops on 'swordfish assessment' and on 'growth variability by age as it relates to assessments' were organized and convened at the Biological Station in 1991 and 1993. A bluefin tuna mark-recapture study was initiated in the Hell Hole, in collaboration with the Southwest Nova Scotia Tuna Association, with the aim of producing estimates of population size, exploitation rates, and migration patterns.









Pelagic Fisheries Management Studies

Staff: T.D. Iles (Project Leader)

A documentation and summary of 40 years of fisheries research on three continents was being carried out to ensure that data, concepts, ideas and interpretations accumulated and developed over this period are made available to any other interested scientist with common interests. Various manuscripts will be prepared, including a book, to be called 'The Ontogenetic Imperative' that will examine the interaction of ecological and evolutionary theory, based largely on the research in fisheries biology in relation to fisheries management. Other work undertaken included examining the cost of reproduction concept, the 'retention issue,' recruitment studies, and analysis of the 4WX herring biological database. Dr. Iles retired in July 1993, but was continuing this work on a part-time basis.

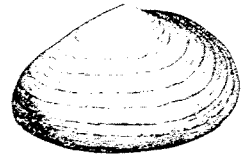
INVERTEBRATE FISHERIES

Biological Station scientists provide management advice and conduct assessment surveys and research on commercial invertebrate species in the Bay of Fundy area. The species studied include lobsters and scallops, which are currently the two most valuable harvested marine species in the Bay of Fundy, as well as soft-shell clams and currently underutilized invertebrate species with commercial potential. The results of the studies are communicated to the fishing industry, management bodies, and other scientists.

1990-93 Activities

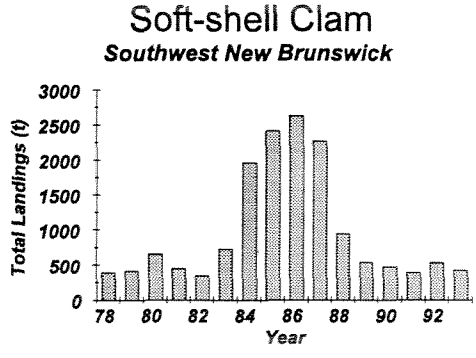
Soft-Shell Clam Fishery Research

Staff: S.M.C. Robinson (Project Leader), R.A. Chandler, J.D. Martin



This long-term project was designed to look at the basic population characteristics of the soft-shell clam (*Mya arenaria*) in the Scotia-Fundy Region. Abundance, population age structure, growth, mortality, condition, and reproductive aspects were investigated, as well as how these attributes were affected by the fishery in different habitats.

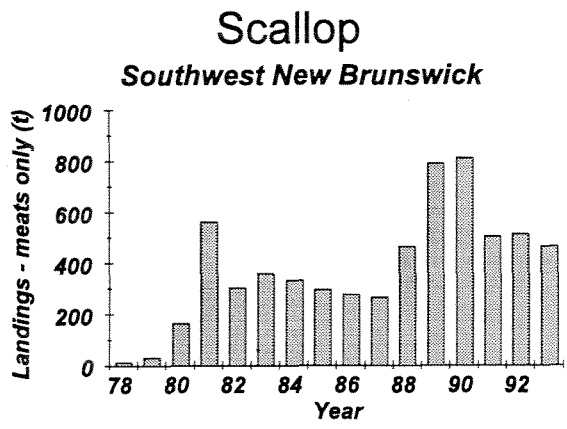
A study done with local industry in Lepreau Basin examined the effects of digging on the settlement of clams. The results indicated that digging did not affect growth, but there was an increase in settlement of larvae, possibly due to increasing the roughness of the bottom. Another study at Lepreau looked at the effects of barriers on beaches to increase natural spat settlement. Video footage was taken of soft-shell clams during feeding and a relationship was established between siphon diameter and clam size, providing a possible tool for field assessment of clam bed biomass. Studies at Grand Manan assessed the feasibility of relaying clams from a high density, fecally-contaminated beach to a clean beach with a lower population density. Preliminary results indicated that the effort has promise as a population enhancement tool.

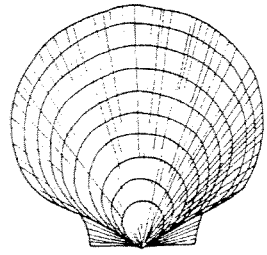


Scallop Population Dynamics and Assessment

Staff: S.M.C. Robinson (Project Leader), R.A. Chandler, J.D. Martin, G.J. Parsons

Fishery-related aspects of the population dynamics of the sea scallop (*Placopecten magellanicus*) were studied in the New Brunswick area of the Scotia-Fundy Region, in order to provide advice for the efficient management of the fishery. Annual surveys of scallop spat settlement in Quoddy Region were conducted using artificial collectors at 16 stations. The linkages between spat settlement, oceanographic circulation, and other ecological processes which affect successful benthic recruitment were explored. A study was conducted on the use of RNA/DNA ratios as a measure of condition in bivalves. The work-to-date showed significant variability in the measurement, apparently due to differential precipitation of the nucleic acids. Chlorophyll a concentrations in Passamaquoddy Bay from spring to fall were mapped, for correlation with bivalve population densities. Results indicated that phytoplankton levels were higher in the upper part of the Bay. Gonadosomatic indices were measured annually from a reference scallop population in Passamaquoddy Bay. A study on selectivity of the standard Digby scallop drags was carried out.

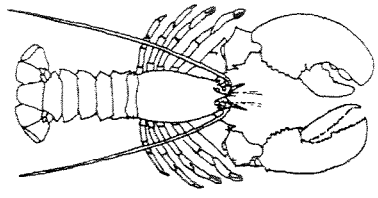


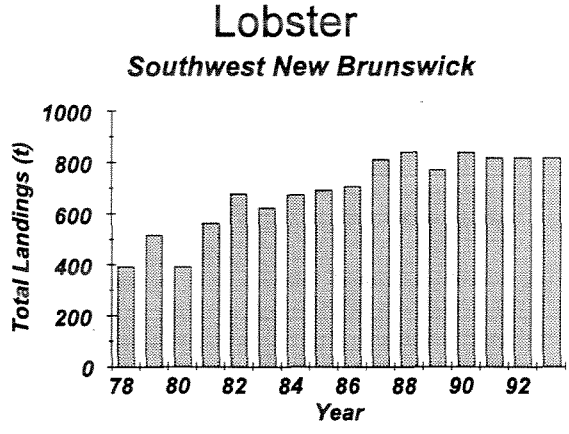


Lobster Fisheries Ecology

Staff: P. Lawton (Project Leader), J.D.A. Robichaud

This project dealt with the monitoring of the lobster (*Homarus americanus*) fishery in the Bay of Fundy (Lobster Fishing Areas 35, 36 and 38). The objectives were to assess stocks and production of lobsters and make recommendations on the relative merits and potential effects of various management strategies (e.g., size limits, quotas, seasons, fishing effort, gear type); develop methods of analysis and theoretical models for the above. Research was conducted into all aspects of the life history, ecology, and environment of lobsters relevant in the short- and long-term to an understanding of natural and man-induced fluctuations in lobster stock size. This included studies on juvenile and adult lobster population parameters, such as growth, size-at-maturity, mortality, recruitment and migration, and how these varied temporally and spatially in relation to biotic and abiotic factors; the application of existing population dynamics theory and approaches; and the development of new analytical methods for the above studies.





Season extension issues in the lobster fishery were addressed through a review of historical data and initiation of tagging studies, which obtained information on catch rates and migration of lobsters between adjacent management units. Field research was conducted on the magnitude of postlarval settlement. Diving studies were conducted on juvenile lobsters in Beaver Harbour area, as a basis of more detailed assessment of seasonal thermal regimes within Bay of Fundy recruitment sites. Rockhopper trawl surveys were conducted in shallow waters of the upper Bay of

Fundy. The surveys found a seasonal assemblage of berried lobsters in shoal waters off Martin Head. Surveys were conducted to document spatial abundance patterns of lobster and scallop resources in the vicinity of active and proposed salmon aquaculture sites in southwest New Brunswick. Baseline information was obtained on the lobster fishery of the Annapolis Basin as part of review of potential salmon aquaculture development. Staff collaborated with USA scientists in a 10 day research cruise during which submersibles were used to document lobster population demography in offshore canyons in the Gulf of Maine.

Lobster Biology

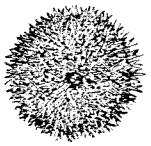
Staff: S.L. Waddy (Project Leader), D.E. Aiken, W.W. Young-Lai, P. Lawton

Biological research was conducted in support of fisheries management on the mechanisms that influence survival, growth, development, reproduction and recruitment of the American lobster (*Homarus americanus*) and the way in which these were influenced by the environment. Biological and technological information was transferred to the private sector and fisheries managers in support of the traditional storage and shipment industry, and in support of enforcement of lobster regulations.

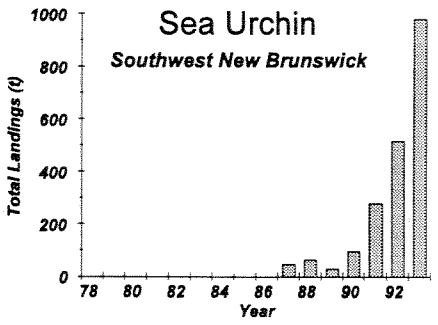
Studies were completed on the size at maturity of lobsters from two locations in the southern Gulf of St. Lawrence and updated reproductive and size-at-maturity data were applied to the Egg- and Yield-Per-Recruit models. Other studies examined the control of spawning in Bay of Fundy lobsters, including the effects of changing seawater temperature. A series of laboratory experiments were conducted on mechanisms that regulate molt synchrony, vertical migration, and recruitment in larval lobsters. Another study examined the effect of size, aggression and population density on growth and survival of postlarval and juvenile lobsters. Collaborative research with USA and Dutch scientists was begun with the aim of unravelling the endocrine regulatory processes that control molting and reproduction. A study conducted in collaboration with Moore-Clark evaluated the efficacy of various feed additives as attractants in feeds for the lobster storage industry.

Resource Potential of Underutilized Invertebrate Species

Staff: S.M.C. Robinson and P. Lawton (Project Leaders), J.D. Martin, J.D.A. Robichaud, R.A. Chandler



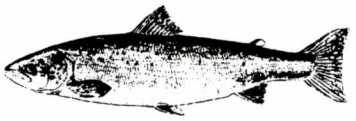
Studies were conducted on the growth, mortality, reproduction, ecology, and population structure of underutilized invertebrate species that have commercial fisheries potential in the Bay of Fundy, so that advice could be given for the prudent management of emergent fisheries. Species studied included sea urchins (*Strongylocentrotus droebachiensis*), sea cucumbers (*Cucumaria frondosa*), and periwinkles (*Littorina* spp.).



Sea urchin populations were surveyed along the Fundy coast as far east as Point Lepreau to determine standing stock. Biological studies were initiated to obtain information on growth, reproduction and movement of sea urchins. Studies revealed that jaw morphometrics may have potential for determining the nutritional state of sea urchins. A study was conducted on the effects of scallop drags on sea urchin populations and associated bottom fauna. A field and laboratory study was initiated on the population demography of sea cucumbers in the Quoddy Region, in collaboration with the University of New Brunswick. A survey was conducted on periwinkle distribution on Deer Island.

AQUACULTURE RESEARCH

Aquaculture research at St. Andrews began during the Biological Station's first year in 1908, when research on oyster culture was carried out. More recently, the Biological Station was instrumental in carrying out the first successful trials of salmon aquaculture in Atlantic Canada in the late 1970s. This trial, carried out at Lords Cove, Deer Island, was a joint project of DFO, the Province of New Brunswick, and the private sector. Annual production in the salmon sea cage industry in southwestern New Brunswick is now worth about $100 million. In addition to carrying out research in support of the salmon aquaculture industry, current research at the Biological Station is examining other finfish and invertebrate species with culture potential, including halibut, haddock, striped bass, eels, and scallops.



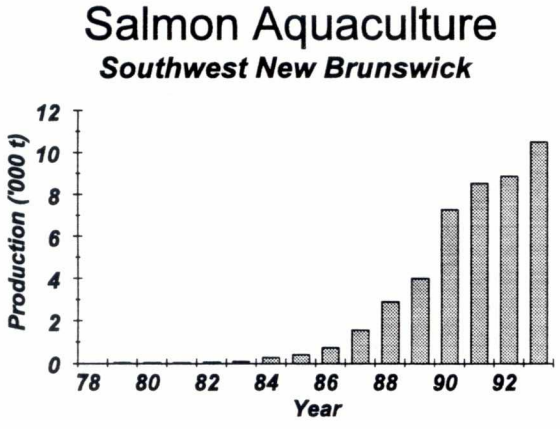
1990-93 Activities

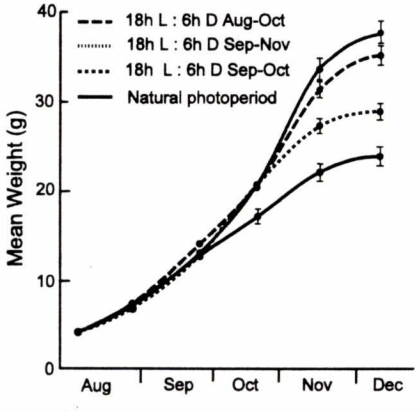
Salmonid Growth, Smolting, and Reproduction

Staff: R.L. Saunders (Project Leader), P.R. Harmon, J.D.E. Knox, R.H. Peterson, D.J. Martin-Robichaud

The objectives of this project were to provide solutions to biological problems encountered or anticipated in salmonid aquaculture and to improve the productivity and cost-effectiveness of salmonid culture. Physiological research was conducted on growth and smolting of Atlantic salmon (*Salmo salar*) in order to elucidate the effects of environmental manipulation on metabolism, growth and behaviour; smolting was evaluated on the basis of endocrinological, metabolic and osmoregulatory activity; the environmental and genetic bases for age-at-maturity were investigated; field tests were conducted on sea farms to scale-up promising laboratory results; and culture technology was transferred to the private sector through cooperative research and contacts with commercial salmon producers. Dr. Saunders retired in December 1993, but was continuing this work on a part-time basis.

Studies on food deprivation of post-smolts in the first winter resulted in significant reductions in the incidence of male and female grilse, and the findings resulted in recommendations to industry on application of this technology. It was found that the use of elevated winter temperature to stimulate growth may not lead to enhanced smolt production, because males are likely to mature, and both males and females may remain parr. Three confirmed transgenic male salmon matured and were crossed with normal females; the progeny will be assessed for growth, maturation and smolting. Research on the production of underyearling and fall smolts produced encouraging results. The presence of overhead cover at first-feeding of fry provided some beneficial effects for the first two weeks, after which other factors appeared more important. Other studies examined the fate of previously mature male parr and the interaction between temperature and substrate on yolk utilization in salmon alevins. The size of salmon fry at





Growth of juvenile Atlantic salmon reared under various photoperiod regimes. L = light; D = dark.

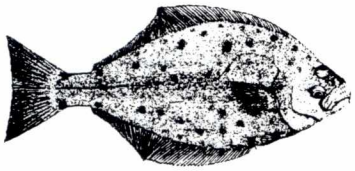
swim-up was positively correlated with the percentage of the hatchery tray that was covered with artificial substrate. Much of this research was performed in collaboration with industry and universities. The 4th International Salmonid Smolt Workshop was held at the Biological Station in 1992.

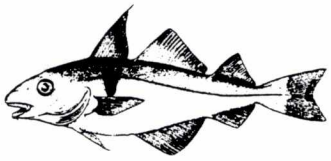
Marine Finfish Aquaculture

Staff: K.G. Waiwood (Project Leader), K.G. Howes, J.C. Reid

This project developed technologies for the culture of new marine finfish species in support of the aquaculture industry in the Scotia-Fundy Region. Research focused on halibut (*Hippoglossus hippoglossus*) and haddock (*Melanogrammus aeglefinus*) and consisted of four thrusts: developing and maintaining a facility for studying all stages in the life cycle of halibut and haddock; conducting research on the culture of halibut and haddock; providing advice to non-industry clients; and providing assistance to industry in support of the commercial culture of halibut and haddock.

On-growing studies of halibut in modified herring weirs and salmon cages indicated that this aspect of halibut culture is economically feasible. Facilities for the production of food organisms for halibut and haddock larvae (algae, rotifers, artemia) were expanded, and in 1993 resulted in the first successful production of juvenile haddock and halibut in Canada. A successful larval halibut feeding strategy yielded promising results. The use of 1100 L, submerged plastic bags proved successful for the rearing of larval halibut. Experiments were successfully completed on the contribution of batch and maternal effects and the effects of light on halibut egg buoyancy.





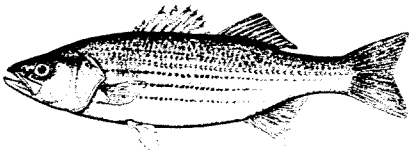
Environmental Requirements for Early Fish Development

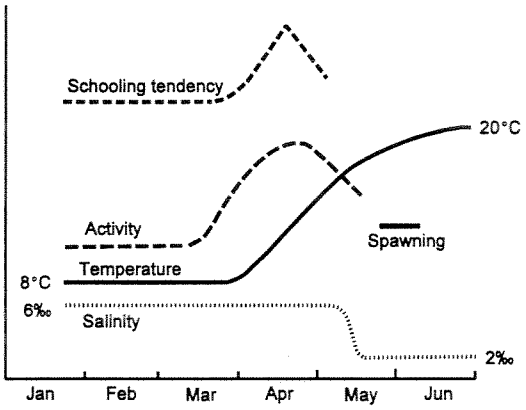
Staff: R.H. Peterson (Project Leader), D.J. Martin-Robichaud

The ways in which environmental perturbation and culture conditions can affect the physiology and early development of fish were investigated. The objectives were to determine the optimal environments for culture of early stages of fish and to predict how environmental changes could affect fish populations through effects on early life stages.

Striped bass (*Morone saxitilis*) were induced to spawn 2-3 weeks earlier than normal by manipulation of temperature and photoperiod. Growth of juveniles was assessed at three salinities and three temperatures. A study was conducted on water balance in eggs. A striped bass broodstock was maintained at the Biological Station, and eggs and larvae were provided to the private sector for production. A striped bass workshop was organized and convened at the Biological Station in 1990.

Striped bass locomotory activity in relation to ambient temperature and salinity, in the period leading up to spawning.



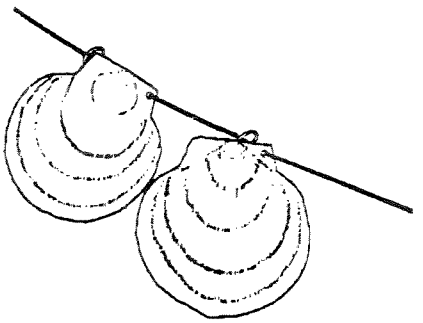


Research was conducted on the determination of the optimal temperature for growth of eel (*Anguilla rostrata*) elvers. All-female lumpfish (*Cyclopterus lumpus*) were produced by feeding larvae on estrogen-loaded *Artemia.* Cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) egg and larval development to first feeding was successful at 4-8°C and 30‰; development was unsuccessful at 10 and 20‰ and at temperatures in excess of 8°C.

Invertebrate Aquaculture Research

Staff: D.E. Aiken (Project Leader), S.L. Waddy, W.W. Young-Lai, S.M.C. Robinson, J.D. Martin, R.A. Chandler

Biological and bioengineering research was conducted on invertebrate species with commercial aquaculture potential in southwestern New Brunswick. Scallop (*Placopecten magellanicus*) culture sites were established at two locations in Passamaquoddy Bay. Each site was equipped with pearl, lantern and shibetsu nets and stocked with several thousand sea scallops. One of the sites was in conjunction with a salmon farm, and will be used to evaluate the co-culture of scallop and salmon. A field study was conducted to determine spatial and temporal abundance, availability and growth of sea scallop spat as seedstock for a potential scallop culture industry. Results indicated that the highest number and sizes were found in the northern part of Passamaquoddy Bay. Several new materials were compared for efficiency in scallop spat collection. One of the new materials, Netron, outperformed traditional monofilament nylon as a settlement medium and proved far easier to harvest and sort. Benthic collectors were evaluated for scallop seedstock collection and rejected in favor of a horizontal longline system that suspended spat collection bags 2-3 meters off the bottom. A collaborative project was initiated with the Station's marine chemistry group to determine the levels and variability of toxins in scallops held in suspension culture as opposed to normal residency on the bottom.



Major scientific meetings on aquaculture were organized, by Station staff, including: Aquaculture Canada 92 (Vancouver, 1992), and the Bivalve Culture Workshop (Orlando, 1992). In 1991, S.L. Waddy was elected president of the Aquaculture Association of Canada, and in 1993, president of the World Aquaculture Society.

AQUATIC ENVIRONMENTAL STUDIES

Biological Station scientists conduct aquatic environmental studies to address the numerous environmental issues affecting fisheries and in response to concerns expressed by government agencies, industries, and the public. Current activities fall within two categories:

- aquatic ecology
- marine chemistry

AQUATIC ECOLOGY

Marine ecological research is carried out on the effects of aquaculture on the marine environment, environmental factors affecting bivalve feeding, and the ecology of toxin-producing microalgae and their effects on fisheries and aquaculture operations. The freshwater program at the Biological Station has recently concentrated on studies of the effects of acid rain and acid rain control programs on fish, particularly salmon, and freshwater ecosystems.

1990-93 Activities

Aquaculture Ecology Research

Staff: D.J. Wildish (Project Leader), J.L. Martin, A.J. Wilson (to March 1993)

The aims of this work were to determine the extent and biological implications of habitat changes caused by the intensive culture of finfish or bivalve molluscs, so that remedial measures to minimize self pollution can be taken; and to fully understand the environmental factors influencing the holding capacity of cultured marine fish and the production of cultured suspension-feeding marine bivalve molluscs. The research was multidisciplinary and involved collaboration with chemical, physical and biological oceanographers.

Studies on sedimentary conditions under salmon cages were carried out; however, most field projects concerning the environmental impact of aquaculture have been terminated or scaled down due to lack of funding. Attempts to find empirical rules relating production optima and key environmental variables for the Bay of Fundy salmonid culture industry were initiated. Laboratory calibration was carried out on the use of plaster cylinders, as an inexpensive method for measuring water movement at aquaculture sites; field testing is planned.

Laboratory studies on environmental factors affecting bivalve feeding continued in collaboration with Dr. D. Kristmanson (University of New Brunswick). A proposal for a book entitled 'Marine benthic suspension feeders and flow' was accepted for publication. A joint Canada/France project was initiated to determine the effects of the toxic dinoflagellate *Alexandrium* on bivalve filtration; this knowledge is required to estimate toxin uptake rates.

Benthic workshops on 'mariculture impacts on coastal systems' (1990) and 'hydrodynamics and the benthos' (1992) and a workshop on 'the assimilative capacity of the Letang Inlet for salmon aquaculture wastes' (1992) were co-organized and hosted at the Biological Station.

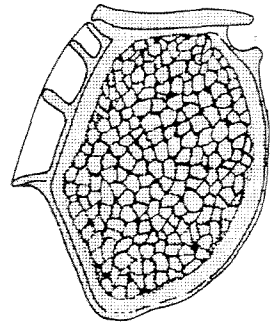
Phytotoxin Research

Staff: D.J. Wildish (Project Leader), J.L. Martin, A.J. Wilson (to March 1993)

The aim of this research program was to document phytoplankton autecology of species of microalgae which are harmful (or potentially harmful) to humans, finfish or bivalve molluscs, particularly those of commercial value.

Individual projects were selected based on their practical relevance in resolving problems primarily in mariculture in the Bay of Fundy, but also in traditional fisheries.

The Bay of Fundy phytoplankton monitoring program was conducted annually since 1987. The occurrence and source of domoic acid in the Bay of Fundy has been studied in collaboration with the marine chemistry group (see below). Domoic acid was found in plankton tows when the dominant species was *Pseudonitzschia pseudodelicatissima*. High concentrations of *Dynophysis* sp. were found, which led to the first confirmed identification of diarrhetic shellfish toxin in the Bay of Fundy. Considerable progress was made in preparing the large data base for statistical analysis of the temporal trends of phytoplankton abundance; this could eventually be used to predict seasonal bloom patterns. Sediment samples were collected throughout the Bay of Fundy to determine the density and distribution of *Alexandrium* cysts. This will be important in determining the foci of summer blooms and therefore indicate where PSP problems are likely to occur.



Dynophysis sp.

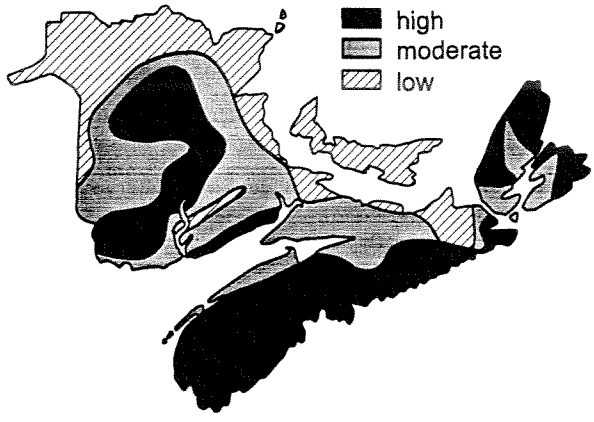
Progress was made on developing a flume-based system for testing salmon smolt responses to potentially toxic microalgae present in the Bay of Fundy. A collaborative study with the Station's marine chemistry group examined the uptake and elimination of PSP toxins by lobsters.

Impacts of Acid Rain Control Programs on Salmonid Ecology

Staff: G.L. Lacroix (Project Leader), E.P. McCurdy, J.D.E. Knox

The objectives of this project were to determine the effects of the sulphur dioxide control programs and the resultant increase or decrease in environmental acidification on Atlantic salmon (*Salmo salar*) and its habitat, the rate and extent of aquatic recovery, and the need for further emissions reductions to protect fish habitat in rivers of Scotia-Fundy.

Aquatic sensitivity of Maritimes to acidic deposition



The regional Long Range Transport of Atmospheric Pollutants (LRTAP) research and monitoring projects were coordinated from the Biological Station. A regional exercise to summarize the research of many individuals and to collaborate and develop a model to assess the production of Atlantic salmon in acidified rivers proved to be very successful. Laboratory experiments on the effect of silicon on Al-ligand-gill dynamics yielded new findings which challenged those previously proposed. Monitoring of water chemistry, fish densities, and salmon spawning in limed and untreated sections of Fifteen Mile Brook, NS continued. Remarkably, streambed liming continued to be effective 6 years after initial application and helped to assess the potential for recovery of Atlantic salmon in acidified rivers under present international agreements. A study was initiated, in collaboration

with the Atlantic Salmon Federation, using biotelemetry to study interactions between aquaculture and wild Atlantic salmon in a Bay of Fundy river.

Quoddy Region Bio-Physical Interactions

Staff: W. Watson-Wright (Project Leader), F.H. Page, S.M.C. Robinson

This multi-displinary, multi-purpose project began in 1993. The project focussed on describing and developing an understanding of the physical environment of the Quoddy Region, as a basis for studies on issues of importance such as aquaculture development, fisheries enhancement, and biological-physical interactions. Progress has been made in setting up a database for storing and accessing mongthly temperature, salinity, and depth data collected in the Quoddy Region. Information on water temperatures was presented to clients in the aquaculture industry, who were concerned due to sub-zero water temperatures during the winter of 1993. Proposals were made to secure funding to expand the capability to monitor environmental conditions, especially water temperature.

MARINE CHEMISTRY

In the past, marine chemistry research at the Biological Station dealt exclusively with the identification of hazards and the estimation of risks of organic chemicals to fisheries. Since the 1987 toxic mussels incident at Cardigan River, Prince Edward Island, the Station's chemistry group has also become involved in research on marine toxins. In addition, because of its chemical analytical equipment and expertise, the chemistry group cooperates with other programs at the Biological Station on matters requiring analytical chemistry. Increasing attention is also given to chemicals used in aquaculture.

1990-93 Activities

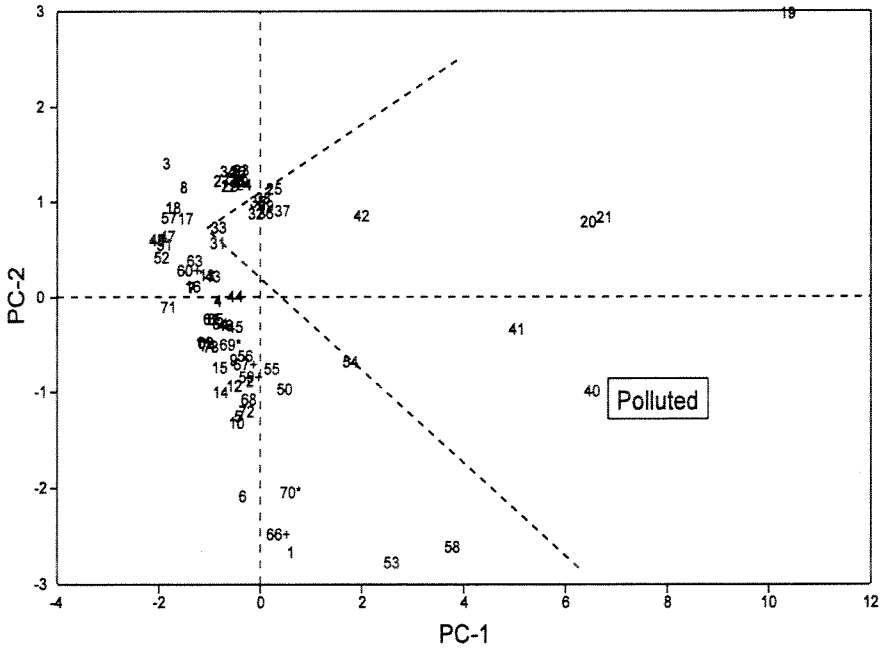
Risk Assessment of Organic Chemicals to Fisheries

Staff: V. Zitko (Project Leader), J.M. Babineau, H.M. Akagi, K.G. MacKeigan.

The objectives of this project were the detection, quantitation, and confirmation of anticipated as well as unanticipated industrial organic chemicals in water, sediment, and biological samples; the identification of hazards and the assessment of risks to fisheries of existing as well as new organic chemicals; techniques of information extraction from analytical and toxicological data; and the development of quantitative structure-activity relationships for toxicity assessment, and of spectral as well as retention time data bases for the identification of chemicals.

It was demonstrated that priority ranking of chemicals for detailed hazard assessment is a highly subjective process, in spite of assorted "quantitative" ranking schemes. As a result, different lists of priority chemicals are published by different countries. A new proposed antifouling formulation was found to contain an additional, undeclared active ingredient; this demonstrates the importance of checking the actual composition of materials submitted for hazard identification and risk assessment. A chemometrical method based on an algorithm called 'artificial neural network' was used quite successfully to predict the toxicity of certain classes of chemicals to aquatic biota; the only required input was the information given by structural formulae of the chemicals. Assorted software was written for data manipulation and quality control/quality assurance, as well as information extraction and display.

A field method for the detection of the antibiotic oxytetracycline in medicated feed was developed and a method for the detection of residues of another antibiotic, oxolinic acid, in cultured salmon was tested by intercalibration with several laboratories. A study of the stability of oxytetracycline on 'accelerated' ageing of medicated feed was



Estimation of sediment toxicity in the Miramichi estuary, compared to California samples. Numbers are stations: Miramichi outer bay 1-18; San Francisco Bay 19-33; Oakland 34-42; Miramichi estuary 43-74. Of samples tested for toxicity, '*' were toxic, '+' were not toxic in mussel larvae test. Coordinates are Principal Components derived from 8 variables. Samples similar in composition have similar coordinates.

completed. Measurements of carotenoids in eggs of salmon collected from the Magaguadavic River in the fall of 1992 were completed, as part of a study investigating the influence of farmed salmon escapees on wild salmon populations.

Considerable analytical and chemometrical support, as well as technical expertise were provided to the Miramichi River Environmental Assessment Committee (MREAC), the Atlantic Coastal Action Program (ACAP) Saint John Technical Advisory Committee, industry, and DFO's Gulf Region. Several chemicals found on the beaches by DFO and by citizens' groups were identified and several fish kills were investigated. A brominated flame retardant, HBCD, was identified in styrofoam used in aquaculture floats.

Molluscan Toxins, Techniques and Improvements

Staff: V. Zitko (Project Leader), J.M. Babineau, H.M. Akagi, K.G. MacKeigan.

The objectives of this project were the implementation, adaptation, and development of techniques for the detection, identification, and quantitation of natural toxins and other natural compounds of interest in biological samples. Measurements of toxins and related compounds are provided to other projects at the Biological Station. At present, only methods for domoic acid and okadaic acid are maintained.

Aquatic Toxicology of Marine Phytotoxins

Staff: K. Haya (Project Leader), L.E. Burridge, B.A. Waiwood, V. Zitko.

This project was concerned with the impact of toxin-producing phytoplankton blooms on wild and cultured finfish and shellfish industries. Within the Scotia-Fundy Region, paralytic shellfish toxins, domoic acid and diarrhetic shellfish toxins are of concern. The objectives were to: identify the lethality of marine phytotoxins to fish; determine the movement of phytotoxins through the food web; develop techniques for the detection and quantification of toxins; and improve prediction and detection of toxic algal blooms and the accumulation of toxins in shellfish. This project was initiated as a result of DFO's response to the "toxic mussel crisis" in PEI in 1987 and is conducted in collaboration with the Station's Applied Ecology Section.

Domoic acid was found in plankton tows in the Bay of Fundy, when the dominant species was *Pseudonitzschia pseudodelicatissima*. Unialgal cultures of this species have been isolated from water collected in the Bay of Fundy and cells from these cultures have produced domoic acid. Cooperative studies with university researchers were conducted on the toxicity of domoic acid. Of particular interest was the finding of synergism among domoic, glutamic, and aspartic acids. A laboratory study on the uptake and depuration of PSP toxins by lobsters fed formulated feed fortified with PSP toxins suggested that wild lobsters may accumulate PSP toxins through food and that there is a relative increase in saxitoxin during the depuration of PSP toxins. A study in collaboration with the Invertebrate Fisheries Section found that the depuration of PSP toxins from scallops is extremely slow. A field study was initiated to examine the depuration rates of PSP in scallops held at the surface compared to the bottom.

Biochemical Indicators of Health of Aquatic Organisms

Staff: K. Haya (Project Leader), B.A. Waiwood, L.E. Burridge.

Stresses inflicted on an organism's mechanisms for maintaining a healthy physiological state may cause changes in histological properties and behavioral, physiological and biochemical processes. The objective of this project was to develop such responses into a series of diagnostic tests and techniques to identify conditions of ill-health in aquatic animals, communities and populations. Emphasis was on the relationship between exposure to chemicals (pesticides and drugs used in finfish aquaculture), starvation, growth, intermediary metabolism (energy and carbohydrate) and osmoregulation. Included are studies to aid in the differentiation of effects caused by 'natural stressors' and chemicals. The project also responded to emergency issues which may require the determination of lethality, accumulation and sublethal effects on cultured and wild animals.

Under controlled laboratory conditions, juvenile salmon showed decreases in stores of energy (glycogen and creatine phosphate) when exposed to pesticides and low pH. Glycogen stores were also found to vary with degree of physical stress during capture, nutritional status, life stage, and dissolved oxygen concentration. More information is needed on the normal variability of these biochemical indicators and the effects of natural stressors such as salinity, temperature, photoperiod, life stage, and water chemistry.

A two year study of the seasonality of plasma cortisol and insulin in juvenile Atlantic salmon was completed. The study has established a baseline for stress assessment. As a follow-up, a study of the effects of cortisol implants, was initiated. The isolation of rainbow trout insulin proved to be impractical and the possibility of using coho or mammalian insulin is being investigated. Another study found that uneaten salmon feed containing the drug ivermectin, a potential sea lice treatment, could be lethal to shrimp and other crustaceans that might eat such feed beneath cages.

COOPERATIVE SCIENTIFIC PROGRAMS

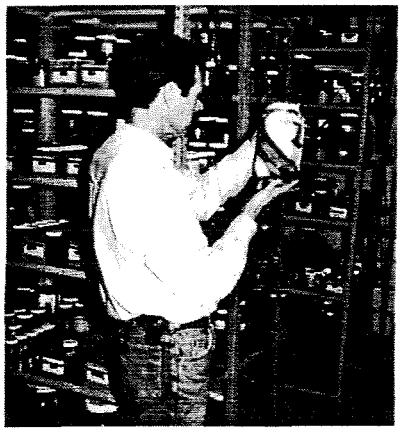
The Biological Station carries out cooperative projects with other scientific research organizations in the St. Andrews area. DFO is currently providing core funding and/or facilities for three cooperative projects:

- Atlantic Reference Centre
- Salmon Genetics Research Program
- Atlantic Salmon Demonstration and Development Farm

ATLANTIC REFERENCE CENTRE

Core Staff: K.J. Sulak (Director; to end of 1993), G.W. Pohle, L.C. Van Guelpen, W.E. Hogans

The Atlantic Reference Centre (ARC) provides taxonomic and ecological expertise centred on an extensive reference collection, which serves as the primary repository for important aquatic biota collections from the Atlantic Canada region, including published voucher specimens. The ARC functions to maintain, expand, document and manage the reference collection; to provide identification services for DFO scientists; to prepare appropriate taxonomic guides; to collaborate with DFO investigations in appropriate areas of ARC staff expertise; to promote and facilitate collection-based research by visiting investigators; to develop and maintain a highly trained scientific and technical staff able to provide service primarily in taxonomic identification, and in other areas including environmental baseline and monitoring studies, population biology studies, larval and juvenile rearing work, and parasitology; to provide technical training and advice in taxonomic identification and methodology of sampling, preserving, processing biological specimens, and in techniques of microscopic examination; and to provide public advisory service with respect to the regional fauna in terms of identity, life history and distribution of marine organisms.



The ARC is a joint project of DFO Scotia-Fundy Region and the Huntsman Marine Science Centre. It was formed in 1984 through consolidation of the HMSC Ichthyoplankton Laboratory and the Biological Station Identification Centre. DFO provides the facilities housing the collection, as well as core funding.

A research project conducted during 1990-1992 monitored changes in the benthic community directly under, and in the immediate vicinity of, salmon sea cages (Dr. S. Lim, Project Leader). During late 1992 and early 1993, Dr. Pohle spent 8 months at the Institute of Marine Sciences in Barcelona, Spain, where he had been invited to restore and verify the identifications of more than 20,000 specimens of crustaceans.

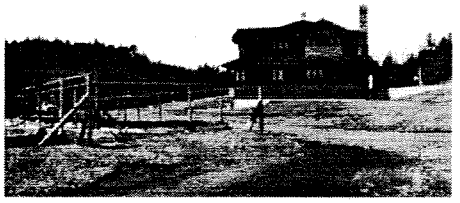
In 1992, the ARC collection was moved into a new 400 square meter building located on the Biological Station campus. The new building is expected to meet storage requirements for the next 20 years, as well as providing modern facilities for specimen processing, curation, computer documentation, and research.

SALMON GENETICS RESEARCH PROGRAM

Chief Scientist: G.W. Friars

The Salmon Genetics Research Program (SGRP) is a cooperative project, initiated by the Department of Fisheries and Oceans and the Atlantic Salmon Federation (ASF) in 1973. The program's objective is the application of genetics to better management of wild and aquaculture salmon stocks. The research program is conducted at the Atlantic Salmon Federation's facilities in Chamcook, near St. Andrews. DFO provides core funding for the

program. Other main financial sponsors are: the New Brunswick Salmon Growers' Association (NBSGA), the New Brunswick Department of Fisheries and Aquaculture, and the National Research Council. Additional funding is provided through the Disease Prevention in New Brunswick Farmed Salmon project, administered by the University of New Brunswick.



The goals of this project are to design, develop and test models, protocols and procedures for breeding which have practical application both in the management of wild Atlantic salmon stocks and in aquaculture; to coordinate the development of improved strains of Atlantic salmon so that the strategies of salmon enhancement and cage rearing can be realized; to implement the selection of four year classes of Saint John River stock and a high grilse strain for aquaculture; to develop three year classes of fish for sea ranching; and to encourage collaborative research with governments, universities and private organizations to complement the breeding program at ASF. Since 1989, the SGRP has been the primary breeder of improved strains for the New Brunswick Salmon Growers' Association.

Recent collaborative research included projects on triploidy, disease resistance, smolt mortality, DNA fingerprinting, development of a Y probe for sex determination, frequency and effects of sea cage escapees, sea lice resistance, and husbandry techniques. Collaborating organizations included: DFO, New Brunswick Department of Fisheries and Aquaculture, Research and Productivity Council, Atlantic Veterinary College, University of New Brunswick, Memorial University, Dalhousie University, University of Guelph, University of Stirling (Scotland), Moore-Clark Co. (Canada) Inc., Aqua Health, Connors Bros. Ltd., and the New Brunswick Salmon Growers' Association.

ATLANTIC SALMON DEMONSTRATION AND DEVELOPMENT FARM

General Manager, New Brunswick Salmon Growers' Association: W. Thompson
Farm Site Manager: N. Alward

The Biological Station organized the establishment of the Atlantic Salmon Demonstration and Development Farm (ASDDF) in 1985, under the Canada/New Brunswick Fisheries Economic and Regional Development Agreement (ERDA) on Fisheries Development. The purpose of the farm is to develop and demonstrate scientific and technical knowledge on salmon farming and to transfer the technology to the aquaculture industry. Since 1989, the farm has been managed by the New Brunswick Salmon Growers' Association (NBSGA).

The farm is located at Lime Kiln Bay, about 20 km due east of the Biological Station. DFO provided the office and laboratory building, a storage building, equipment, and the original salmon cages (of which 8 are still in use), as well as operating funds and smolts in the early years. During 1990-93, DFO continued to provide some of the smolts for the farm. Additional funding was provided by the Atlantic Canada Opportunities Agency (ACOA), the New Brunswick Department of Fisheries and Aquaculture, and Supply and Services Canada. By 1993, the farm had a total of 26 salmon cages.

Research was conducted in collaboration with government, universities, and industry. Since the mid-1980s a broodstock development project has been conducted in cooperation with the Salmon Genetics Research Program. Other projects carried out since 1990 included: comparisons of cage types; moist vs. dry feeds; automatic vs. hand feeding; oral vaccine for vibrio; starvation vs. medication for treatment of vibrio (completed); drug withdrawal times (completed); fall smolt transfers; pigmentation; diet formulations; sea lice control; and anti-foulants. Collaborating organizations included: DFO, the New Brunswick Department of Fisheries and Aquaculture, Moore-Clark Co. (Canada) Inc., Connors Bros. Ltd., Cards Net Manufacturing, the University of New Brunswick, Universal Foods Corp., Aqua Health Ltd., and the St. Mary's Indian Band.

SUPPORT SERVICES

The scientific activities of the Biological Station could not have been carried out without the assistance provided by a dedicated support services staff. The services provided by this group included: facilities management; secretaries and word processing; library services; computing; research vessel crews; materiel management; photography and drafting; central registry; finance; personnel; and communications.

The Station's support services staff belonged to various Branches within DFO, including: Biological Sciences (secretaries, word processing, computing, electronics); Management Services (facilities, materiel management, photography and drafting, central registry, library, research vessels); Comptroller; Personnel; and Communications. Members of the Canadian Corps of Commissionaires provided security, main entrance and telephone reception, and alarm surveillance.

The Coordinator of Support Services managed those activities carried out by support staff in the Biological Sciences and Management Services Branches. After W.J. Ross' retirement in June 1991, this position was filled on an acting basis by B.A. Waiwood (July 1991-August 1992) and P.M. Ross (from September 1992).

Secretaries and Word Processing

Staff: M.J. Hurley, C.S. Carney (Secretaries); B.J. Best (Word Processing)

These services were provided to Station staff, as permitted by the resources available. A reduction in secretarial staff was partly compensated for through increases in efficiency obtained with computer technology.

Computer Centre

Staff: S.E. Bellis, B.H. Hatt, S.I. Taylor

Computer facilities are an essential tool for the conducting of today's scientific activities. The Station's Computer Centre provided central computing power, programming, system support (both hardware and software), and data entry services to staff at the Station. The Centre also managed the Station's local area networks and provided support for desktop computers. From 1988, central computing power was provided by a Digital VAX 6210. In 1993, this system was replaced with a Hewlett Packard 755/725 system.

Electronics

Staff: S.M. Polar (deceased December 1993)

The electronics section provided electronics design, construction, maintenance, and repairs for the Station's scientific and support programs.

Facilities Management

Staff: B.J. Kohler (Supervisor), R.A. Carson, D.E. Haughn, R.L. Johnson

This section administered approximately 5000 square meters of laboratory and office facilities at the Biological Station. This included operation, maintenance, and improvements to the physical plant and involves area such as carpentry, plumbing, heating and air conditioning, electricity, water supplies, and groundskeeping. The Station's

facilities staff and operations were to be transferred from DFO to Public Works and Government Services Canada in early 1994.

Office space in the Cottage 1&2 annex building was converted into the new Harry Hachey Conference Centre, named in honor of one of the Station's pioneering research scientists. This facility, which was officially dedicated in May 1991, can accommodate about 100 people, almost double that of the previous Conference Room in the Main Building. The previous Conference Room was converted into a Staff Room. The other major facilities change during 1990-93 was the construction of the new Atlantic Reference Centre building, which opened in 1992 (see Atlantic Reference Centre section).

Materiel Management

Staff: P.M. Ross, B.J. Best (Acting), J.L. Beaton

This group looked after purchasing, inventory control, vehicle fleet management. It also operates stores and warehouse facilities. The purchasing portion of this group was to be transferred to the Comptroller Branch in early 1994.

Photography and Drafting

Staff: F.B. Cunningham

This section was responsible for designing and creating technical and scientific illustrations in all communications media; preparing posters and display panels; taking photographs; processing and printing films; and maintaining cameras and audio-visual equipment.

Central Registry

Staff: M.E. Couturier (Supervisor), M.M.V. Bender

The Central Registry was responsible for records management at the Station. It also managed the Station's mail room and telecommunications operations.

Library Services

Staff: M.J. Rudi (Librarian), J.E. Cleghorn

In 1993, the Biological Station's research library currently had approximately 150 journal subscriptions and 7000 books, including an excellent historical collection of fisheries-related books, serials, and Departmental publications not available elsewhere in New Brunswick. Services provided included: acquiring, cataloguing, and classifying new material; interlibrary loans; and reference services including on-line searches. In addition to serving Station staff, the library was used by many external users, including visiting scientists, students, and industry clients.

The library was involved in several major projects recently. A collection development policy was created and approved. Over 1000 books were weeded from the collection. A major recataloguing and reclassification project was begun, with the purpose of adopting the standard systems used by research libraries internationally. The revised records were added to WAVES, the Departmental library database (available as a CD-ROM). In 1991-92, the library received for the first time dedicated funds for a book budget and procedures were developed for the

management of these funds. The library was challenged to investigate other means of providing services to its users in the face of declining budgets. It investigated and promoted the use of various electronic methods of disseminating information, as alternatives to the traditional and costly means.

Research Vessels

CSS *JL Hart*: W.P. Miner (Master 1990), J.D. Lumsden (Master 1991-93); M.L. Banks, G.H. Cline (1990), D.E. Haughn (1990-91), D.G. Lumsden (1992-93), R.L. O'Neil (1992), R.J. Pitre (1991), F. Randell (1993)
CSS *Pandalus III*: F.S. Guptill (Master 1990),W.P. Miner (Master 1991-93)

In 1908, the Station's research vessel complement consisted of the 10.7 m (35 ft.) *SeaGull*, the 7.3 m (24 ft.) *Sagitta*, and two rowboats. During 1990-93, the Biological Station vessels included the 19.8 m (65 ft.) *JL Hart*, the 12.8 m (42 ft.) *Pandalus III*, the 7.6 m (25 ft.) *Gemma*, and other smaller vessels. As well, Station scientists had access to larger DFO vessels based in Dartmouth.

The *JL Hart* (built in 1974) conducted a wide range of work, such as midwater and bottom trawling, scallop dragging, water sampling, and benthic sampling, and also utilized specialized gear over an area from St. Andrews to Georges Bank. This vessel's operating season was from about April to November. In addition to serving Station staff, the *JL Hart* was also utilized by other Scotia-Fundy scientists.

The *Pandalus III* (built in 1986) operated year-round, primarily as a day boat to serve the Station's resource and stock assessment and associated biological research programs. The *Pandalus III* was utilized primarily in the Passamaquoddy Bay area.

The *Gemma*, which was christened in May 1992, was built primarily for studies on invertebrate populations, such as clams, sea urchins, lobsters, and scallops, in local waters of Passamaquoddy Bay and the Fundy Isles area.

Personnel Services

Staff: S.A. Anderson, L. Riva

The Station's office of the Personnel Branch provided general personnel services, as well as pay and benefits services, for the Biological Station and for the DFO Area Office for Southwestern New Brunswick.

Financial Services

Staff: D.J. Matthews, E. Dines

The Station's office of the Comptroller Branch provided financial service requirements for the Biological Station and for the DFO Area Office for Southwestern New Brunswick.

Communications

Staff: S.M. Taylor

The Station's office of the Communications Branch served to increase awareness and appreciation of fisheries science and DFO activities at the Biological Station and the Mactaquac Fish Culture Station. This included writing articles for the Department, newspapers, and magazines, as well as preparing displays for schools and the general public.

BIOLOGICAL STATION STAFF - JANUARY 1990 TO DECEMBER 1993

Director

COOK, R.H. *BSc (McGill), PhD (Dalhousie)* (to March 1992)
WATSON-WRIGHT, W.M. *BPE, MSc, PhD (Dalhousie)* (from June 1992)

Director's Office

CHANG, B.D. *BSc, MSc (British Columbia)* Program Biologist
FAWKES, G.E. Programmer/Analyst
ILES, T.D. *BSc, DSc (Wales)* Senior Scientist
PARKER, M.T. Secretary (retired June 1991)
ROSS, P.M. *BA (New Brunswick)* Acting Coordinator, Administrative and Support Services (from September 1992)
ROSS, W.J. *BSc (New Brunswick), MSc (Alberta), MBA (Western Ontario)* Manager, Administrative and Support Services (retired June 1991)
WAIWOOD, B.A. *BSc (St. Andrews, Scotland)* Acting Coordinator, Administrative and Support Services (July 1991-August 1992)

Pelagic Fisheries Section

BUERKLE, U. *BSc (Guelph), MSc, PhD (McGill)* Research Scientist, Herring Acoustics
DICKSON, C.A. Senior Biological Technician (retired June 1993)
DOUGHERTY, W.H. Fisheries Technician (retired September 1992)
FIFE, F.J. *BSc (Guelph)* Fisheries Technician (from September 1991)
GORDON, D.J. *BSc (McGill), MSc (Guelph)* Fisheries Technician (retired June 1991)
MELVIN, G.D. *BSc (Dalhousie), MSc (Acadia), PhD (New Brunswick)* Research Scientist, Pelagics (from September 1990)
PORTER, J.M. *BSc (Acadia), MSc (Manitoba), PhD (Durham, England)* Research Scientist, Large Pelagics
POWER, M.J. *BSc (Acadia)* Technician (to July 1993); Fisheries Biologist (from July 1993)
SOCHASKY, J.B. *BSc (Queen's)* Fisheries Technician
STEPHENSON, R.L. *BSc (Trent), PhD (Canterbury, New Zealand)* Section Head/Research Scientist
STONE, H.H. *BSc (Guelph), MSc (Acadia)* Large Pelagics Assessment Biologist (from August 1993)
TRYNOR, J.D. Acoustics Technician

Gulf of Maine Section

BROWN, L.L. Fisheries Technician
BUZETA, M.-I. *BSc (Concordia)* Assessment Biologist (from Finfish Aquaculture Section April 1990)
CLARK, D.S. *BSc (Saskatchewan), MSc (Memorial)* Fisheries Biologist (from September 1991)
GALE, J.R. *BSc (Memorial)* Programmer/Analyst
GAVARIS, S. *BSc (Memorial)* Section Head/Biologist
HUNT, J.J. *BSc (Guelph)* Surveys and Ageing Biologist
LOSIER, K.R.J. *BSc (Mt. Allison)* Oceanographic Technician
NEILSON, J.D. *BSc (British Columbia), MNRM (Manitoba), PhD (Simon Fraser)* Research Scientist, Groundfish (on leave March 1992-February 1994)
NELSON, C.W. Fisheries Technician
PAGE, F.H. *BSc, MSc (New Brunswick), PhD (Dalhousie)* Research Scientist, Oceanography (from April 1991)
PERLEY, P.D. *BSc (Acadia)* Fisheries Technician
PERRY, R.I. *BSc, PhD (British Columbia)* Research Scientist, Oceanography (to April 1991)
ROBICHEAU, R.K. Senior Ageing Technician (retired June 1991)
SAMPSON, H.M. Fisheries Technician
STRONG, M.B. *BSc (Mt. Allison)* Senior Surveys Technician
TRIPPEL, E.A. *BSc, MSc (Toronto), PhD (Guelph)* Research Scientist, Groundfish (from September 1990)
VAN EECKHAUTE, L.A.M. *BSc (Guelph)* Assessment Biologist (from February 1990)

Invertebrate Fisheries Section

AIKEN, D.E. *BA, MA (New Hampshire), PhD (Alberta)* Section Head/Research Scientist
CHANDLER, R.A. *BA (Acadia)* Molluscan Technician
LAWTON, P. *BSc (Bradford, England), PhD (Wales)* Research Scientist, Crustacean Ecology
MARTIN, J.D. *BSc (New Brunswick)* Biologist
ROBICHAUD, J.D.A. *BSc, MSc (Moncton)* Crustacean Biologist
ROBINSON, S.M.C. *BSc (Acadia), MSc (Simon Fraser), PhD (British Columbia)* Research Scientist, Molluscan Ecology
WADDY, S.L. *BSc (Mt. Allison)* Research Scientist
WILLIAMSON, A.M. *BSc (Mt. Allison), BEd (New Brunswick)* Technician (retired June 1991)
YOUNG-LAI, W.W. *BSc (Calgary)* Technician

Finfish Aquaculture Section

HARMON, P.R. *BSc (Mt. Allison)* Aquaculture Technologist
HOWES, K.G. *BSc (Guelph)* Aquaculture Technician
KNOX, J.D.E. *BSc (New Brunswick Saint John)* Aquaculture Technician (from October 1990)
MARTIN-ROBICHAUD, D.J. *BSc (Guelph), MSc (New Brunswick)* Biologist
PETERSON, R.H. *BSc, MSc (New Brunswick), PhD (Carleton)* Section Head (from April 1993)/ Research Scientist, Physiology
REID, J.C. *DEC (Collège de la Gaspésie)* Aquaculture Technician (from March 1991)
SAUNDERS, R.L. *BSc (Massachusetts), MA, PhD (Toronto)* Section Head (to March 1993)/Research Scientist, Salmon Physiology
STEWART, M.W. *BSc (New Brunswick)* Technician (to August 1990)
WAIWOOD, K.G. *BSc (Sir George Williams), MSc (Queen's), PhD (Guelph)* Research Scientist, Marine Fish Culture

Applied Ecology Section

LACROIX, G.L. *BSc (Waterloo), PhD (New Brunswick)* Research Scientist, Aquatic Ecology
MARTIN, J.L. *BA (New Brunswick)* Biologist
WILDISH, D.J. *BSc, PhD, DSc (London)* Section Head/Research Scientist
WILSON, A.J. Technician (retired March 1993)

Toxicology and Organic Contaminants Section (Physical and Chemical Sciences Branch)

AKAGI, H.M. *BSc (Dalhousie)* Mass Spectrometer Technician
BABINEAU, J.M. Electronics Technician
BURRIDGE, L.E. *BSc (Dalhousie)* Toxicological Biologist
HAYA, K. *BSP, PhD (British Columbia)* Research Scientist, Toxicology
MACKEIGAN, K.G. *BSc (New Brunswick)* Technician
WAIWOOD, B.A. *BSc (St. Andrews, Scotland)* Chemist
ZITKO, V. *Ing. Chem. (Slovak Tech.), CSc (Slovak Acad. Sci.)* Section Head/Research Scientist

Comptroller Branch

DINES, E. Accounts Clerk
MATTHEWS, D.J. Financial Analyst

Personnel Branch

ANDERSON, S.A. Personnel Generalist
RIVA, L. Pay and Benefits Specialist

Communications Branch

TAYLOR, S.M. *BSc (Acadia), BSc (Dalhousie)* Science Communications Officer (from June 1990)

Support Services (Biological Sciences and Management Services Branches)

BANKS, M.L. Engineer, CSS *JL Hart*
BEATON, J.L. Purchasing and Stores Clerk (from May 1990)
BELLIS, S.E. Computer System Manager
BENDER, M.M.V. Central Registry Clerk
BEST, B.J. Word Processing Supervisor/Acting Materiel Management Officer (September 1992-September 1993)
CARNEY, C.S. Secretary (from March 1991)
CARSON, R.A. Laboratory Maintenance Supervisor
CLEGHORN, J.E. Library Clerk
CLINE, G.H. Mate, CSS *JL Hart* (to November 1990)
COUTURIER, M.E. Central Registry Supervisor
CUNNINGHAM, F.B. Photographer/Draftsman
GUPTILL, F.S. Captain, CSS *Pandalus III* (retired March 1992)
HATT, B.H. Data Conversion Operator
HAUGHN, D.E. Cook/Deckhand, CSS *JL Hart* (to December 1990; Mate, CSS *JL Hart* (to October 1991); General Maintenance (from November 1991)
HENDERSON, D.D. Laboratory Maintenance Supervisor (to December 1991)
HURLEY, M.J. Secretary
IRWIN, M.M. Secretary (retired August 1990)
JOHNSON, R.L. Machine Operator and Trades Helper
KOHLER, B.J. Maintenance Supervisor
MCMULLON, P.W.G. Photographer (retired April 1991)
MINER, W.P. Captain, CSS *JL Hart* (to December 1990); Captain, CSS *Pandalus III* (from May 1991)
POLAR, S.M. Electronics Technician (deceased December 1993)
ROSS, P.M. *BA (New Brunswick)* Material Management Officer
RUDI, M.J. *BA, MA (Western Ontario), MLIS (McGill)* Librarian
SREEDHARAN, A. *BSc (Kerala, India), MSc (Massachusetts)* Statistician (retired June 1991)
TAYLOR, S.I. Computer System Operator
TEAKLES, C.E. General Maintenance (retired May 1991)

Term, Contract, and Other Staff

1990

BOUVET, F.
DUSTON, J.
JAMES, C.A.
LEGRESLEY, M.M.
LYONS, M.C.
MACINTYRE, A.D.
MCCURDY, E.P.
MAYNARD, T.L.
POWER, J.
RINGUETTE, M.M.
SAULNIER, A.M.
THORPE, B.E.

1991

DUSTON, J.
FENETY, P.L.
HOVEY, A.
LEGRESLEY, M.M.
LUMSDEN, J.D.
LYONS, M.C.
MACINTYRE, A.D.
MCCURDY, E.P.
MAYNARD, T.L.
PITRE, R.J.
RINGUETTE, M.M.
SAULNIER, A.M.
STOKESBURY, M.J.W.
THORPE, B.E.

1992

BRADFORD, W.
CARSON, N.L.
COUTURIER, C.Y.
DUSTON, J.
ELDER, D.A.
FERGUSON, R.
HANKE, A.R.
HATT, K.
HOVEY, A.
JACKSON, T.
LEGRESLEY, M.M.
LUMSDEN, D.G.
LUMSDEN, J.D.
MACINTYRE, A.D.
MCCURDY, E.P.
MENTON, D.J.
MOISAN, M.
O'NEIL, R.L.
PARSONS, G.J.
RINGUETTE, M.M.
SAULNIER, A.M.
STOKESBURY, M.J.W.
THORPE, B.E.

1993

BEAR, E.
BERNIER, S.
BRADFORD, W.
DUSTON, J.
ELDER, D.A.
FERGUSON, R.
HANKE, A.R.
HATT, K.
HOVEY, A.
JACKSON, T.
LEGRESLEY, M.M.
LUMSDEN, D.G.
LUMSDEN, J.D.
LYONS, M.C.
MACINTYRE, A.D.
MCCURDY, E.P.
MOISAN, M.
MORGAN, S.
MOWATT, P.M.
PAUL, J.
RANDELL, F.
RINGUETTE, M.M.
SAULNIER, A.M.
STOKESBURY, M.J.W.
THORPE, B.E.
TOWNSEND, D.

Atlantic Reference Centre (Core Staff)

SULAK, K.J. Director and Curator of Fishes
HOGANS, W.E. Curatorial Assistant/Taxonomic Specialist
POHLE, G.W. Curator of Invertebrates
VAN GUELPEN, L.C. Collections Manager

Canadian Corps of Commissionaires

1990

BARTLETT, E.
BROWN, H.
BROOK, D.
CAHILL, M.
LAPLANTE, J.M.
SIMPSON, R.

1991

BROOK, D.
CROSBY, P.J.
IRVING, J.
LAPLANTE, J.M.
MCMORRAN, A.B.
SIMPSON, R.

1992

BABINEAU, J.B.
BROOK, D.
CROSBY, P.J.
IRVING, J.
LAPLANTE, J.M.
MCMORRAN, A.B.
SIMPSON, R.

1993

BABINEAU, J.B.
BROOK, D.
CARTWRIGHT, E.C.
CROSBY, P.J.
LAPLANTE, J.M.
MCMORRAN, A.B.
SIMPSON, R.

Graduate Students

COUTURIER, C.Y. *Dalhousie University*
KACERGIS, M.C. *University of Maine at Orono* (1991-1992)
PARSONS, G.J. *University of Guelph*
RANGELEY, R.W. *McGill University*

Student Employment

1990	**1991**
COLBORNE, L.L.	COLBORNE, L.L.
GAUDET, R.R.	COOPER, J.A.
PFEIFFER, E.M.	STUART, J.C.
THORPE, B.E.	WILDISH, J.A.
WILDISH, J.A.	
1992	**1993**
BEATON, K.	BEATON, K.
COLBORNE, L.L.	FERGUSON, C.G.
FERGUSON, C.G.	
WILDISH, J.A.	

High School Coop Students
(Sir James Dunn Academy, St. Andrews)
1993

LUND, S.

Visiting Researchers

BERGE, Å. *University of Bergen, Norway* (May-November 1992)
HAIST, V. *Pacific Biological Station, Nanaimo* (May-July 1992)
KRISTIANSEN, A. *Austevoll Aquaculture Research Station, Storebø, Norway* (October-December 1993)
LANE, D.E. *University of Ottawa* (August 1991-August 1992)
MANGOR-JENSEN, A. *Marine Research Institute, Bergen, Norway* (June 1992)
MORIN, P.-P. *Postdoctoral Fellow* (September 1991-December 1992)
STEFANSSON, S. *University of Bergen, Norway* (May-November 1992)

Visiting Students

BOSSER, P. *École Supérieure d'Agriculture d'Angers, France* (April-July 1991)
BRUNEAU, L. *École Supérieure d'Agriculture d'Angers, France* (May-August 1993)
GODFRIN, S. *École Supérieure d'Agriculture d'Angers, France* (April-July 1991)
INGRAHAM, D. *University of New Brunswick.* (from May 1993)
JUSTOME, B. *École Supérieure d'Agriculture d'Angers, France* (April-August 1993)
LECLERC, J.-F. *École Supérieure d'Agriculture d'Angers, France* (April-July 1993)
LUIZI, F. *University of Namur, Belgium* (January-May 1993)
NOUVEL, S. *École Supérieure d'Agriculture d'Angers, France* (April-July 1993)
ROCHEREAU, N. *École Supérieure d'Agriculture d'Angers, France* (May-August 1993)
SERVAIS, F. *École Supérieure d'Agriculture d'Angers, France* (April-July 1993)
SINGH, R. *University of New Brunswick at Saint John* (May-August 1993)
STOKESBURY, K. *Université Laval* (from September 1992)

PUBLICATIONS BY BIOLOGICAL STATION STAFF 1989-1993

The following lists include publications authored or co-authored by Biological Station staff. Publications by contract employees, students, visitors, and former Station staff are included where the publications are based on research carried out at the Biological Station. Publications of the Salmon Genetics Research Program and the Atlantic Reference Centre are not included, except where co-authored by Biological Station staff. In 1993, the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Research Document Series was replaced by the DFO Atlantic Fisheries Research Document series.

1989 PUBLICATIONS

Primary Publications

AIKEN, D.E. AND S.L. WADDY. 1989. Interaction of temperature and photoperiod in the regulation of spawning by American lobsters *Homarus americanus*. Can. J. Fish. Aquat. Sci. 46: 145-148.

1989. Allometric growth and onset of maturity in male lobsters: the crusher propodite index. J. Shellfish Res. 8: 7-11.

CHARMANTIER, G., M. CHARMANTIER-DAURES, AND D.E. AIKEN. 1989. Accelerating lobster growth with human growth hormone. World Aquacul. 20(2): 52-53.

1989. La somatotrophie stimule la croissance de jeunes homards américains, *Homarus americanus* (Crustacea, Decapoda). C.R. Acad. Sci. Paris 308 (Ser.III): 21-26.

CHENOWETH, S.B., D.A. LIBBY, R.L. STEPHENSON, AND M.J. POWER. 1989. Origin and dispersion of larval herring (*Clupea harengus*) in coastal waters of eastern Maine and southwestern New Brunswick. Can. J. Fish. Aquat. Sci. 46: 624-632.

FARMER, G.L., R.L. SAUNDERS, T.R. GOFF, C.E. JOHNSTON, AND E.B. HENDERSON. 1989. Some physiological responses of Atlantic salmon (*Salmo salar*) exposed to soft, acidic water during smolting. Aquacul. 82: 229-244.

FREEDMAN, B., O. MAESSEN, S. BEAUCHAMP, J.J. KEREKES, R.H. PETERSON, AND K. FISHER. 1989. Trace elements in water, sediment, and biota of three oligotrophic lakes in Queens and Annapolis Counties, Nova Scotia. Proc. NS Inst. Sci. 39: 123-132.

HANKE, A.R., G.W. FRIARS, R.L. SAUNDERS, AND J.M. TERHUNE. 1989. Family x photoperiod interaction on growth in juvenile Atlantic salmon, *Salmo salar*. Genome 32: 1105-1112.

HAYA, K. 1989. Toxicity of pyrethroid insecticides to fish. Environ. Toxicol. Chem. 8: 381-391.

KOELLER, P.A., L. COATES-MARKLE, AND J.D. NEILSON. 1989. Feeding ecology of juvenile (age-0) silver hake (*Merluccius bilinearis*) on the Scotian Shelf. Can. J. Fish. Aquat. Sci. 46: 1762-1768.

KOMOURDJIAN, M.P., J.C. FENWICK, AND R.L. SAUNDERS. 1989. Endocrine-mediated photostimulation of growth in Atlantic salmon. Can. J. Zool. 67: 1505-1509.

KOSLOW, J.A., R.I. PERRY, P.C.F. HURLEY, AND R.O. FOURNIER. 1989. Structure and interannual variability of the plankton and its environment off southwestern Nova Scotia in late spring and early summer. Can. J. Fish. Aquat. Sci. 46 (Suppl.1): 44-54.

KÜGEL, B. AND R.H. PETERSON. 1989. Perivitelline fluid pH of rainbow trout (*Oncorhynchus mykiss*) eggs in relation to ambient pH. Can. J. Fish. Aquat. Sci. 46: 2070-2073.

LACROIX, G.L. 1989. Production of juvenile Atlantic salmon (*Salmo salar*) in two acidic rivers of Nova Scotia. Can. J. Fish. Aquat. Sci. 46: 2003-2018.

1989. Ecological and physiological responses of Atlantic salmon in acidified organic rivers of Nova Scotia, Canada. Water Air Soil Pollut. 46: 375-386.

LAWTON, P. 1989. Predatory interaction between the brachyuran crab *Cancer pagurus* and decapod crustacean prey. Mar. Ecol. Prog. Ser. 52: 169-179.

LOUGH, R.G., P.C. VALENTINE, D.C. POTTER, P.J. AUDITORE, G.R. BOLZ, J.D. NEILSON, AND R.I. PERRY. 1989. Ecology and distribution of juvenile cod and haddock in relation to sediment type and bottom currents on eastern Georges Bank. Mar. Ecol. Prog. Ser. 56: 1-12.

MCCORMICK, S.D., R.L. SAUNDERS, AND A.D. MACINTYRE. 1989. Mitochondrial enzyme and Na^+,K^+-ATPase activity, and ion regulation during parr-smolt transformation of Atlantic salmon (*Salmo salar*). Fish Physiol. Biochem. 6: 231-241.

1989. The effect of salinity and ration level on growth rate and conversion efficiency of Atlantic salmon (*Salmo salar*) smolts. Aquacul. 82: 173-180.

NEILSON, J.D. AND W.R. BOWERING. 1989. Minimum size regulations and the implications for yield and value in the Canadian Atlantic halibut (*Hippoglossus hippoglossus*) fishery. Can. J. Fish. Aquat. Sci. 46: 1899-1903.

NEILSON, J.D., K.G. WAIWOOD, AND S.J. SMITH. 1989. Survival of Atlantic halibut (*Hippoglossus hippoglossus*) caught by longline and otter trawl gear. Can. J. Fish. Aquat. Sci. 46: 887-897.

PERRY, R.I., P.C.F. HURLEY, P.C. SMITH, J.A. KOSLOW, AND R.O. FOURNIER. 1989. Modelling the initiation of spring phytoplankton blooms: a synthesis of physical and biological interannual variability off southwest Nova Scotia, 1983-1985. Can. J. Fish. Aquat. Sci. 46(Suppl.1): 183-199.

PETERSON, R.H., R.A. BOURBONNIERE, G.L. LACROIX, D.J. MARTIN-ROBICHAUD, P. TAKATS, AND G. BRUN. 1989. Responses of Atlantic salmon (*Salmo salar*) alevins to dissolved organic carbon and dissolved aluminum at low pH. Water Air Soil Pollut. 46: 399-414.

PETERSON, R.H., K. COOMBS, J. POWER, AND U. PAIM.

1989. Responses of several fish species to pH gradients. Can. J. Zool. 67: 1566-1572.

PETERSON, R.H. AND D.J. MARTIN-ROBICHAUD. 1989. First feeding of Atlantic salmon (*Salmo salar* L.) fry as influenced by temperature regime. Aquacul. 78: 35-53.

1989. Community analysis of fish populations in headwater lakes of New Brunswick and Nova Scotia. Proc. N.S. Inst. Sci. 38: 55-72.

PETERSON, R.H., A. SREEDHARAN, AND S. RAY. 1989. Accumulation of trace metals in three species of fish from lakes in New Brunswick and Nova Scotia (Canada): influence of pH and other chemical parameters. Water Pollut. Res. J. Can. 24: 101-117.

ROBICHAUD, D.A., R.F.J. BAILEY, AND R.W. ELNER. 1989. Growth and distribution of snow crab, *Chionocetes opilio*, in the southeastern Gulf of St. Lawrence. J. Shellfish Res. 8: 13-23.

SAUNDERS, R.L., J.L. SPECKER, AND M.P. KOMOURDJIAN. 1989. Effects of photoperiod on growth and smolting in juvenile Atlantic salmon (*Salmo salar*). Aquacul. 82: 103-117.

SPECKER, J.L., T.W. WHITESEL, S.L. PARKER, AND R.L. SAUNDERS. 1989. Thyroidal response of Atlantic salmon to sea water challenge: predictor of growth in sea water. Aquacul. 82: 307-318.

STEPHENSON, R.L. AND M.J. POWER. 1989. Observations of herring retained in the Bay of Fundy: variability in vertical movement and position of the patch edge. Rapp. P.-v. Réun. Cons. int. Explor. Mer 191: 177-183.

WAIWOOD, K.G. AND M.-I. BUZETA. 1989. Reproductive biology of southwest Scotian Shelf haddock (*Melanogrammus aeglefinus*). Can. J. Fish. Aquat. Sci. 46(Suppl.1): 153-170.

WIGGS, A.J., E.B. HENDERSON, R.L. SAUNDERS, AND M.N. KUTTY. 1989. Activity, respiration and excretion of ammonia by Atlantic salmon (*Salmo salar*) smolt and postsmolt. Can. J. Fish. Aquat. Sci. 46: 790-795.

WILDISH, D.J., A.J. WILSON, AND B. FROST. 1989. Benthic macrofaunal production of Browns Bank, Northwest Atlantic. Can. J. Fish. Aquat. Sci. 46: 584-590.

ZITKO, V. 1989. Characterization of PCBs by principal components analysis (PCA of PCB). Mar. Poll. Bull. 20: 26-27.

1989. A simple look at the structure of data matrices. Trends in Analyt. Chem. 8: 161-162.

1989. Composition of chlorinated dibenzodioxins and dibenzofurans in various samples. Sci. Total Environ. 80: 127-137.

Interpretive Scientific Publications

AIKEN, D.E. [ED.] 1989. World Aquacul. 20(1): 84 p.
[ED.] 1989. World Aquacul. 20(2): 72 p.
[ED.] 1989. World Aquacul. 20(3): 80 p.
[ED.] 1989. World Aquacul. 20(4): 112 p.

AIKEN, D.E. AND S.L. WADDY. 1989. Culture of the American lobster, *Homarus americanus*. p.79-122. *In* A.D. Boghen [ed.] Cold-water aquaculture in Atlantic Canada. Canadian Institute for Research on Regional Development, Moncton, NB.

BURRIDGE, L.E. AND K. HAYA. 1989. The use of fugacity model to assess the risk of pesticides to the aquatic environment on Prince Edward Island. p.193-203. *In* J.O. Nriagu and J.S.S. Lakshminarayana [ed.] Aquatic Toxicology and Water Quality Management. John Wiley and Sons, New York, NY.

CAMPBELL, A. 1989. The lobster fishery of southwestern Nova Scotia and the Bay of Fundy. p.141-158. *In* J.F. Caddy [ed.] Marine invertebrate fisheries: their assessment and management. John Wiley & Sons, New York, NY.

SAUNDERS, R.L. 1989. Salmonid aquaculture: present status and prospects for the future. p.31-75. *In* A.D. Boghen [ed.] Cold-water aquaculture in Atlantic Canada. Canadian Institute for Research on Regional Development. Moncton, NB.

Scientific and Technical Reports

ACID RAIN STUDY GROUP. 1989. Report of the study group on toxicological mechanisms involved in the impact of acid rain and its effects on salmon. Copenhagen, 11-15 March 1989. ICES C.M.1989/ M:4, Ref.E, 67 p.

AIKEN, D.E. 1989. Salmon farming in Canada: the Pacific coast. World Aquacul. 20(2): 11-18.

1989. The economics of salmon farming in the Bay of Fundy. World Aquacul. 20(3): 11-19.

[ED.] 1989. Bull. Aquacul. Assoc. Can. 89-1: 44 p.

[ED.] 1989. Bull. Aquacul. Assoc. Can. 89-2: 44 p.

ANON. 1989. Report of ICES Working Group on Genetics, Dublin, Ireland, May 24-26,1989. ICES C.M.1989/F:17.

BUERKLE, U. 1989. Results of the 1989 winter acoustic surveys of NAFO Div. 4WX herring stocks. CAFSAC Res. Doc. 89/41: 22 p.

CAMPBELL, A. 1989. Interim report on dispersal of lobsters, *Homarus americanus*, tagged off southern Nova Scotia. Can. Manuscr. Rep. Fish. Aquat. Sci. 2022: iv + 29 p.

CHANDLER, R.A., G.J. PARSONS, AND M.J. DADSWELL. 1989. Upper and northern Bay of Fundy scallop surveys, 1986-1987. Can. Tech. Rep. Fish. Aquat. Sci. 1665: iii + 37 p.

COOK, R.H. [ED.] 1989. Canada. p.2-11. *In* H. Rosenthal [ed.] Activity report 1988 Mariculture Committee. ICES C.M. 1989/F:1.

COUTURIER, C. AND D.E. AIKEN. 1989. Possible role of photoperiod in sea scallop reproduction. Bull. Aquacul. Assoc. Can. 89-3: 65-67.

DADSWELL, M.J. AND G.J. PARSONS. 1989. Potential for giant scallop (*Placopecten magellanicus*) aquaculture in Nova Scotia. Aquanotes (Aquacul. Assoc. NS) 11:

17-21.

DUSTON, J., R.L. SAUNDERS, P.R. HARMON, AND D. KNOX. 1989. Increase in photoperiod and temperature in winter advance completion of some aspects of smoltification in Atlantic salmon. Bull. Aquacul. Assoc. Can. 89-3: 19-21.

GAVARIS, S. 1989. Assessment of eastern Georges Bank haddock. CAFSAC Res. Doc. 89/49: 27 p.

HUNT, J.J. 1989. Status of the Atlantic cod stock on Georges Bank in unit areas 5Zj and 5Zm, 1978-88. CAFSAC Res. Doc. 89/47: 26 p.

1989. Results of a silver hake otolith exchange between Canada and the USSR. NAFO SCR Doc. 89/11: 5 p.

LACROIX, G.L. 1989. Physiological responses of salmonids as indicators of sublethal stress in acidified organic rivers of Atlantic Canada. p.418-428. *In* J. Bohác and V. Ruzicka [ed.] Proc. Vth Int. Conf. Bioindicatores Deteriorisationis Regionis, Vol.II. Institute of Landscape Ecology, Czechoslovak Academy of Sciences, Ceské Budejovice.

LOSIER, R.J. AND L.E. WAITE. 1989. Systematic listing of scientific and/or common names of invertebrates, vertebrates and marine plants and their respective codes used by Marine Fish Division, Department of Fisheries and Oceans, Scotia-Fundy Region (revised). Can. Data Rep. Fish. Aquat. Sci. 721: 139 p.

NEILSON, J.D. AND W.R. BOWERING. 1989. Minimum size regulations and the implications for yield and value in the Canadian halibut fishery. CAFSAC Res. Doc. 89/5: 11 p.

PETERSON, R.H. 1989. Species distribution of mayfly (Ephemeroptera) nymphs in three stream systems in New Brunswick and Nova Scotia with notes on identification. Can. Tech. Rep. Fish. Aquat. Sci. 1685: iii + 14 p.

PINIERO, C. AND J.J. HUNT. 1989. Comparative study on growth of European hake from the southern stock using whole and sectioned otoliths and length frequency distribution. ICES C.M. 1989/G:37.

SAUNDERS, R.L. 1989. Canadian genetics studies relevant to aquaculture. p.11-14. *In* Report of ICES Working Group on Genetics, Dublin, Ireland, May 24-26,1989. ICES C.M. 1989/F:17 (Mariculture Committee).

STEPHENSON, R.L. AND M.J. POWER. 1989. Assessment of the 1988 4WX herring fishery. CAFSAC Res. Doc. 89/59: 39 p.

1989. Reappearance of Georges Bank herring: a biological update. CAFSAC Res. Doc. 89/60: 14 p.

1989. The 1988 4Vn herring fishery; biological update. CAFSAC Res. Doc. 89/61: 14 p.

1989. A review of the "Scots Bay" herring fishery in the upper Bay of Fundy (4X). CAFSAC Res. Doc. 89/62: 12 p.

STRONG, M. 1989. A comparison of age data derived from scales and otoliths for 5Ze haddock 1988. CAFSAC Res. Doc. 89/53: 5 p.

UTHE, J.F., H.C. FREEMAN, G.B. SANGALANG, K. HAYA, AND L.S. SPERRY. 1989. Acid rain and reproduction in Atlantic salmon: effects and mitigation. p.63-68. *In* Characteristics and conservation of fish habitat. Proceedings of the Fish Habitat Awareness Seminar, 22-24 June 1988. Acadia University, Wolfville, NS.

WADDY, S.L. [ED.] 1989. Bull. Aquacul. Assoc. Can. 89-3: 128 p.

WADDY, S.L. AND D.E. AIKEN. 1989. Control of spawning in the American lobster: winter temperature and photoperiod requirements. Bull. Aquacul. Assoc. Can. 89-3: 94-96.

WAIWOOD, K.G. 1989. Halibut - a potential aquaculture species for Atlantic Canada. Bull. Aquacul. Assoc. Can. 89-2: 21-24.

WILDISH, D.J. 1989. Mariculture and potential multiple use resource conflicts in Atlantic Canada. p.107-117. *In* Characteristics and conservation of fish habitat. Proceedings of the Fish Habitat Awareness Seminar, 22-24 June 1988. Acadia University, Wolfville, NS.

WILDISH, D.J., A.J. WILSON, W.W. YOUNG-LAI, A.D. DECOSTE, D.E. AIKEN, AND J.D. MARTIN. 1989. Economic feasibility of scallop culture in the Bay of Fundy. p.85-87. *In* Atelier sur l'élevage du pétoncle géant tenu a Gaspé (Québec) les 30 novembre et 1er décembre 1988. Ministère de l'Agriculture, des Pêcheries et de l'Alimentation, Pêches maritimes, Québec, PQ.

Popular and Miscellaneous

AIKEN, D.E. 1989. Editorial. World Aquacul. 20(1): 1.

1989. The allure of omega-3. World Aquacul. 20(1): 39.

1989. Editorial. World Aquacul. 20(2): 2.

1989. Editorial. World Aquacul. 20(3): 2.

1989. Opening shots. World Aquacul. 20(4): 3-4.

1989. The fiber factor in cholesterol management. World Aquacul. 20(4): 32.

CHARMANTIER, G., M. CHARMANTIER-DAURES, S. WADDY, AND D.E. AIKEN. 1989. Osmoregulation and salinity tolerance in the nemertean *Pseudocarcinonemertes homari*, a predator of the eggs of *Homarus americanus*: an eradication technique. Amer. Zool. 29: 65a (abstract).

HAYA, K., L.E. BURRIDGE, J.L. MARTIN, AND B.A. WAIWOOD. 1989. Domoic acid in mussels, *Mytilus edulis*, from Passamaquoddy Bay, New Brunswick, Canada. p.10. *In* S.S. Bates and J. Worms [ed] Proceedings of the First Canadian Workshop on Harmful Marine Algae, Gulf Fisheries Centre, Moncton, N.B., September 27-28,1989. Can. Tech. Rep. Fish. Aquat. Sci. 1712 (abstract).

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24 January 1990
FIONA O'FLYNN
University of New Brunswick
Fredericton, NB
and
Salmon Genetics Research Program
St. Andrews, NB
Aquaculture in Ireland

2 March 1990
ROBERT L. VADAS
Department of Botany and Plant Pathology
University of Maine
Orono, ME, USA
Recruitment and ecology of *Ascophyllum nodosum*

26 April 1990
LUC ROSEBERRY
Université de Rimouski
Rimouski, PQ
Orientation in the soft-shell clam, *Mya arenaria*

25 June 1990
EDWARD A. TRIPPEL
Department of Biology
Limnological Institute
Kontanz, Germany
Coldwater trophic associations in boreal forest lakes

25 June 1990
YVAN LAMBERT
Department of Fisheries and Oceans
Maurice Lamontagne Institute
Mont-Joli, PQ
Influence of spawning season on reproductive effort and cost of reproduction of Atlantic herring

16 July 1990
GARY D. MELVIN
Washburn and Gillis Associates
Fredericton, NB
The hilsa fishery of Sarawak, Malaysia

17 July 1990
BOB GREGORY
University of British Columbia
Vancouver, BC
Foraging ability and predation risk of chinook salmon fry in turbid water: implications to life history strategies

17 July 1990
FRED H. PAGE
Department of Oceanography
Dalhousie University
Halifax, NS
Evaluating the role of early life stage transport in fish population regulation

25 July 1990
HOWARD BROWMAN
Huntsman Marine Science Centre
St. Andrews, NB
Prey search strategies in larval fish

14 August 1990
ROGER FOXALL
Institute for Marine Biosciences
National Research Council
Halifax, NS
The Institute of Marine Biosciences, Halifax, Nova Scotia: an overview of the programs and activities

11 September 1990
GARY SHARP
Visiting Scientist
National Oceanic and Atmospheric Administration
Center for Ocean Analysis and Prediction
Monterey, CA, USA
Climate variability and ocean consequences

13 September 1990
DOUG BERTRAM
Recipient of Huntsman Marine Science Centre Fellowship
McGill University
Montreal, PQ
Consequences of differential age at metamorphosis in laboratory-reared winter flounder

6 November 1990
DONALD P. WESTON
University of Maryland
Horn Point Environmental Laboratories
Cambridge, MD, USA
Measuring and managing the benthic effects of aquaculture

21 November 1990
MICHEL GLÉMAREC
Laboratoire d'Océanographie biologique
Université de Bretagne occidentale
Brest, France
Impacts of the Amoco-Cadiz oil spill, 1978: general ecology, economic consequences, and legal issues

7 December 1990
WILLIAM FULL
Department of Geology
Wichita State University
Wichita, KS, USA
Fourier shape analysis: quantitative analysis of external morphology

8 January 1991
GEORGE A. ROSE
Department of Fisheries and Oceans
Science Branch
St. John's, NF
Modelling the migrations of the "northern" cod: an example of predator-prey spatial interactions within a dynamic physical system

6 February 1991
EDWARD D. HOUDE
Chesapeake Biological Laboratory
University of Maryland
Solomons, MD, USA
Spawning strategy, larval mortality, and recruitment in marine fishes

21 March 1991
MIKE HEATH
Marine Laboratory
Department of Agriculture and Fisheries for Scotland
Aberdeen, Scotland, UK
Oceanographic processes and the survival of herring larvae in the North Sea

6 June 1991
JAMES D. SCHUMACHER
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration
Seattle, WA, USA
Fisheries Oceanography Coordinated Investigations (FOCI): some interactions between early life history stages of walleye pollock and their environment in the western Gulf of Alaska

5 July 1991
R.S. BAILEY
Marine Laboratory
Aberdeen, Scotland, UK
The interrelationship between seabirds and fish stocks: a case study at Shetland

15 October 1991
PAUL KING
Psychologist
St. Andrews, NB
Stress in the workplace

17 October 1991
BRIAN NICHOLLS
Department of Fisheries and Oceans
Bedford Institute of Oceanography
Dartmouth, NS
Canada/USA Gulf of Maine Council on the Marine Environment: a progress report

24 October 1991
EDWARD A. BLACK
British Columbia Ministry of Agriculture, Fisheries & Food
Victoria, BC
Lessons in managing salmon farms during algal blooms

28 November 1991
PIERRE-PHILIPPE MORIN
Post-doctoral Fellow
St. Andrews Biological Station
Olfactory and thyroidal evidence of a critical period of development in Atlantic salmon during smoltification

9 December 1991
DUNCAN MATHESON
Canadian Broadcasting Corporation
Fredericton, NB
Bridging the gap between science and the media

3 February 1992
ALAN SINCLAIR
Department of Fisheries and Oceans
Institut Maurice-Lamontagne
Mont-Joli, PQ
Fish distribution and management: by-catch, small fish, and gear conflicts

3 February 1992
ROBERT L. STEPHENSON
St. Andrews Biological Station
Gulf of Maine herring: a focus on recent initiatives and issues

4 February 1992
WENDY M. WATSON-WRIGHT
Department of Fisheries and Oceans
Inspection Branch
Halifax, NS
Maritime maladies from marine biotoxins: recent incidents in Scotia-Fundy

4 February 1992
DAVID E. AIKEN
St. Andrews Biological Station
Lobster biology: from the esoteric to the sublime

19 February 1992
MICHAEL KINGSLEY
Department of Fisheries and Oceans
Institut Maurice-Lamontagne
Mont-Joli, PQ
Beluga of St. Lawrence: an application of systematic sampling

26 February 1992
DANIEL E. LANE
University of Ottawa
Ottawa, ON
Setting TACs: on the quest for a new paradigm

11 March 1992
MATTHEW LITVAK
Huntsman Marine Science Centre
St. Andrews, NB
The bigger they are, the harder they fall: the impact of age and size on the vulnerability of fish larvae to predators

18 March 1992
DERRICK ILES
St. Andrews Biological Station
Recruitment diagnosis of 4X cod and 4X haddock

1 April 1992
J.C. COULSON
University of Durham
Durham, England, UK
Parallel long-term trends across four marine trophic levels and weather

22 April 1992
JULIE M. PORTER
St. Andrews Biological Station
Bluefin tuna studies in the Scotia-Fundy Region

27 April 1992
JAMES A. WILSON
Department of Agricultural and Resource Economics
University of Maine
Orono, ME, USA
Chaotic dynamics in a multiple species fishery: a model of community predation

19 May 1992
SHIRLEY S.L. LIM
Atlantic Reference Centre
Huntsman Marine Science Centre
St. Andrews, NB
Effects of organic enrichment from Atlantic salmon aquaculture sites on the benthic macrofaunal communities in the lower Bay of Fundy

29 June 1992
LAWRENCE MYSAK
Centre for Climate and Global Change Research
McGill University
Montreal, PQ
Interdecadal climate variability in the northern North Atlantic and possible implications for fisheries

20 July 1992
ROBERT H. COOK
Department of Fisheries and Oceans
Aquaculture Coordination Office
Halifax, NS
Role and functions of the Regional Aquaculture Coordination Office

7 August 1992
BENNO KÜGEL
Bavarian State Bureau for Water Resources Management
Munich, Germany
Application of the use of bioindicators for lowland stream restoration

14 August 1992
BRUCE G. HATCHER
Department of Oceanography
Dalhousie University
Halifax, NS
Population dynamics of juvenile sea scallop *Placopecten magellanicus* in shallow coastal environments: the quick and the dead

1 October 1992
FRANCISCO WERNER
Skidaway Institute of Oceanography
Savannah, GA, USA
Numerical modelling of larval settlement in turbulent bottom boundary layers

13 October 1992
EDWARD A. TRIPPEL
St. Andrews Biological Station
The male gamete and its role in zygote formation in Atlantic cod stocks exhibiting early maturity

21 October 1992
GILLES BOEUF
Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER)
Centre de Brest
Plouzane, France
Salmonid aquaculture in Chile

25 November 1992
DAVID J. WILDISH
St. Andrews Biological Station
Hydrodynamic control of filtration in bivalve molluscs

26 November 1992
DONALD S. CLARK
St. Andrews Biological Station
The groundfish hydroacoustics program at St. Andrews

10 December 1992
MARK POWELL
University of Prince Edward Island
Charlottetown, PE
Some aspects of non-specific pathophysiological responses in salmonid fish

16 December 1992
YASUKATSU OSHIMA
Department of Applied Biological Chemistry
Faculty of Agriculture
Tohuku University
Tsutsumidori Amamiya
Aoba-ku, Sendai, Japan
Application of HPLC to studies on paralytic shellfish toxins

18 February 1993
VIBEKE BROCK
Odense University
Odense, Denmark
Biomarkers of heavy metal contamination in marine bivalves and flatfish

26 February 1993
GREG GOFF
Ocean Sciences Centre
Memorial University of Newfoundland
St. John's, NF
Alternative marine species culture. Six years with Atlantic halibut - what have we learned?

24 March 1993
KEVIN STOKESBURY
Ocean Production Enhancement Network (OPEN) Project
Département de Biologie/Groupe interuniversitaire de recherches océanographiques du Québec (GIROQ)
Université Laval
Québec, PQ
Spatial distribution of the giant scallop *Placopecten magellanicus* in unharvested beds of Baie de Chaleurs, Québec

14 April 1993
BRUCE MACDONALD
Department of Biology
University of New Brunswick (Saint John)
Saint John, NB
Particle quality and selection efficiency in a suspension feeding bivalve, *Placopecten magellanicus*

27 April 1993
STEVE W. ROSS
National Estuarine Research Reserve
University of North Carolina at Wilmington
Wilmington, NC, USA
Recruitment and population dynamics of estuarine dependent juvenile fishes of North Carolina

4 May 1993
PATRICK LASSUS
Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER)
Laboratoire phycotoxines et nuisances
Nantes, France
PSP and DSP toxinogenesis and effects on bivalves

14 June 1993
ROBERT L. VADAS
Department of Plant Biology and Pathology
University of Maine
Orono, ME, USA
Recruitment failure and potential impact of harvesting on *Ascophyllum*

4 August 1993
WOJCIECH PIASECKI
NSERC Postdoctoral Fellow
University of New Brunswick
Fredericton, NB
and
Faculty of Marine Fisheries and Food Technology
University of Agriculture in Szczecin
Szczecin, Poland
Life cycle of the sea louse *Caligus elongatus* von Nordmann, 1832 (Copepoda, Siphonostomatoida) studied under laboratory conditions

11 August 1993
MICHAEL VECCHIONE
National Marine Fisheries Service
Systematic Laboratory
National Museum of Natural History
Smithsonian Institution
Washington, DC, USA
In situ observations on deep sea cephalopods

30 August 1993
DAVID R. IDLER
J.L. Paton Research Professor
Ocean Science Centre
Marine Science Research Laboratory
Memorial University of Newfoundland
St. John's, NF
The use of testosterone implants to improve maturation of Atlantic salmon kelt

8 September 1993
GERHARD POHLE
Atlantic Reference Centre
Huntsman Marine Science Centre
St. Andrews, NB
Barcelona - the beauty and the beast

1 December 1993
JOHN THOMPSON
Department of Primary Industry and Fisheries
Tasmania, Australia
The Tasmanian scallop enhancement project - some lessons for the Bay of Fundy

CONFERENCES, WORKSHOPS AND SCIENTIFIC MEETINGS AT THE BIOLOGICAL STATION 1990-1993

1-2 March 1990
Aquaculture workshop: the environmental impacts of finfish culture
Sponsored by the Gulf of Maine Working Group and the Huntsman Marine Science Centre

8-10 August 1990
11th Annual Canada/United States Fisheries Discussions

12 September 1990
Striped bass workshop
Organized by R.H. Peterson

24-28 September 1990
Groundfish Subcommittee meeting
Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC)

7-8 November 1990
Fourth Biennial Benthic Workshop: mariculture impacts on coastal systems
Organized by D.J. Wildish, B.T. Hargrave (Bedford Institute of Oceanography), and J. Grant (Department of Oceanography, Dalhousie University)

10-17 September 1991
Swordfish assessment workshop
International Commission for the Conservation of Atlantic Tunas (ICCAT) - coordinated by J.M. Porter

12 November 1991
New Developments in Salmon Farming
Organized by the Norwegian Trade Council, in cooperation with the New Brunswick Salmon Growers' Association

22 January 1992
Workshop on the assimilative capacity of the Letang Inlet for salmonid aquaculture wastes
Organized by the Habitat Ecology Division (Bedford Institute of Oceanography) and the St. Andrews Biological Station

19-23 October 1992
Fourth International Salmonid Smolt Workshop
Organized by R.L. Saunders

28-29 October 1992
Fifth Biennial Benthic Workshop: hydrodynamics and the benthos
Organized by D.J. Wildish, B.T. Hargrave (Bedford Institute of Oceanography), and J. Grant (Department of Oceanography, Dalhousie University)

17-18 February 1993
Southwest New Brunswick Groundfish Fishery: A Strategy for the Future
Organized by the New Brunswick Department of Fisheries and Aquaculture

24-25 February 1993
Aquaculture-Environment Interaction Workshop
Convened by the Gulf of Maine Council on the Marine Environment - sponsored by the New Brunswick Department of Fisheries and Aquaculture

17-21 May 1993
Pelagic Subcommittee Meeting
Fisheries Resource Conservation Council - chaired by J.J. Hunt

15-16 June 1993
Shellfish Habitat Restoration Workshop
Convened by the Gulf of Maine Council on the Marine Environment - sponsored by the New Brunswick Department of Fisheries and Aquaculture

6-10 July 1993
Intersessional workshop on the technical aspects of methodologies which account for individual growth variability by age
International Commission for the Conservation of Atlantic Tunas - convened by J.M. Porter

MISSIONS INVOLVING BIOLOGICAL STATION STAFF 1990-1993

The following list includes missions on which Biological Station staff participated during 1990-1993. The list excludes the *Pandalus III* and the *Gemma*, which are used primarily for day trips within the Quoddy Region. The *JL Hart* was based at the Biological Station. The *Alfred Needler, EE Prince, Dawson, Lady Hammond, Wilfred Templeman,* and *Parizeau* were based at the Bedford Institute of Oceanography, Dartmouth, NS.
* refers to joint cruises with Marine Fish Division (BIO). Names in bold refer to officers-in-charge. Names in parentheses refer to Biological Station term employees, contract staff, and students.

Dates	Vessel	Location	Purpose	Biological Station Participants
1990				
04Jan-23Jan	*Alfred Needler*	Chedabucto Bay	herring survey (acoustic)	**Dickson**, Buerkle, Trynor
19Feb-07Mar	*Alfred Needler*	Georges Bank	groundfish survey	**Hunt**, Strong, Sampson, Nelson, Perley, Dougherty,*
13Mar-22Mar	*Alfred Needler*	eastern Scotian Shelf	groundfish survey	Trynor*
05Apr-12Apr	*EE Prince*	Bay of Fundy, Grand Manan	lobster survey and tagging	**Robichaud**
17Apr-27Apr	*Alfred Needler*	Georges Bank	ichthyoplankton and hydrography survey	**Perry**, Sampson, Losier, Brown, Nelson*
30Apr-18May	*JL Hart*	Grand Manan	collect live halibut and haddock	**Howes**
18May-02Jun	*Alfred Needler*	western Scotian Shelf	haddock, zooplankton survey	Dougherty, Trynor*
11Jun-14Jun	*JL Hart*	Quoddy Region	food fish collection	**Sampson**
03Jul-19Jul	*JL Hart*	Passamaquoddy Bay, Fundy Isles	scallop survey	**Robinson**, Chandler, JD Martin, (Colborne)
03Jul-01Aug	*Alfred Needler*	Scotian Shelf and Georges Bank	groundfish survey	Nelson, Sampson, Losier*
23Jul-27Jul	*JL Hart*	Quoddy Region	phytotoxin survey	**JL Martin**
14Aug-16Aug	*JL Hart*	St Croix estuary	acoustic gear trials	**Buerkle**, Gordon
15Aug-16Aug	*Dawson*	Passamaquoddy Bay, Bay of Fundy	test ROV for benthic, scallop, lobster studies	Wildish, McMullon, Lawton, Robinson
20Aug-24Aug	*JL Hart*	Quoddy Region, Grand Manan	herring weir sampling	**Stephenson**, Gordon, Power
27Aug-30Aug	*JL Hart*	Quoddy Region	phytotoxin survey	**JL Martin**
03Sep-13Sep	*EE Prince*	Georges Bank	large pelagics survey	**Porter**, Dickson
04Sep-14Sep	*JL Hart*	Grand Manan to Upper Bay of Fundy	scallop survey	**Robinson**, Chandler, JD Martin, (Colborne)
24Sep-25Sep	*JL Hart*	Quoddy Region	phytotoxin survey	**JL Martin**

Dates	Vessel	Location	Purpose	Biological Station Participants
1990 (continued)				
01Oct-05Oct	*JL Hart*	Passamaquoddy Bay	test towed under-water sled; video recording of scallop drag	**Robinson**, JD Martin, Chandler, (Parsons, MacIntyre)
01Oct-11Oct	*Alfred Needler*	Georges Bank	cod, haddock, herring surveys (acoustic and trawl)	**Buerkle**, Buzeta, Hunt, Dickson, Gavaris, Melvin, Perley, Van Eeckhaute
15Oct-19Oct	*JL Hart*	Quoddy Region	test performance of Concord trawl	**Strong**, Hunt, Gale
22Oct-08Nov	*EE Prince*	Bay of Fundy, eastern Gulf of Maine	larval herring and zooplankton survey	**Gordon**, Dougherty, Nelson, Trynor*
25Oct-15Nov	*Lady Hammond*	Georges Bank, SWNS	larval herring survey	**Power**, Trippel, Melvin*
08Dec-16Dec	*Alfred Needler*	Inner Gulf of Maine	transboundary pollock survey	Hunt*
1991				
05Jan-29Jan	*Alfred Needler*	Chedabucto Bay	herring survey (acoustic)	**Dickson**, Buerkle, Trynor, Dougherty, Perley
12Feb-28Feb	*Alfred Needler*	Georges Bank	groundfish survey	**Strong**, Brown, Buzeta, Losier, Van Eeckhaute, Sampson*
04Mar-18Mar	*Alfred Needler*	eastern Scotian Shelf	groundfish survey	Perley*
13May-06Jun	*JL Hart*	St Mary's Bay	collect live haddock and cod; winter flounder survey	**Perley, Van Eeckhaute, Buzeta, Brown**, (Kacergis, Godrin, Bosser)*
03Jul-13Jul	*Alfred Needler*	western Scotian Shelf	groundfish survey	**Hunt**, Neilson, Sampson, Losier, Brown*
15Jul-26Jul	*JL Hart*	Passamaquoddy Bay, Saint John area	scallop survey	**Robinson**, Chandler, JD Martin
17Jul-28Jul	*Lady Hammond*	eastern Scotian Shelf	groundfish survey	Perley, Gale, Strong*
25Jul-02Aug	*EE Prince*	Scotts Bay	roe herring survey (acoustic)	**Buerkle**, Stephenson, Dickson, Trynor
29Jul-01Aug	*JL Hart*	Quoddy Region	phytotoxin survey	**JL Martin**
07Aug-09Aug	*JL Hart*	Grand Manan	lobster survey/tagging	**Robichaud**, (M Stokesbury)
28Aug-01Sep 15Sep-19Sep 03Oct-07Oct	*EE Prince*	Hell Hole (SWNS)	bluefin tuna tagging study	**Porter**, (C Couturier, Hogans)
03Sep-12Sep	*JL Hart*	Passamaquoddy Bay, Bay of Fundy	scallop survey; spat collector deployment	**Robinson**, Chandler, JD Martin
03Sep-14Sep	*EE Prince*	German Bank (SWNS)	herring survey (acoustic)	**Buerkle**, Dickson, Power, Stephenson

Dates	Vessel	Location	Purpose	Biological Station Participants
1991 (continued)				
24Sep-02Oct	*EE Prince*	Cow Pen (Scotian Shelf)	swordfish and large pelagics survey	**Porter**, Dickson, (Hogans)
27Oct-12Nov	*Lady Hammond*	Georges Bank	larval/adult herring survey	**Melvin**, Power*
28Oct-15Nov	*EE Prince*	Bay of Fundy, eastern Gulf of Maine	larval herring and zooplankton survey	**Sochasky**, Dougherty, Nelson, Fife
04Dec-15Dec	*Alfred Needler*	Eastern Shore and Chedabucto Bay	herring survey (acoustic)	**Buerkle**, Dickson, Trynor, Clark
1992				
06Jan-18Jan	*Alfred Needler*	Eastern Shore and Chedabucto Bay	herring survey (acoustic)	**Buerkle**, Dickson, Trynor, Clark
24Feb-10Mar	*Alfred Needler*	Georges Bank	groundfish survey; test acoustic gear	**Buzeta**, Van Eeckhaute, Trippel, Sampson, Perley, Nelson, Dougherty, Clark
13Mar-23Mar	*Alfred Needler*	eastern Scotian Shelf	groundfish survey	Strong*
22Jun-25Jun	*JL Hart*	Quoddy Region	phytotoxin survey	**JL Martin**
22Jun-06Jul	*Alfred Needler*	Scotian Shelf and Bay of Fundy	groundfish survey; test acoustic gear	Hunt, Sampson, Strong, Page, Nelson, Brown, Perley, Clark*
30Jun-30Jul	2 charter boats	Bay of Fundy	lobster tagging study	**Lawton**, Robichaud
06Jul-16Jul	*JL Hart*	St Mary's Bay to Cape Sable I	inshore haddock survey; test single beam acoustics	Clark, Losier*
20Jul-05Aug	*JL Hart*	Passamaquoddy Bay, Bay of Fundy	scallop survey	**Robinson**, Chandler
04Aug-09Aug	*EE Prince*	Hell Hole (SWNS)	bluefin tuna tagging and biology	**Porter**, Dickson, (M Stokesbury)
08Sep-11Sep	*JL Hart*	Bay of Fundy	lobster survey	**Lawton**, Robichaud, (Moisan)
08Sep-23Sep	*EE Prince*	Hell Hole (SWNS)	bluefin tuna survey and biology	**Dickson**, (M Stokesbury, Hanke)
14Sep-18Sep	*JL Hart*	Quoddy Region	phytotoxin survey	**JL Martin**
21Sep-06Oct	*JL Hart*	Grand Manan	scallop survey	**Robinson**, Chandler, (Parsons, C Couturier)
28Oct-13Nov	*EE Prince*	Bay of Fundy, eastern Gulf of Maine	larval herring and zooplankton survey	**Sochasky**, Perley, Fife, (M Stokesbury)
17Nov-26Nov	*EE Prince*	Georges Bank	adult herring survey	**Strong**, Sochasky*
23Nov-01Dec	*Parizeau*	Georges Bank	larval herring survey	**Melvin**, Power, M Couturier*

Dates	Vessel	Location	Purpose	Biological Station Participants
1993				
04Jan-23Jan	*EE Prince*	Chedabucto Bay	herring survey (acoustic)	**Buerkle**, Clark, Dickson, Trynor
08Mar-19Mar	*Wilfred Templeman*	Georges Bank	groundfish survey	**Buzeta**, Van Eeckhaute, Perley, Sampson, Brown*
21Jun-25Jun	*JL Hart*	western Bay of Fundy	phytotoxin survey	**JL Martin**
05Jul-15Jul	*JL Hart*	Passamaquoddy Bay	scallop spawning stock survey	**Chandler**, JD Martin
05Jul-01Aug	*Alfred Needler*	Scotian Shelf, Bay of Fundy	groundfish survey	**Hunt**, Strong, Perley, Clark, Brown, Sampson, (Hanke)*
19Jul-06Aug	*JL Hart*	St Mary's Bay	inshore haddock survey; test dual beam acoustics	Clark*
01Aug-30Sep	charter	Annapolis Basin and Digby Gut	lobster survey	**Lawton**, Robichaud
09Aug-19Aug	*JL Hart*	upper Bay of Fundy	lobster survey, including spawning areas and tagging	**Lawton**, Robichaud
13Sep-17Sep	*JL Hart*	western Bay of Fundy	phytotoxin survey	**JL Martin**
18Oct-05Nov	*EE Prince*	Bay of Fundy, eastern Gulf of Maine	larval herring and zooplankton survey	**Sochasky**, Nelson, Fife, Perley, (Paul)
12Nov-26Nov	*Alfred Needler*	Georges Bank	larval herring survey; adult acoustic survey	**Melvin**, Power, Buerkle, Trynor*

ACKNOWLEDGEMENTS

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