



Environment Canada

Fisheries and
Marine Service

Environnement Canada

Service des pêches
et des sciences de la mer

1975 Report

Resource Development Branch

Maritimes Region
Halifax, N.S.

June, 1976





Environment Canada

Fisheries and
Marine Service

Environnement Canada

Service des pêches
et des sciences de la mer

1975 Report

Resource Development Branch

Maritimes Region
Halifax, N.S.

June, 1976

Editor — K. E. H. Smith
Design and
production — N. A. Whynot
Printing — Earl Whynot and Associates Ltd.

IMPORTANT

This report constitutes a summary of preliminary scientific and technical data for the information of colleagues, and should not be cited without prior approval of the Chief, Resource Development Branch.

CONTENTS

INTRODUCTION	1	Osmoregulation in Atlantic Salmon and Rainbow Trout	27
SCIENTIFIC LIAISON AND SPECIAL PROJECTS	3	Sublethal Effects of Dissolved Zinc on Atlantic Salmon Parr	27
MARINE FISHERIES	5	Analytical Chemistry Services and Investigations	27
SHELLFISH MANAGEMENT AND DEVELOPMENT	5	FISH PASSAGE PROGRAM	27
Oyster Spatfall Inventory	5	Design and Construction	27
Oyster Population Surveys	6	Tusket River Evaluation	29
Caraquet Bay	6	River Philip Evaluation	29
Summerside Harbour	7	East River, Sheet Harbour Evaluation	30
Hillsborough River	7	St. Croix River Evaluation	30
Cocagne River	8	Maintenance and Improvements	31
Management of Natural Oyster Populations	8	Stream Clearance	31
Buctouche River	8	ENGINEERING SERVICES	31
Richibucto River	8	FRESHWATER AND ANADROMOUS FISHERIES	33
Resource Enhancement Projects	8	MIRAMICHI RIVER SALMON	33
Caraquet Bay	8	Adult Abundance, Timing and Exploitation	33
North St. Simon River	9	Smolt Migration and Exploitation	35
Cooper Bed Reserve	9	Juvenile Salmon Abundance	36
Summerside Harbour	9	Black Salmon (Kelt) Angling Study	36
Shemogue Harbour	10	Bright Salmon Angling Study	37
Estuarine Resource Inventory	10	Hatchery Contributions	37
On-Site Technical Assistance to Industry	11	RESTIGOUCHE RIVER SALMON	37
Management of Oyster Spat-Collection Activities	12	Adult Abundance, Timing and Exploitation	38
Oyster Farming Courses	13	Smolt Timing and Migration	38
Soft-Shell Clam Inventories	14	Juvenile Salmon Abundance	38
Soft-Shell Clam Depuration	14	Adult Salmon Mortality	39
Oyster Lease Administration	15	Hatchery Contributions	39
MARINE PLANTS PROGRAM	15	SAINT JOHN RIVER SALMON	39
Harvesting Technology	16	Adult Abundance and Migration	40
Ecological Impact of <i>Chondrus</i> Harvesting	17	Nashwaak River Adult Trapping	41
Standing Crop — <i>C. crispus</i> and Associated Plants	18	Mactaquac Area	41
Phenology of <i>C. crispus</i>	20	Area Above Mactaquac	42
Miscellaneous Activities	20	Adult Exploitation	43
FISH HABITAT PROTECTION AND ENGINEERING SERVICES	21	Juvenile Abundance	44
AQUATIC ALTERATION INVESTIGATIONS	21	Hatchery Contributions	44
Point Lepreau Nuclear Power Development	22	NOVA SCOTIA SALMON	45
Wreck Cove Hydroelectric Development	22	Commercial Fishery	45
Erosion and Sedimentation Control	23	Sport Fishery	45
Gravel Removal and Channeling	24	West River, Sheet Harbour	46
Estuarial Dredging	24	St. Mary's River	47
Small Dam Construction	24	Margaree River	47
Marine Installations	25	SALMON DEVELOPMENT AND REHABILITATION	48
Highway Structures and Public Utilities	25	Morell River	48
Water Abstraction	25	Tetagouche River	49
Miscellaneous Aquatic Alterations	25	Nepisiguit River	49
Other Investigations	25	Bartholomew River	50
ENVIRONMENTAL QUALITY PROGRAM	26	Northwest Millstream	50
Gays River Baseline Study	26	Tomogonops River	51
		East River, Sheet Harbour	51
		LaHave River	51
		Liscomb River	52
		Atlantic Salmon Kelt Study	53
		SALMON CATCH STATISTICS	54
		Commercial Fishery	54
		Sport Fishery	54
		SAINT JOHN RIVER ALEWIFE AND SHAD	55
		ANNAPOLIS RIVER STRIPED BASS	56
		Creel Census	56
		Biological Studies	56
		Mercury and Pesticide Levels	57
		Contract Study	57

TROUT FISHERY DEVELOPMENT	57
Halifax-Dartmouth Fishery	57
Lake Inventory	57
Broodstock Development	58
FISH CULTURE PROGRAM	59
Hatchery Operations	59
Fish Production	60
Production Quality	62
Production Cost	62
Fish Health	63
Fish Culture Investigations	64

Hatchery Evaluation	66
Aid to Other Agencies	66
Hatchery Engineering Services	66
Commercial Fish Culture	68

PUBLICATIONS BY	
BRANCH STAFF — 1975	69

STAFF SERVING IN FULL-TIME	
POSITIONS — 1975	71

INTRODUCTION

The year 1975 will be remembered by most of us in the Resource Development Branch. Some will remember drastic reductions in manpower resources that caused cancellation of biological investigations, closure of a fish culture station, and serious reductions in all phases of our program. Some will remember the farewell party where "goodbye" was said to over a century and a quarter of fish culture experience. Some will remember 1975 as the first year in over a decade that salmon spawning escapements reached adequate levels in the Miramichi and Saint John rivers. Others will remember the year because it was the first full operational year for the new marine plants program. Still others will remember making new friends with European colleagues who visited on the occasion of the Sixty-Third Statutory Meeting of ICES. But I believe all of us in the Resource Development Branch will remember 1975 most because it was during this year that reorganization of the Fisheries and Marine Service resulted in the termination of the organizational entity known as the Resource Development Branch.

Change is an inevitable process in a dynamic organization and one that helps to insure responsiveness and relevance. In the introduction to our 1972 Report, I discussed the challenge of continual adjustment to the accelerating array of technological, scientific and social changes that confronted Maritime fisheries. Reorganization in the Fisheries and Marine Service has been an evolutionary process in response to that challenge. We hope that new organizational structures will better serve the needs of all who derive benefit from Canada's recreational and commercial fisheries.



Hatchery supervisor, G. B. Robbins, explaining operations of Mactaquac Hatchery to visiting members of the ICES Atlantic Salmon Conservation Tour.

This year's report indicates the broad range of problems tackled by the Branch and the degree of scientific and technical sophistication required to solve them. Unfortunately, budget restrictions limited our ability to respond to new problems without withdrawing support from some important previous commitments. Hence, we were forced to close the Kejimikujik Hatchery in Nova Scotia and abandon our salmon monitoring activity at Westfield on the Saint John River. In addition, we remain unable to launch the kind of grass-roots district biologist approach that would provide familiarity with local fishery problems and opportunities. The result is a defensive, rear-guard effort that, if allowed to continue, will have serious long-term consequences for freshwater and estuarine fishery resources of the Region.

In early December, 1975, three senior hatchery managers retired, taking with them over a century of fish culture experience which will be extremely difficult to replace. I would like to take this opportunity to acknowledge their valuable contributions to the Branch and, on behalf of all the staff, to extend to Tom Lydon, Rusty Peverill, Ralph Webber and their wives our very best wishes for a long and happy retirement. I mentioned last year the loss of Mr. R. F. Hawkins, Supervisor of Hatcheries, due to illness. Although Ron is now on the mend, he was forced to retire in 1975 because of poor health. His loss, after 25 years of outstanding service to the Branch, required major adjustments in the Fish Culture Section and we miss his vigorous guidance to an important phase of our operations. All of us wish Ron and his wife, Gaynelle, a long, rewarding and well-earned retirement.

In New Brunswick, the ban on commercial salmon fishing initiated in 1972 has resulted in spawning escapements three to four times greater than those experienced in 1971. A close relationship is being demonstrated between spawning escapement and subsequent spawning success, as indicated by salmon fry abundance. The first adult returns from these improved spawning escapements will occur in 1976, when a portion of the grilse run will have been derived from spawning escapements in 1972. A commercially harvestable surplus of large salmon is not predicted until 1978 for the Restigouche, Miramichi and Saint John rivers, although grilse runs may show some improvement in 1976 and noticeable improvement in 1977.

Allocation of the Atlantic salmon harvest has always presented difficult problems, whether between recreational and commercial fishermen, or between Dane and Canadian, or between mainlander and Newfoundlander. This latter problem of Newfoundland fishermen intercepting salmon originating from mainland rivers is the subject of a joint scientific assessment by Branch biologists working with colleagues from Quebec and Newfoundland. The aim of the study is to determine the degree of mixing of mainland and Newfoundland stocks, with a view to recommending regulations that would reduce the number of mainland salmon taken by the Newfoundland commercial fishery, while not preventing the harvest of Newfoundland stocks. The assessment group met several times during 1975, but recommendations are not expected until the fall of 1976.

The Greenland salmon catch in 1975 was approx-

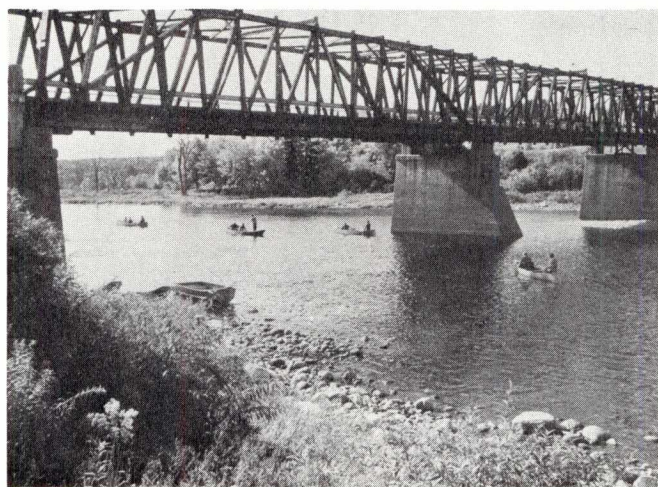
imately 2,000 metric tons. This catch was taken in less than a month (August 20-September 15) and represents a slight increase over that reported for 1974. This year (1975) will be the last that non-native Greenlanders will fish off Greenland, and hence the annual catch should level off at about 1,200 metric tons in compliance with an ICNAF quota. Future prospects for home-water catches look promising. Both commercial and sport fishermen will benefit from a reduction in this distant fishing mortality. Effective home-water regulations will be required, however, if the full benefits of reduced Greenland commercial fishing and improved spawning escapements are to be maintained.

Once again, the salmon run returning to Mactaquac Dam on the Saint John River, New Brunswick, increased. A total of 19,085 salmon and grilse was collected at the Mactaquac fish collection facilities in 1975. Of these, 8,040 were 2-sea-year or older salmon and 11,045 were 1-sea-year grilse. Thirty-eight percent of this run originated from smolts reared at the Mactaquac Hatchery. The rate of return from hatchery-produced smolts has increased about tenfold from the first years of hatchery production, but still remains lower than what we believe to be attainable. The current smolt return rate is about 3%, but hatchery personnel feel this can be doubled within the next five years.

The development of hatcheries as an effective tool of the resource manager has been an important objective of the Resource Development Branch. During the past five or six years, significant progress has been made in making hatchery-produced fish more viable and effective in a variety of fishery enhancement programs. For example, return rates from smolt releases in the LaHave River in southern Nova Scotia have increased from 0.5% in 1968 to 3% in 1975, basically due to improved fish quality and stock selection. Similarly, our trout stocking evaluation program has shown that returns to the angler from yearling releases can be improved at least fourfold in scientifically managed fisheries. A present impediment to broader application of the hatchery tool in fishery enhancement throughout the Maritimes is the lack of biological support for implementation. Almost all professional staff are committed to solving critical problems, involving protecting fish habitat or protecting local salmon stocks from over-fishing in distant fisheries, as well as in local commercial, Indian and sport fisheries.

A mortality of an estimated 400-500 adult salmon occurred in the Restigouche River during June and July. The causative agent was identified as the bacterium *Aeromonas salmonicida* which causes the disease known as furunculosis. This instance was the first confirmed occurrence of the disease in the Maritimes Region and rigid control measures were instituted to prevent its spread.

The International Council for the Exploration of the Sea (ICES) held its Sixty-Third Statutory Meeting in Montreal during October, 1975. This was the first year the Council held its annual meeting outside Europe, and several participating scientists took advantage of the occasion to visit various laboratories and field programs in eastern Canada. The Resource Development Branch organized a tour for the Anadrom-



ICES tour members en route down the Miramichi River.

ous and Catadromous Fish Committee of ICES, and included in the itinerary a canoe trip down the Miramichi River and a "salmonar" in a sport-fishing camp. Both visitors and staff enjoyed the informal atmosphere and benefited from the exchange of ideas and experiences.

Many activities of staff members are not covered in this report. Various Resource Development Branch members have attended scientific meetings, given talks and lectures, presented scientific papers, refereed manuscripts, served on working parties and committees, attended training courses and participated in various community activities of their choice. All of these endeavours play an important role in the success of the Branch. In particular, we were happy to loan Mr. T. G. Carey, Head of our Fish Culture Program, to the UN Food and Agricultural Organization for a year to help organize an international meeting on aquaculture. We will be even happier, of course, to see him return from Rome in July, 1976.

As a result of reorganization, we must say "goodbye" to the Marine Fishery Management Section of the Branch and "welcome" to the Anadromous Group from the St. Andrews Biological Station. It has been a personally satisfying experience working with Neil MacEachern and his group of oyster and marine plant experts, and I wish them well in their future endeavours. I am also looking forward to even closer collaboration with our St. Andrews colleagues who share our interest in salmon and trout. It now becomes a challenge for us all to work together so as to guarantee the success of new organizational structures that are evolving. Evolution is a continual, purposeful process to which individuals and organizations must all submit. It is a process that rewards adaptability.

During the past decade or more, we have developed close working relationships with a large number of agencies — federal, provincial, private and foreign. While most of these will continue, I would like to take this opportunity to express, on behalf of myself and my staff, our appreciation for their past collaboration with the Branch. We look forward to continuing this cooperation with all those who share our concern for freshwater-dependent fish.

C. P. Ruggles, Branch Chief

SCIENTIFIC LIAISON AND SPECIAL PROJECTS

The Scientific Liaison and Special Projects Section plays a support role for the Resource Development Branch in its application of science to Maritime fishery resources. The Section's role is to expedite communication of scientific information and to develop information useful in appraising or refining programs in the various Branch activities.

The external flow of scientific information is the area of communication which receives emphasis. The editor has prepared a guide for Branch writers for use in preparing neat, uniform and clear format for the technical information in publications. Assistance and guidance are routinely provided to the scientific and technical staff to expedite publication of the many kinds of information generated by Branch activities. Scientific reports published by the Branch follow the Fisheries and Marine Service cover-series format. Technical Reports incorporate the results of scientific studies and are distributed widely to colleagues and other interested people. Data Record Reports, listing compilations and tabulations of background data, which are used as reference material for Technical Reports and for answering specific inquiries, are generally not widely available. Internal Reports will contain consultants' reports, proceedings of major meetings, policy development papers, and other material which is confidential or requires a restricted distribution. Information Reports are designed mainly for public consumption and include brochures, semi-technical material, policy statements, and similar items. The fifth type of report is that one publication of which this writing is a part.

The major reporting effort completed in 1975 was the preparation and publication of the Branch's annual summary of activities, the "1974 Report". Increased efforts by Branch staff in 1975 also resulted in the completion of 11 reports in the Technical Series, 17 in the Data Record Series, two in the Information Series two in the Internal Series and one other. In addition to those groups listed above, Branch staff also contributed a number of papers to various outside publications. Those reports and papers available for general distribution are listed at the back of this report.

The editor is supported by our graphic designer, who uses his special skills to integrate illustrative materials into Branch publications and audio-visual requirements. Other operational units within the Fisheries and Marine Service, indeed within Environment Canada, occasionally engage our graphic designer for his special skills in design and illustration. The addition of a graphic camera to our darkroom equipment has added flexibility and speed to the flow of illustrative materials at a more modest cost.

Increased complexity is a characteristic of current fish resource management, enhancement, and development. The Section Head has been involved in developing required assessment, appraisal, and advice for the identification of programs and options.

For example, there has been a rising interest in establishment of a commercial aquaculture industry. The Service has a responsibility for ensuring the continued viability of native stocks of fishes and shellfishes. In order to promote the orderly development of aquaculture, staff prepared some guidelines for the industry which addressed such topics as species limitations, permit requirements, and import prohibitions. Further, an early draft on fishery regulations for aquaculture was assembled.

Another topic of fish development interest is the St. Croix River on the New Brunswick-Maine Border. The anadromous fish resources of this river have been depressed for over a century by man-made obstacles to fish migration and by main-stem pollution. The U.S.A. has implemented an industrial waste control program which should markedly improve water quality in the main stem in 1976. Therefore, an extensive review of the history of actions by concerned agencies was undertaken to collate the background information in one place. In addition, a report was prepared on the problems to be faced if anadromous fish restoration is mounted in the near future. One of the identified problems is the mortality of downstream migrants in the powerhouse turbines. A literature review and an assessment of the physical characteristics of the existing turbines was undertaken to determine the need for studies related to installation of downstream bypass facilities.

The Program Working Party on Atlantic Anadromous Fishes has recognized an interaction between the Newfoundland commercial salmon fishery and the mainland stocks in Quebec and the Maritimes. The Party has instituted formation of a Technical Committee for a more precise identification of that interaction. Staff are involved with ensuring maximum input so that impact on Maritime salmon stocks will be fully recognized.

R. E. Cutting

MARINE FISHERIES

The Marine Fisheries Section undertakes surveys, biological investigations and applied research projects to provide advice and to implement management and development procedures for shellfish and marine plants. The Section also administers a service to provide leases of bottom areas in estuaries and coastal waters for the cultivation of oysters and other mollusks.

In 1975, there was no basic change in the shellfish program from that of the previous year. Many of the projects are of a long-term nature, as better biological interpretation is possible on data which show the long-term trend. One such example is the spatfall monitoring work. This field project was initiated in 1971 and is now in its final year, with the effort concentrated on analyzing and reporting the results. Good progress in recent years has been made in the estuarine resource inventory surveys and, although not all areas have been covered, emphasis is changing from inventory work to application of the information obtained to date for oyster enhancement. The oyster population assessments are of a continuing nature, with the effort concentrated in the heavily exploited areas.

The inventory project on the soft-shell clam (*Mya arenaria* L.) was continued in 1975, and the depuration work was carried on in cooperation with other government agencies and industry.

The current year was the first full operational one for the new Marine Plants Program. The main emphasis has been placed on obtaining the data base necessary for managing the resource. Investigations were concentrated on *Chondrus crispus* (Irish moss) as this species is the most heavily exploited of the six marine algae of commercial value and is the one with the highest dollar value to the harvesters. Although *Chondrus* is harvested in several areas of the Maritimes, the biological investigations have been confined to only two areas, western Prince Edward Island and southwestern Nova Scotia, because of staff limitations.

Details on the various projects undertaken by the Section during the year are described in the following presentations.

N. E. MacEachern

SHELLFISH MANAGEMENT AND DEVELOPMENT

In 1975, the Shellfish Management and Development Unit continued its emphasis on the direct application of biological and technical knowledge to fisheries management and development. Considerable effort was placed on the provision of on-site biological and technical assistance to specific oyster

producers, on the compilation of a comprehensive data base for the management and development of specific high-potential oyster stocks, and on pilot, commercial-scale, clam depuration studies directed at the utilization of bacteriologically contaminated softshell clams.

In shellfish management, the Unit's capability for resource enhancement has been increased substantially through the acquisition of a 42-ft shallow-draft boat, specially designed for work in the shallow bays and estuaries of the Maritimes. With the acquisition of this boat, there has been a shift in program emphasis towards the utilization of resource information accumulated over the last seven years. This shift recognizes that the public fishery areas are the primary source of our present oyster production and are the most likely areas for rapid production increases under proper management.

Estuarine Resource Inventory projects were suspended for the year, so that additional manpower and resources could be directed at a reduction in the number of outstanding lease applications.

In shellfish farming and extension, the Unit continued to provide on-site biological and technical assistance to a number of cooperatives and associations in New Brunswick. Oyster rearing experiments at the Gillis Cove, Cape Breton, field station were de-emphasized in order that the biologist-in-charge could devote full time to the write-up of a major backlog of off-bottom rearing data. Courses in oyster culture and oyster lease management were given in Prince Edward Island and in New Brunswick. A managerial scheme for oyster spat-collection preserves, such as Gillis Cove and Portage Inlet, was developed and successfully implemented.

Shellfish development efforts in 1975 were again directed at soft-shell clam depuration studies and population surveys of potential sources of bacteriologically contaminated clams for depuration. The addition of Dr. Ginette Robert to the staff contributed very significantly to the work of the Unit.

Administration of oyster leasing activities was continued, with additional effort being made to eliminate some of the remaining backlog of lease applications and applications for resurvey. The 1972 leasing policy guide was revised into booklet form for easy distribution and retention by all lessees.

T. W. Rowell

Oyster Spatfall Inventory

A 5-yr program, designed to determine commercially reliable oyster spat collection sites, was completed in 1975.

To date, spatfall data have been obtained for areas in Prince Edward Island and New Brunswick. A summary is presented (Table 1) showing the number of stations, the percentage of stations which caught spat (percent success), and the percentage of stations where more than 50 spat were recorded per scallop shell (percent commercial success). The mean number of spat per station indicates the relative oyster reproduction success from year to year in each area.

In 1975, the oyster spatfall in Prince Edward

Table 1. Summary of oyster spatfall-monitoring data, 1971-75.

Year	Number of stations	Percent success	Percent commercial success	Mean number spat/station
Prince Edward Island				
1971	40	90	30	138
1972	40	68	18	309
1973	40	95	60	574
1974	40	97	62	298
1975	40	95	50	645
Southern New Brunswick				
1971	38	66	26	173
1972	41	56	12	33
1973	44	61	39	93
1974	31	84	35	155
1975	30	83	56	451
Northern New Brunswick				
1971	36	85	22	66
1972	36	56	11	24
1973	40	85	52	181
1974	29	97	18	39
1975	29	97	46	116

Island was good. The mean was the highest in five years, mainly because of a heavy set in the Bideford River system. The number of locations where spat were caught was about the same as last year. However, the number of locations where a commercial set was recorded was lower than in 1974, mainly because of a comparatively low set in Hillsborough River and a complete spatfall failure in Mill River.

In New Brunswick, a comparison between four important locations (Table 2) indicates that 1975 produced the best spatfall in five years. In southern New Brunswick, the Main Buctouche River had a very heavy set, while the Cocagne River continued the steady improvement observed since 1972. In northern New Brunswick, the Baie du Vin River had its best spatfall in five years and the set in Caraquet Bay was just a little below that of 1973.

The warm and generally clement weather of the past summer was undoubtedly the major factor in the overall spatfall success recorded throughout the two provinces this year.

R. E. Lavoie

Oyster Population Surveys

These studies evaluate important characteristics of the major natural oyster populations of the Maritimes. The initial study of a population normally includes such parameters as distribution, density, structure and standing crop. Subsequent surveys indicate changes in these parameters under the influence of natural limiting factors and commercial exploitation, and allow the formulation of specific management recommendations.

In 1975, reassessment surveys were conducted in Caraquet Bay, New Brunswick, and in the Wilmot and Dunk rivers, Summerside Harbour, Prince Edward Island. The initial survey of the Hillsborough (East) River, Prince Edward Island, started in 1974, was completed.

Caraquet Bay

A survey was conducted on the public oyster ground in Caraquet Bay to assess the population response to the changing exploitation pattern of recent years.

At present, the public oyster fishing ground is divided into two parts. The southern half of the bed is bacteriologically contaminated and open for a spring re-laying fishery from May 16 to July 31. The northern half is open to a fall fishery for direct marketing between October 1 and December 31. During the spring fishery, approximately 8,500 boxes of oysters were re-laid from the contaminated area to leases located in Caraquet Bay and in areas as far south as Shediac Bay.

Immediately following the spring fishery, a population survey was carried out over the entire public bed to determine changes in population structure and the effects of the recent fishery. On the southern part of the bed, where the fishery had taken place, the high-density areas were thinned out considerably and overcrowding was not as evident as in the previous year. The high-density areas on the north side, however, were found to be increasing in size, and oyster quality had declined somewhat. This year's fall fishery will serve to thin and cull these high-density areas.

In general, growth and recruitment have compensated for natural mortality and exploitation. The total standing crop of market-size oysters over the entire

Table 2. Mean number of spat per station for four locations in New Brunswick.

Location	Mean Number of spat per station					Overall mean
	1971	1972	1973	1974	1975	
Southern New Brunswick						
Main Buctouche River	515.8	73.5	361.7	538.1	1,206.3	539.2
Cocagne River	— ¹	14.0	71.3	149.3	167.3	100.5
Northern New Brunswick						
Baie du Vin River	25.2	46.8	60.2	26.6	69.8	45.7
Caraquet Bay	135.7	1.4	269.0	75.9	248.3	145.9

¹Station not monitored.



Fishermen landing oysters in Caraquet Bay.

100-acre public fishing ground remains almost unchanged from 1974, at slightly in excess of 50,000 boxes. This represents 17.4% of the population, only slightly less than the 17.9% recorded in 1974. Although not particularly large, recruitment from the 1974 year-class was sufficient to maintain a healthy population structure (Fig. 1). The population has responded well to the increased fishing pressure of recent years and to the changes in the exploitation pattern brought about by the contamination problem since 1972.

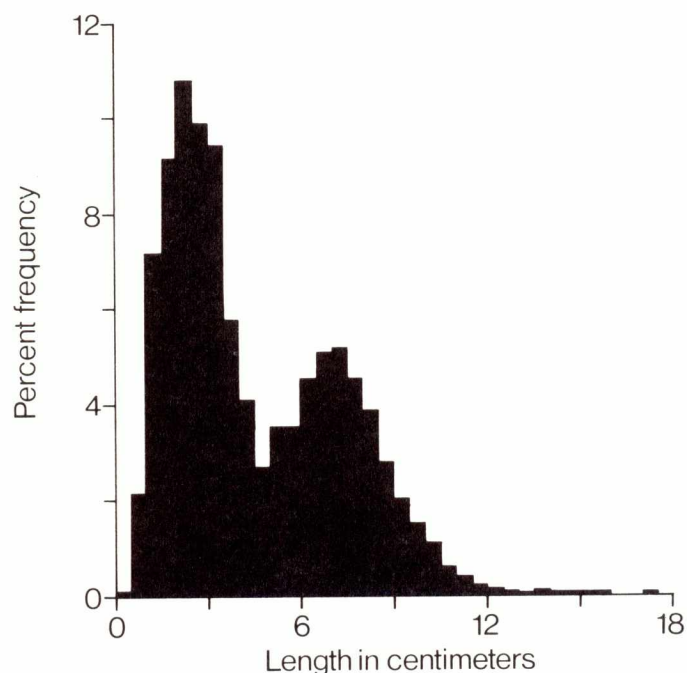


Fig. 1. Length-frequency distribution of oysters in Caraquet Bay, New Brunswick, 1975.

Summerside Harbour

The combined landings from a spring re-laying fishery conducted in the Dunk and Wilmot rivers traditionally make Summerside Harbour the single most important oyster-producing area of Prince Edward Island. Because of their importance, the oyster populations of these rivers have been monitored over the past few years.

In 1974, a very limited survey indicated that the standing crop of market-size oysters in the Dunk River had decreased from its 1973 level, and it was felt that oyster production from the river would decline slightly. However, a more comprehensive population survey conducted this summer showed a significant increase in the availability of market-size oysters, even after the spring fishery had been completed.

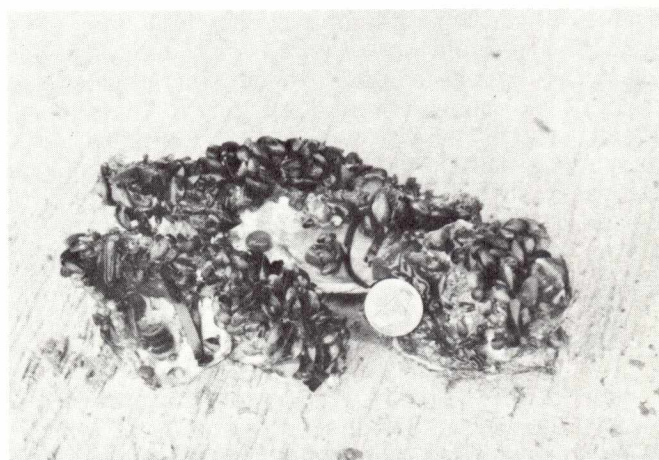
A similar survey was conducted in the Wilmot River, where production has been low for the past several years. A complete analysis of the data has not yet been made, but preliminary results indicate that this river is again capable of sustaining increased fishing pressure.

The exploitation pattern in the Wilmot River has already changed in response to the population improvement, with fishing pressure higher this year than in 1973 and 1974. Although no reliable figures are available at this time, the landings from the Wilmot appear to have supplemented those of the Dunk to the extent that the total 1975 landings from Summerside Harbour are slightly increased over those of 1974.

Hillsborough River

In 1975, an oyster population survey was carried out on the main production areas of the Hillsborough River, Prince Edward Island. The purpose of the survey was to supplement existing knowledge of the population for management purposes and to assess the impact of a large-scale re-laying project conducted over the past three years. The re-laying project has been conducted by the provincial Department of Fisheries since 1972, in an attempt to expand the fishing ground.

The donor area for the required oyster stocks is about 3.5 mi in length and 150 acres in area, and lies in the vicinity of Cranberry Wharf. Most of the population is in the channel, at low-tide depths of up to 8 m. Only about 25 acres are located in water shallow enough to permit fishing by conventional tonging methods. Oysters for the re-laying project were removed from the deeper areas. A complete assessment of the data has not been made, but indications are that the deep-water population has not been detrimentally affected.



Mussel fouling of oysters in Hillsborough River.

The receiving area consists of approximately 70 acres of shallow beds below Glenfinnan Island. Although oysters planted on the new beds have suffered mortalities as a result of siltation, mussel fouling, and starfish predation, it is evident that the program has succeeded in improving the quality of the transplanted oysters.

Cocagne River

An oyster population survey was carried out in Cocagne River, beginning at the boundary of the contaminated zone below the old highway bridge and continuing about 4 mi upriver. The river was found to support a population which is typical of many small rivers, with dense concentrations of oysters on either slope of the channel. In the upper reaches of the river, these concentrations were confined mainly to the outside slope of bends in the channel. The population structure indicates that recruitment has been regular over the past few years, with all year-classes being well represented.

R. E. Lavoie

Management of Natural Oyster Populations

This section reports on the action taken and the results obtained in oyster-producing areas where the Branch has conducted studies and prepared recommendations in response to requests and proposals received from the industry and the public.

Buctouche River

For three years previous to 1975, the Buctouche Bay Oyster Cooperative in New Brunswick was granted a permit to drag oysters from the section of the Buctouche River channel between Priest Point and the old railroad bridge. After dragging operations were completed in 1974, a total 3-yr quota of 3,300 boxes of unsorted oysters and shells had been fished and re-laid on the Cooperative's leases.

The impact of this experimental fishery on the oyster population has been monitored by annual survey. The 1975 survey confirmed that the dragging operation did not seriously damage the oyster population, and the Cooperative was granted another permit to drag a maximum of 1,600 boxes of unsorted oysters (including spat and shells) from the same section. The quota was reached prior to July 15. It is estimated that about 600,000 oysters of all sizes were re-laid. The quality breakdown of the market-size oysters was as follows: choice, 11%; standard, 40%, commercial, 49%. This poor quality is representative of oysters in this area of the channel. Thinning of these stocks and the growth, under cultivation on leases, of the smaller oysters will lead to a marked improvement in their quality and value.

Richibucto River

In 1974, a special permit was granted to the Village Bay Oyster Company of Richibucto Village, New Brunswick, to drag oysters of all sizes from a section of the Richibucto River channel located

immediately upstream from the Main River bridge. A prior survey had revealed the presence of an unexploited oyster population in that portion of the river, at depths varying between 9 and 11 meters. At these depths, it is virtually impossible to fish oysters with tongs and rakes. The survey indicated that the population suffers from clustering and that, before reaching market size, most of the oysters are forced into the muddy bottom and perish.

To allow utilization of these oysters for lease stocking, the Company was granted a second permit to fish a maximum of 500 boxes of mixed oysters and shell. A total of 412 boxes, about 100,000 oysters of all sizes, was re-laid. The quality breakdown of the market-size oysters was: choice, 12%; standard, 28%; commercial, 60%. As with the Buctouche Channel oysters, it is anticipated that the quality and value of the smaller oysters will be increased significantly as a result of this transfer.

R. E. Lavoie

Resource Enhancement Projects

This section reports on projects involving physical manipulation of natural oyster populations and habitats in order to improve the quality and the quantity of oysters available to the fishery. The projects are based on knowledge obtained from resource inventory surveys, oyster population studies and historical or statistical records of formerly productive areas. Preparation and execution often involves cooperation with other federal and provincial agencies, as well as with the industry. The Branch's newly acquired resource enhancement boat played a major role in the 1975 projects. Although it is too early to fully assess the impact of this year's work, a preliminary evaluation of the results is given whenever possible.

Caraquet Bay

The public fishing area in Caraquet Bay, northern New Brunswick, contains a large shell-bed, much of which produces high-quality oysters. However, the easterly section of this bed, although obviously quite productive at one time, is now almost completely barren.



New boat acquired in 1975 for use in Branch oyster enhancement projects.

Since the bottom in this section of the bed appears highly suitable for oyster production, an experimental management project, using the new resource enhancement boat, was initiated. A 15-acre area was dragged to clean the bottom and expose natural shell for larval attachment. Bottom conditions were obviously much improved by the cleaning. However, because of the late date of delivery of the boat, the work was probably carried out too late in the season to produce maximum results.

North St. Simon River

It appears that after Malpeque Disease destroyed the oyster population of the North St. Simon River, Gloucester County, New Brunswick, the lack of fishing activity allowed eelgrass invasion and siltation to take place. The empty shells of the defunct population lay under 10-15 cm of mud, unavailable as cultch to oyster larvae. Despite siltation, the bottom is still firm enough to support oysters of good quality.

Various studies conducted since 1971 indicate that the limited population in the channel of the river is producing spat, and that lack of cultch is the limiting factor preventing the reestablishment of oysters over a much larger area.

In late July, a limited attempt was made to remove eelgrass from the bottom and expose the natural shell buried in the mud, by towing open drags over the bed. This procedure had to be abandoned as the fully grown eelgrass was fouling the drags, thus reducing efficiency to almost nil. Such an operation would be beneficial only if conducted during the early stages of eelgrass growth.

In order to assess the spat collection potential should bottom cultch be exposed, a total of 85 boxes (2.5 metric tons) of mixed shells was spread over an area of clean bottom during spatfall. It is estimated that the introduced cultch caught 70 spat per kilogram of shell.

Cooper Bed Reserve

The Cooper Bed Reserve, an area of approximately 15 acres, is located at the mouth of Goodwood (Bideford) River in Malpeque Bay, Prince Edward Island. It contains an estimated 4-5 acres of hard shell bottom. Oysters produced on this bed are of excellent quality, and as recently as 15-20 years ago it was producing several hundred boxes annually. Recruitment, however, gradually declined, until the oyster population eventually reached the stage where it was no longer practical to fish the area. Since it was no longer cultivated by fishing, the entire bed became badly fouled — part of it overgrown with eelgrass — and the oyster population was virtually eliminated.

It was felt that this bed, being conveniently close to the Ellerslie Station, would be a good area on which to carry out experimental management projects, involving the use of cleaning drags to remove eelgrass and condition the bottom for oyster spat collection. In order to repopulate the bed, more than 150,000 high-quality seed oysters from the Conway Narrows Reserve were re-laid onto a newly cleaned area.



Use of a cleaning drag to remove eelgrass from an oyster bed.

It is intended to continue cultivation of the bed to bring it into production and to evaluate techniques whereby formerly productive oyster beds can be rehabilitated.

Summerside Harbour

Oyster population surveys in the Dunk and Wilmot rivers of Summerside Harbour, Prince Edward Island, provided sufficient biological information to allow the design of an oyster enhancement project for the area. The objectives of the project were to improve oyster quality on the existing beds and to increase the size of the oyster producing areas in the bay.

Oysters were fished from over-crowded areas of the beds where shell quality is low and transferred to barren areas of good bottom located outside the main beds. The project was a federal-provincial endeavour, in which the Resource Development Branch designed the project, provided the guidelines and monitored the execution on a daily basis; and the Prince Edward Island Department of Fisheries carried out the operational aspects of buying the oysters from the fishermen and re-laying them to the receiving grounds.

Between August 14 and September 9, 3,985 boxes of oysters were re-laid. In the Dunk River, a total of 3,015 boxes was taken from 12.5 acres of a high-density oyster bed and spread over 15.5 acres of receiving grounds. In the Wilmot River, 970 boxes of oysters were taken from 8.2 acres of high-density oyster bed and spread over 4.5 acres of receiving

grounds.

A preliminary assessment conducted in October revealed that no unusual mortality took place on the donor grounds as a result of the fishing activity. The survival of the transplants on the receiving grounds was 72.5% in the Dunk River and 88.8% in the Wilmot River as of October 15.

Shemogue Harbour

The Shemogue Harbour oyster enhancement project in Westmorland County, New Brunswick, was continued on a limited basis in 1975 (Fig. 2). An assessment of 1974 activities was also conducted.

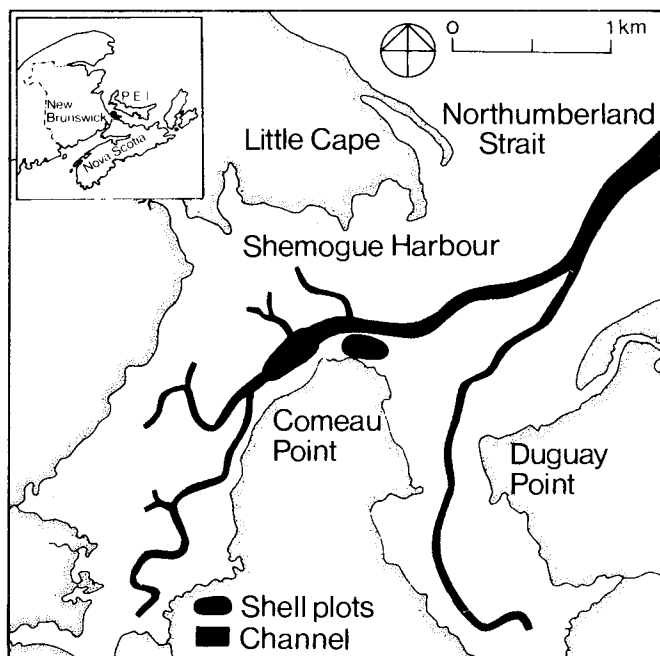


Fig. 2. Location of oyster enhancement project in Shemogue Harbour, Westmorland County, New Brunswick.

This project was initiated in 1974, with the objective of restoring oyster production in the harbour. This area has a reputation for producing high-quality oysters. In 1974, a limited amount of oysters from the Conway Narrows oyster farm and from the Buctouche River channel had been transplanted to different locations in Shemogue Harbour, to test growth and survival and to increase the very limited natural broodstock. Spatfall monitoring stations were also established to determine the feasibility of natural spat collection in the area. Spatfall monitoring was continued in 1975.

Results on the operation of five spatfall monitoring racks in 1974 and 1975 indicated no set. However, at these same locations, a light natural oyster set took place on bottom material in 1974. In 1975, no on-bottom monitoring of these sites was conducted.

In 1975, 2.5 metric tons of clean shell were spread prior to the spawning season in the vicinity of Comeau Point, an area where some young native oysters had been found. A short examination conducted in October failed to reveal any evidence of an oyster set on these shells.

Several factors may be responsible for the limited reproduction success indicated to date: the brood-

stock may be too small to produce large quantities of larvae, the broodstock may be too widely scattered to ensure sufficient egg fertilization, and the considerable tidal exchange may flush most of the larvae out into Northumberland Strait. It is possible that a well-located transplant of broodstock could alleviate the problem.

The experimental transplants were more encouraging. In August and October 1974, a total of 95,000 good-quality mixed oysters from Prince Edward Island had been spread on four plots in the west branch of Shemogue Harbour. At the end of May 1975, the survival on the two plots in the northern portion was 77% and 78% respectively. Two more southerly plots, in the Comeau Point area, had survival rates of 40% and 53%. These lower survival rates can be attributed mainly to dead eelgrass accumulation on the plots and to shifting sand.

The transplants from the Buctouche River were spread on five plots in Shemogue Harbour, three in the east branch and two in the west. These were low-quality oysters of all sizes, which had been fished from the channel of the Buctouche River in June, 1974. These oysters adapted well and spawned in 1974. The winter survival was very good, ranging from 75% to 90%. They grew an average 1.47 cm. Their meat quality and flavour was comparable to that of the native oysters. Shell shape and hardness showed considerable improvement.

R. E. Lavoie

Estuarine Resource Inventory

Estuarine resource inventory surveys have been conducted on a continuous basis since 1971, in order to estimate the oyster growing potential and to determine the distribution and importance of various shellfish species in the bays and estuaries of the Maritimes. Information on the results of previous and current management projects are also obtained from these studies. During 1975, this activity was given a lower priority, and only one survey was carried out — in South St. Simon Inlet, Gloucester County, New Brunswick.

This area contains approximately 75 acres of firm mud bottom in depths suitable for growing oysters. It also contains approximately 25 acres of firm bottom in shallow water, where oysters can be picked by hand. Another 50-75 acres of bottom was considered marginal for oyster culture. The remainder of the area, including the entire easterly section, contains soft mud bottom covered with a heavy growth of eelgrass and is unsuitable for oysters.

A large part of the area of firm mud bottom is covered with eelgrass; in some sections this is heavy enough to interfere with oyster growing. This area also contains patches of shell either on top of the firm mud or buried several inches deep. It was considered that harrowing the area with cleaning drags would probably improve bottom conditions and increase the possibility of getting a catch of spat. An experimental plot on seven acres of this area was cleaned, using two large drags towed by the newly acquired resource enhancement boat.

When the plot was examined after dragging,

bottom conditions were considerably improved. A large amount of eelgrass had been harrowed out and a considerable amount of old buried shell had been exposed for spat attachment. Later examination of the plot indicated a light set of oyster spat.

Oysters in limited commercial quantities were found in a few sections, particularly in the vicinity of Bandy Island and on the picking area where oysters have been fished commercially during the past few years.

W. A. England

On-Site Technical Assistance to Industry

A considerable amount of on-site technical assistance was again given to the oyster producers in Kent County, New Brunswick. The spatfall monitoring program was refined and an oyster larvae monitoring program was added, following the purchase and installation of a "Unitron-BN" plankton microscope in the field laboratory at Buctouche.

The Buctouche, Richibucto, Grande-Digue and Cocagne river systems were monitored for oyster larvae and spatfall in 1975. Forty-five daily monitoring stations and 56 seasonal stations were selected. Observations were recorded from June 1 to September 30 on oyster gonad development, larval size and density in the plankton, water temperature and

salinity, and general weather conditions. Oysters were first observed to have spawned on June 27 and larvae were found in the plankton samples two days later. The first spat were collected on the monitoring shells on July 9. This unusually short larval period (12-15 days) was undoubtedly favoured by the high water temperatures preceding and during the larval stage of development. Peak settlement occurred July 23, with a 24-hr set of 421 spat per shell. Spat collectors — totaling 48,402 shellstrings (15 scallop shells per string), 22,000 cement-coated wood-veneer rings, and 400 cement-coated egg-crate filler bundles — were deployed in the Buctouche River by Kent County oyster producers when advised by the monitoring team. All collectors took a commercially successful set, and survival after two months appeared to be excellent (Fig. 3).

In the Grande-Digue and Cocagne river systems, spatfall was generally light, with only 3 of 17 monitor stations showing a significant set. Spatfall in the Richibucto River system was insignificant. As in 1974, none of these rivers produced a commercial set, and it is unlikely they can be used as reliable sources of spat.

In an effort to discover a less expensive means of obtaining seed oysters for cultivation, other cultch materials were tried as alternatives to the spat collectors presently in use. Soft-shell clam shells, placed in 55 × 83-cm vinyl mesh bags, proved to be

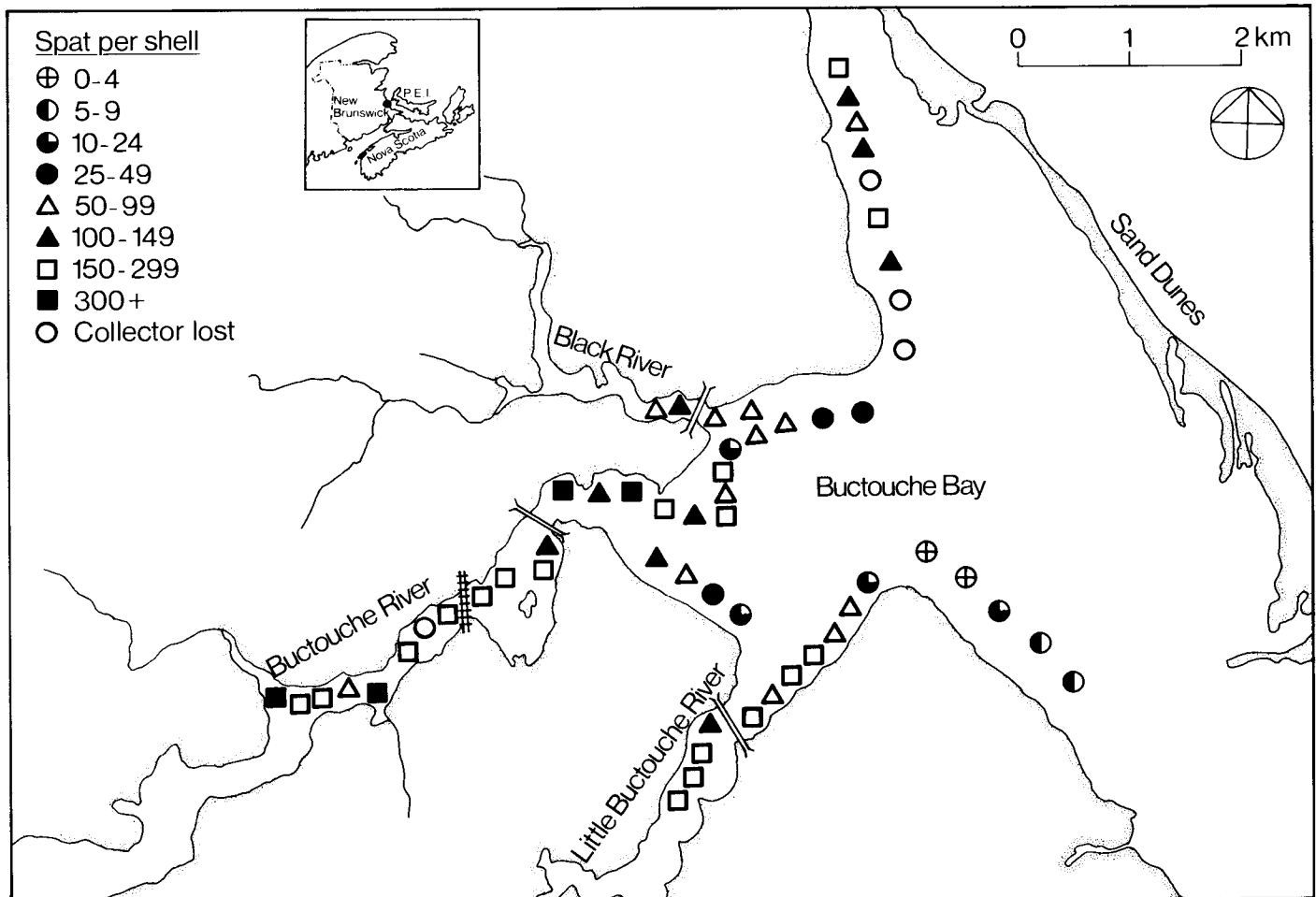


Fig. 3. Average 2-month survival (per 10-cm-diam scallop shell) of commercially collected oyster spat in Buctouche Bay, 1975.

the cheapest collector tried. Cement/sand-coated scallop shellstrings were effective in obtaining a good set, but were awkward and heavy to handle. The coating did facilitate the removal of spat from shells, however, and further refinement of the technique could prove profitable. Freshly shucked scallop shells with organic material on the shells were as effective as shells cleaned by exposure over winter. Two patented West Coast spat collectors were assessed. The "cultchette" type took a very heavy set — so dense, in fact, that growth may be retarded and the oysters may become badly misshapen if not thinned out. This collector is designed to disintegrate after two seasons of growth, thus enabling the oysters on it to be separated readily. Another collector, the "Lawrence" type, was unmanageable due to its size and weight. The setting surface of this collector is designed to fragment as small diamond-shaped cement chips, which facilitate removal and separation of the small oysters. During handling, more than half the cement chips fell out prematurely. Assessment of these collectors will continue, with oyster growth and survival being monitored after placement on the bottom. The cost of producing and harvesting oysters by each method will then be determined.

A detailed inventory and assessment of the oyster stocks of the Buctouche Bay Oyster Producers Cooperative Ltd. was carried out during the summer of 1975. The manpower to do the field work was supplied by New Brunswick Newstart and the New Brunswick Department of Environment and Fisheries. Bottom characteristics, associated biota of the leases, and quantity, size-distribution and quality of the oysters present were assessed. The quantity and quality of shellstring and tray stocks were determined. An estimate was made of the numbers of oysters which would be of marketable size in 1975 and subsequent years. Methods for improving the grade quality and production of oysters were recommended. The results of this assessment were presented as a report to the Cooperative.

A. R. McIver and P. Woo

Management of Oyster Spat-Collection Activities

Oyster farming in some areas of the Maritimes depends heavily on the collection of oyster spat from natural sources. The number of places where dependable spatfall and survival has been monitored and documented is still quite small and, in Cape Breton particularly, there has been some conflict between growers in the use of spat-collection sites. This year a collector quota and space allocation system was developed as a means of managing two of these areas. The system was also designed to control the total spat set, through limiting attachment substrate, in order to ensure against overcropping of the primary food source by the spat. Quotas were fixed for each company or cooperative wishing to collect spat in Gillis Cove and Portage Inlet. The industry participated in developing the quotas and cooperated by adherence to the numbers of rafts and collectors agreed upon.

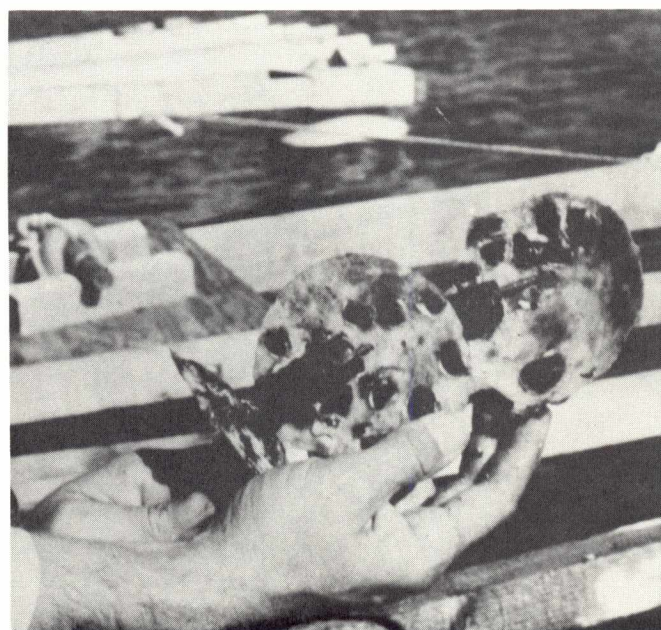
Nineteen seventy-five was a successful year for



Collecting rafts in Portage Inlet spat reserve.

the commercial collection of spat in most areas of Cape Breton. For most areas, the major set took place between July 7 and August 4. At Gillis Cove, the peak set of spat (5,000/shell/24 hr) occurred on July 25. Spat survival to two months is summarized (Fig. 4). This gives a good indication of the effective commercial set in each area of the River Denys Basin. The distribution of the set in Gillis Cove was studied in detail to determine the settlement pattern of the oyster larvae and aid collector allocation in future years. The set was generally heaviest in the upper two-thirds of the water column, with the maximum set in all parts of the cove occurring at a depth of 0.5 m.

A. R. McIver



Three-month-old oyster spat on scallop shell collector, Portage Inlet.

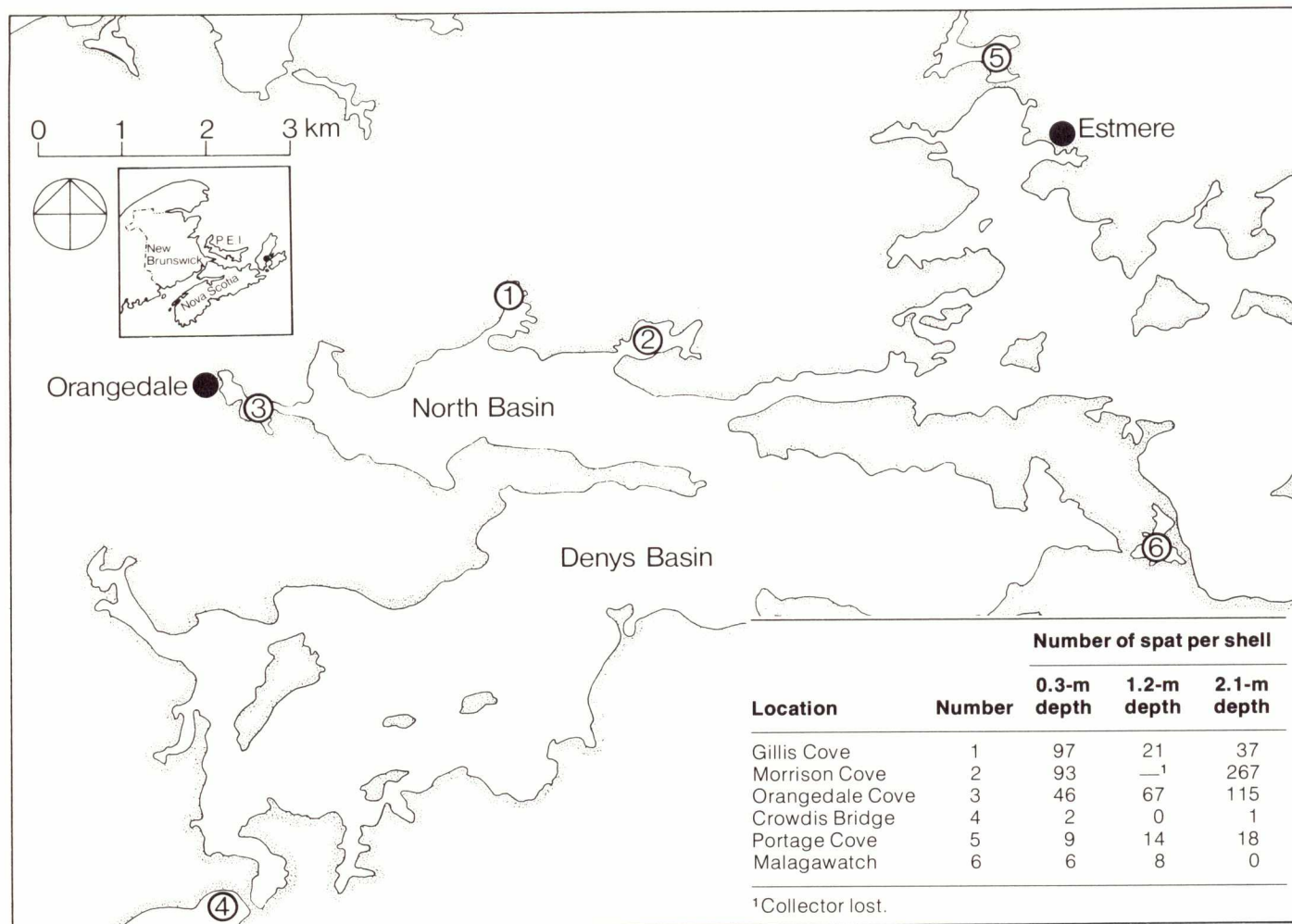


Fig. 4. Spat survival to two months in commercial oyster farming operation, River Denys Basin, Cape Breton, 1975.

Oyster Farming Courses

Emphasis on the development of technical and managerial skills in the key members of oyster farming groups was continued in 1975. A one-week course in oyster culture techniques was presented at the Biological Sub-Station, Ellerslie, Prince Edward Island, and was attended by managers and technicians from oyster farms throughout the Maritimes. Along with formal classroom instruction and related field work, the course was designed to promote the free interchange of ideas between students. The program included such topics as larvae identification, weather and hydrological recording, spatfall monitoring and prediction, oyster farming methods, and stock inventory and assessment techniques. Methods of harvesting and processing were compared, and the relative costs and labour requirements were examined. The course was given in cooperation with New Brunswick Newstart and the Prince Edward Island Marine and Fisheries Training Centre.

A general oyster farming course was given in Baie Ste. Anne to a group sponsored by the New Brunswick Social Services. This included practical instruction in the preparation and deployment of spat collectors.

It has been recognized for some time that there is a need for an up-to-date, technically accurate and

easily readable training manual. This requirement became even more apparent in the preparation and presentation of the previously mentioned courses. A manual of this type is now being developed in manuscript form and, hopefully, will be published in 1976.

A slide and photo library is also being developed and "super-8" films are being produced to illustrate oyster farming techniques.

A. R. McIver



Oyster farming course lecture at Ellerslie, Prince Edward Island.

Soft-Shell Clam Inventories

Further surveys were carried out on moderately polluted tidal flats of the Annapolis Basin, Nova Scotia, in order to gain a better knowledge of their potential for softshell clam (*Mya arenaria*) production. The clam resource of these areas is not presently exploited, but this situation may be improved if commercial depuration proves feasible.

Surveys took place in the following regions of the Annapolis Basin: the Raquette, Joggins River, Smith's Cove, and sections of the Annapolis River. Preliminary analysis of the data show better-than-average densities (more than 60 bushels per acre) at most locations sampled, particularly of market-size clams. Recruitment over the past few years seems to have been low but consistent.

Studies on the distribution of clams in different types of bottom substrates were carried out in the Raquette area. Results indicate that distribution of the clam is correlated with its size; small ones being aggregated and larger ones being randomly dispersed.

Smith's Cove, a small heterogeneous clamflat, was used to test the reliability of sampling techniques presently being used to assess clam populations. Applied to a sizeable clamflat of uniform bottom conditions, these techniques work satisfactorily. However, replicate sampling at Smith's Cove indicated a variability in clam quota estimates of as much as 30%, demonstrating the importance of more intensive sampling and the need for refinement of analytical procedures.

G. Robert

Soft-Shell Clam Depuration

A pilot depuration plant was operated on an experimental basis in the Annapolis Basin area during June, July and August. These trials, a follow-up to those conducted in 1974, were made possible through the cooperation of the Fisheries and Marine Service, the Nova Scotia Department of



Loading baskets of soft-shell clams into a depuration tank.

Fisheries and Allan Fisheries of Digby. Engineering improvements, primarily in the pumping equipment, brought reliability to the system and allowed proper control of the experiments.

The trials, conducted on a semi-commercial scale, were designed to establish those factors of greatest importance to successful depuration. Quality of the seawater supply and particular steps in the operational methodology appear to be the main factors influencing a reduction in bacterial level in the clams. Seawater parameters, such as temperature, salinity, turbidity, dissolved oxygen and pH must resemble as closely as possible those encountered in the natural habitat of the clams being depurated. Good bacteriological quality of the raw seawater is necessary to maximize the effectiveness of the ultraviolet light treatment.

In a flow-through depuration system, the trials indicate that the following procedures are sufficiently reliable if the bacterial load of the shellstock to be depurated does not exceed certain limits (Fig. 5, cf "zero-hour"). During depuration, it is necessary to drain and clean the depuration tank and to carefully hose the holding baskets after 18 hr of the 42-hr depuration schedule. Water flow rate must be sufficient to maintain the oxygen level required in the tank. A flow rate of 0.5 gpm/bu of shellstock was found optimal. As a quality control, bacteriological sampling was performed on the shellstock at 0 hr, 18 hr and 42 hr of the depuration schedule. Additional analyses were conducted on the UV-treated water and the tank water, to evaluate environmental and bacteriological quality throughout the depuration cycle.

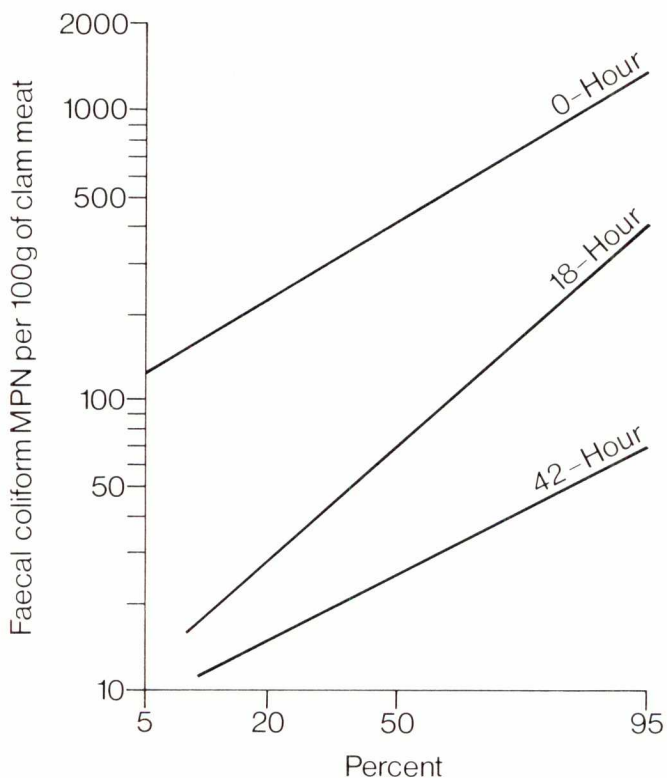


Fig. 5. Probability plot of faecal coliform MPN of depurated lots of soft-shell clams at different periods of depuration time.

During the course of the trials, some lots of shellstock treated similarly did not reduce their bacterial load sufficiently to meet the standard for depurated clams within the 42-hr depuration period. In these cases, the initial load of coliform bacteria, as shown by the faecal coliform count of the shellstock at zero hour, was often as much as ten times greater than the initial counts of lots that depurated. This indicates an upper limit to the initial bacterial load, which, if exceeded, is unlikely to give positive depuration within a reasonable period of time. It is therefore important to know the zero-hour coliform count of the shellstock to be depurated within a very short period of time, and to eliminate those stocks where the likelihood of successful depuration within a reasonable time frame is low. The bacteriological techniques now being used require 48 hr to establish the zero-hour count. By the time it is known, the particular lot has been through the complete depuration cycle whether it was worth it or not. The zero-hour count can be determined in 24 hr or less through



Bacteriological sampling by the multiple-tube dilution test, to evaluate coliform bacteria level in clams.

improved bacteriological sampling techniques, such as the Elevated Temperature Plate Count. For commercial operations it may be necessary to predict trends in the "zero-hour count" by intensive sampling of the clam shellstock over an extensive period of time, say a year, taking into account the effects of summer temperatures, heavier rainfall than usual, seasonal activities like tourism, boating, etc.

G. Robert

Oyster Lease Administration

During the year, 93 new applications for oyster lease surveys and resurveys were received. These new applications, combined with a backlog of 301 applications on file prior to January 1975, gave a total of 394 applications.

In order to reduce the backlog, it was decided to give lease surveys a high priority and to add an additional survey crew for the year. The two crews

disposed of 243 applications, through a combination of surveys, resurveys and withdrawals by the applicant — when informed of the unsuitability of the bottom for oyster culture or when advised by the surveyors that the sites were in bacteriologically contaminated areas or public fishing areas. There are still 151 outstanding applications for survey or resurvey: 44 in Prince Edward Island, 60 in New Brunswick and 47 in Nova Scotia.

The 1972 leasing policy has tended to slow the increase in number of leases, and to promote both the use of larger leases and the consolidation of existing ones. This is particularly apparent for Prince Edward Island (Table 3), where the total number of leases decreased by 34 and the acreage remained virtually the same. For the Maritimes as a whole, there was an increase of 41 leases and 443 acres.

Table 3. Summary of the numbers of oyster leases and acreages of bottom leased in the Maritime Provinces.

Province	Leases		Acres	
	1974	1975	1974	1975
Prince Edward Island	1,089	1,055	4,448	4,453
New Brunswick	804	822	2,375	2,640
Nova Scotia	273	330	1,680	1,853
Totals	2,166	2,207	8,503	8,946

A total of 25 original master-leasing sheets was prepared for oyster leasing in new areas where maps were not available. Revisions of 460 maps were completed, and a new map index system was devised to facilitate use of the maps by the leasing group, the District Protection Offices and other government agencies such as the Environmental Protection Service. Fifty-two leases were cancelled, either on request of the lessee or for non-payment of rental.

The 1972 oyster leasing policy guide was revised into booklet form, for easy distribution, retention and use of lessees.

L. A. England

MARINE PLANTS PROGRAM

Six species of marine plants are commercially harvested in the Maritimes Region. However, one, *Chondrus crispus* (Irish moss), has greater economic importance than the combined total of the other five. Of the 66,598,000 kg of marine plants harvested in 1974, 85% consisted of *C. crispus*. Little is known biologically about any of these but, because of the economic importance of *C. crispus*, studies in 1975 were confined to this species.

The program initiated in 1975 is ongoing, designed to procure that data deemed necessary to permit successful resource management. Four separate studies were carried out; one involved an assessment of harvesting technology and the other three were biological in nature. A brief description of each study is given below, along with a preliminary assessment of certain data.

Harvesting Technology

The location of commercially important beds of *C. crispus*, the number of harvesters working these beds and the harvesting techniques employed have not been well documented in the Maritimes Region. To adequately manage a marine plant resource, this information is required. It is also important to know the home ports to which the harvesters of an area belong and the number of harvesters per port. The two areas with the largest number of harvesters, western Prince Edward Island and southwestern Nova Scotia, were surveyed in 1975 to obtain this basic knowledge (Fig. 6).

The area surveyed in western Prince Edward Island extended from Cape Wolf to Alberton. Six harbours were identified as the home ports of the boats observed in this area, with Miminegash having the largest number. The daily mean number of boats in this area for June, July and August was 141, 229 and 65, respectively, and harvesting took place on 23 separate beds. The proportion of harvesting effort per bed varied greatly, with Pleasant View and both Roseville South and Roseville North attracting the greatest number of harvesters. The majority of boats employed for harvesting *Chondrus* in this area are traditional lobster boats, which range in length from 7.5 m to 13.5 m.

The extent of the ecological impact of marine plant harvesting here may vary significantly with the method of lowering and raising the rakes. There are

two main methods, one being the use of two steel booms, half-inch cable and a pair of winches. The boats using this technique will be referred to as "winchers". The other method simply employs the lobster-trap hauler and the rake is attached with rope.

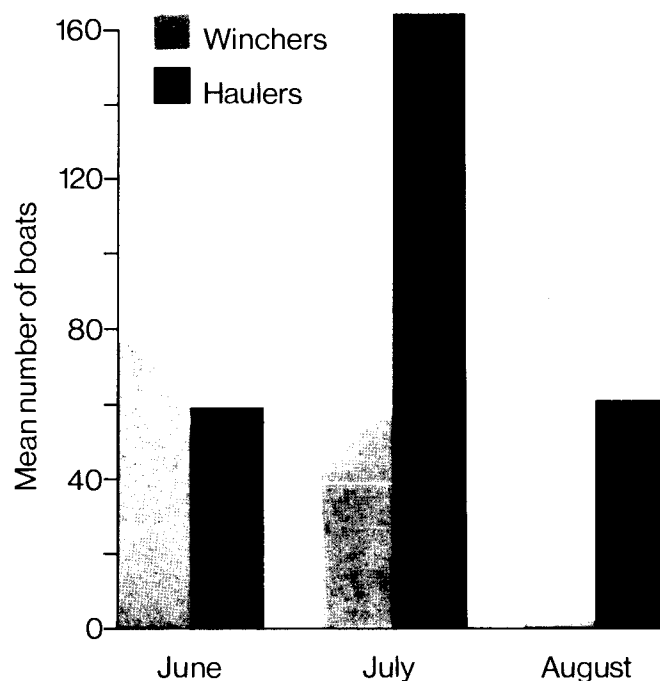


Fig. 7. Methods of harvesting *Chondrus* in western Prince Edward Island, 1975.

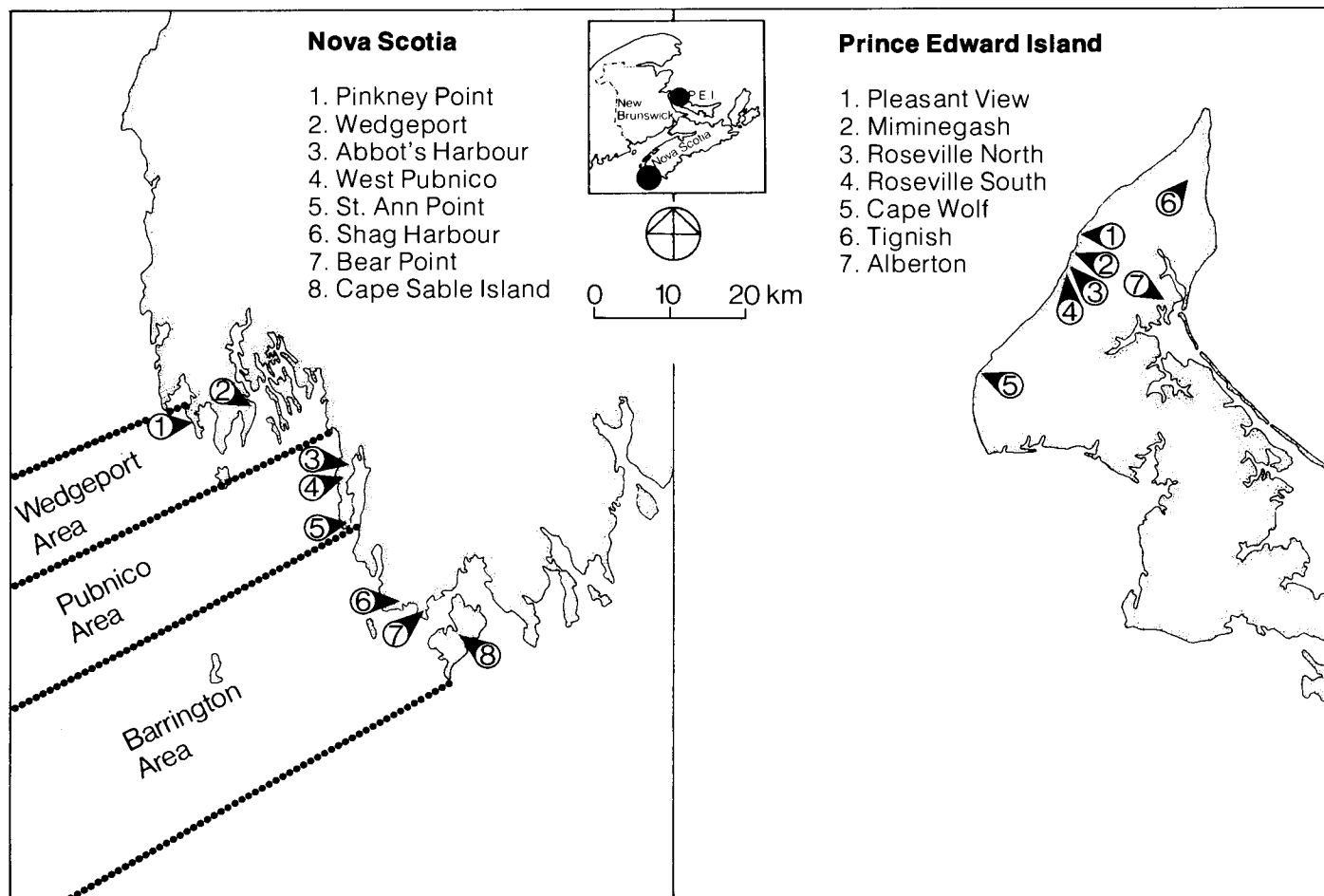


Fig. 6. Major harvesting areas for marine plants in the Maritimes, 1975.



Boat harvesting Irish Moss (*Chondrus crispus*) with typical drag rakes.

These boats will be referred to as "haulers". The former method permits a much larger rake to be employed, and the towing speed is generally much faster than when the latter technique is employed. During June, there were more winchers than haulers; but the number reversed in July, and by August few winchers were observed (Fig. 7). It was generally felt by the harvesters that later in the season the method employed by the haulers was more efficient.

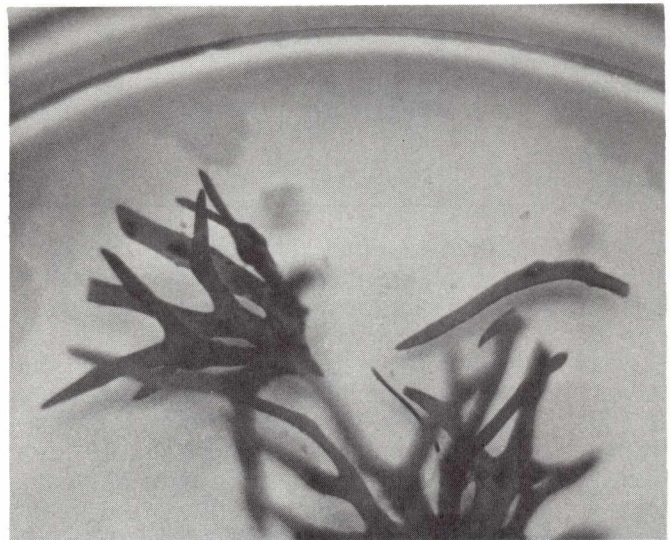
In southwestern Nova Scotia the harvest survey was conducted from Pinkney Point to Cape Sable Island, and the area was divided into three sections: Wedgeport, Pubnico and Barrington (Fig. 6). Along this coast, with the exception of approximately 20 dragrakers, harvesting is carried out by handraking from small, 4-5 m dories. Boat counts were made, and locations of both home ports and commercial beds were noted. Approximately 180 harvesters were counted in each section. In the Wedgeport section, the harvesters came from 17 harbours, with Sluice Point, Pinkney Point and Wedgeport having the greatest numbers. Harvesting took place on approximately 24 beds. The boats came from six harbours in the Pubnico section; the two with the greatest number were Camp Cove Wharf and Abbott's Harbour. Sixteen beds were identified in this section. Of 12 harbours noted in the Barrington section, the three largest were Woods Harbour, Bear Point and Shag Harbour. Twenty-one beds were identified here.

Ecological Impact of *Chondrus* Harvesting

It is important that methods be employed in the harvesting of marine plants that will not adversely affect future populations of the species harvested, nor those of any other commercial species in the community. Of particular interest is the effect of *Chondrus* harvesting on lobster, as both frequently occur together.

Chondrus is a perennial, with a holdfast that has the ability to regenerate. Four morphological classes have been described which frequently occur on the same holdfast. These morphological classes may indeed be age-classes and, if this is the case, it is likely the Class IV plants are the most mature. For the conservation of *Chondrus*, harvesting techniques should not be employed that remove the plant holdfasts nor the immature plants (Classes I and II).

It is important to understand the *Chondrus* association as well; consequently, the other taxa in the harvests were sorted, identified and weighed.



Sample of female (*Chondrus*) plant, showing dark patches of released spores.

There appears to be a significant difference between the handrakes and dragrakes in the percentage of each of the four morphological classes harvested. Classes I and II made up 26.5% of the harvest from the handrakes and 59.9% of the harvest from the dragrakes (Table 4). The high incidence of these two classes in the harvest from the dragrakes may be a function of the number of holdfasts removed. There is some evidence that more Class I and II plants bear holdfasts than do the more mature plants (Table 5). Plants attached to holdfasts made up 5.6% of the harvest from handrakers and 28.3% of the harvest from dragrakers.

Few, if any, lobsters are harvested or injured where handraking is carried out (Table 4). Dragrakes, however, both injure and capture lobster. Observations in Miminegash showed 2.5 lobster per harvesting hour were brought on board, whereas 1.6 per hour were caught in Tignish. It was noted that the lobsters caught on the Miminegash beds were considerably larger than those observed from Tignish.

Table 4. The four morphological classes of *Chondrus* plants harvested and incidental capture of lobster, during observations of commercial operations in 1975.

Area observed	Harvesting gear employed	Hours of observation	Total number of <i>Chondrus</i> plants observed	Percentage of plants collected in each morphological class				Number of lobsters observed per hour of harvesting
				I	II	III	IV	
Western Prince Edward Island								
Miminegash	Dragrakes	381	192,286	23.4	35.5	29.7	11.5	2.5
Tignish	Dragrakes	80	31,186	18.2	42.7	31.5	7.7	1.6
Southwestern Nova Scotia								
	Handrakes	— ¹	44,307	4.3	22.2	42.4	31.0	0.0

¹Observations were periodic.

Table 5. Frequency of *Chondrus* plants bearing holdfasts in commercial harvesting, 1975.

Area observed	Harvesting gear employed	Total number of plants collected bearing holdfasts	Percentage of plants harvested bearing holdfasts	Percentage of plants bearing holdfasts in each morphological class			
				I	II	III	IV
Western Prince Edward Island							
Miminegash	Dragrakes	62,376	31.3	65.8	21.6	11.1	1.5
Tignish	Dragrakes	8,405	25.3	59.8	28.2	11.6	0.6
Southwestern Nova Scotia							
	Handrakes	2,467	5.6	54.8	15.4	22.1	7.6

With regard to holdfast removal, the taking of immature plants and the effects of raking on lobster, it would appear that handraking is far less deleterious than dragraking.

Taxa other than *C. crispus* were identified in the harvests from each of the three areas sampled (Table 6). Thirty-five genera were observed from southwestern Nova Scotia, 27 from Miminegash and 18 from Tignish. The percentage of *Chondrus* in the harvests, however, was similar for each of the three areas; ranging between 83.2% and 84.6% (Table 7).

Standing Crop — *C. crispus* and Associated Plants

A start has been made to acquire base-line data on both the standing crops and the algal associations in all commercially important beds. These data were acquired this year in western Prince Edward Island, in beds off both Miminegash and Tignish, and in southwestern Nova Scotia off West Pubnico (Fig. 6). The method employed involved removing all plants within 0.25-m² quadrats, along transects that dissected the beds vertically to the shore. To permit future surveys in the same location, the base of the transect was permanently marked and the angle of the transect determined by using a transit.

An annual survey, attempting to quantify the standing crop of *C. crispus* in a section of the Miminegash beds (Fig. 6), has been performed over the past seven years by personnel from the Prince Edward Island Department of Fisheries. This year the study was carried out by personnel of the Resource Development Branch using a modified technique. One hundred forty-four quadrats were sampled in a bed of 567,056 m². The mean dry weight of *C. crispus*

per 0.25 m² was 24.5 g, and the amount in the bed was calculated to be 55,571.5 kg. The largest percentage of plants by number were in morphological Class I with the smallest percentage in Class IV (Fig. 8). However, per 0.25 m², Class I plants made up the lowest dry weight, whereas Class III plants had the highest dry weight.

A similar study was carried out in the Tignish area,

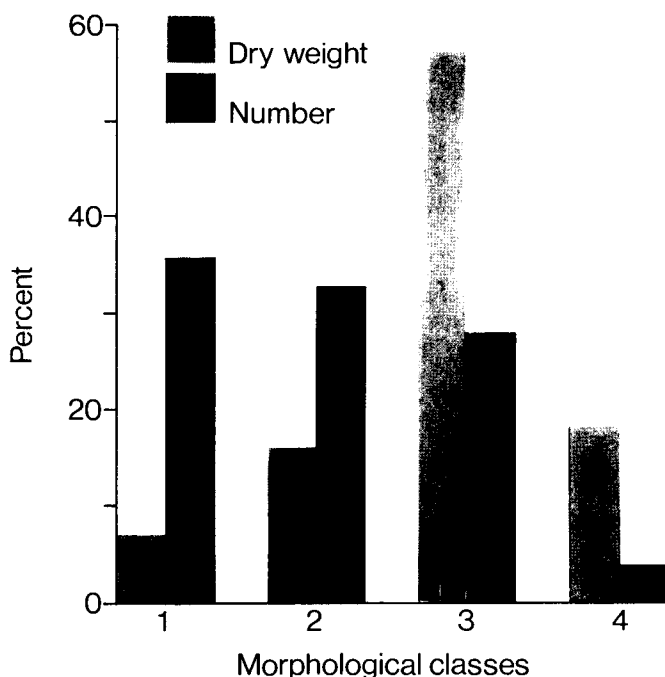
**Fig. 8.** Morphological composition of the standing crop of *C. crispus* in a section of the Miminegash, Prince Edward Island beds, 1975.

Table 6. Taxa observed in the 1975 *Chondrus* harvest of dragrakers from western Prince Edward Island and handrakers from southwestern Nova Scotia.

Taxa observed		Location		
		S-west N. S.	Mimin- egash	Tig- nish
Tracheophyta	<i>Zostera</i> sp.	✓		
Chlorophyta	<i>Chaetomorpha</i> sp.	✓	✓	
	<i>Cladophora</i> sp.	✓	✓	✓
	<i>Spongomorpha</i> sp.	✓	✓	
	<i>Ulva</i> sp.	✓	✓	
Phaeophyta	<i>Acrothrix</i> sp.	✓		
	<i>Ascophyllum</i> sp.	✓		
	<i>Chorda</i> sp.	✓	✓	✓
	<i>Chordaria</i> sp.	✓	✓	✓
	<i>Desmarestia</i> sp.	✓	✓	✓
	<i>Dictyosiphon</i> sp.	✓	✓	✓
	<i>Ectocarpus</i> sp.	✓	✓	
	<i>Fucus</i> sp.	✓	✓	✓
	<i>Halopteris</i> sp.	✓	✓	✓
	<i>Laminaria</i> sp.	✓	✓	✓
	<i>Punctaria</i> sp.	✓	✓	✓
	<i>Pylaiella</i> sp.	✓		
	<i>Saccorhiza</i> sp.	✓		✓
	<i>Scytosiphon</i> sp.		✓	
Rhodophyta	<i>Ahnfeltia</i> sp.	✓	✓	✓
	<i>Ceramium</i> sp.	✓	✓	
	<i>Chondrus</i> sp.	✓	✓	✓
	<i>Corallina</i> sp.	✓	✓	✓
	<i>Cystoclonium</i> sp.	✓	✓	✓
	<i>Euthora</i> sp.	✓		
	<i>Furcellaria</i> sp.	✓	✓	✓
	<i>Gigartina</i> sp.	✓		
	<i>Gloiosiphonia</i> sp.	✓	✓	
	<i>Lithothamnion</i> sp.	✓	✓	✓
	<i>Phycodrys</i> sp.	✓		
	<i>Phyllophora</i> sp.	✓	✓	✓
	<i>Polyides</i> sp.	✓	✓	✓
	<i>Polysiphonia</i> sp.	✓	✓	✓
	<i>Porphyra</i> sp.	✓		
	<i>Ptilota</i> sp.	✓		
	<i>Rhodomela</i> sp.	✓	✓	
	<i>Rhodymenia</i> sp.	✓	✓	

between Cape Kildare and North Cape (Fig. 6). Plants within 87 quadrats along six vertical transects were removed, and the mean dry weight of *Chondrus* per 0.25 m² was 28.1 g.

The benthic algal distribution in southwestern Nova Scotia is considerably different from that of

Northumberland Strait. Both the lack of winter ice and a large semi-diurnal tidal fluctuation permit the development of the extensive intertidal flora. The vertical transects studied here ran throughout the algal zone, and 0.25-m² quadrats were sampled every 5 m. All plants within each quadrat were removed, identified and weighed.

Three transects were laid out between Ledge Harbour and Pubnico Head (Fig. 6). Twenty-two genera of marine plants were identified in one of the transects; however, eight of these made up 98.9% of the standing crop (Fig. 9). The two most important commercial plants in the area, *C. crispus* and *Ascophyllum nodosum*, had the largest standing crops. Above the mean low-water spring tide line, *Fucus vesiculosus* and *A. nodosum* had the largest standing crops. Below this point, *C. crispus* dominated the flora down to about 2.5 m below the chart datum (zero tide). At this point, *Phyllophora* spp. were most abundant to approximately 3.5 m below zero tide. Below this, *C. Crispus* and

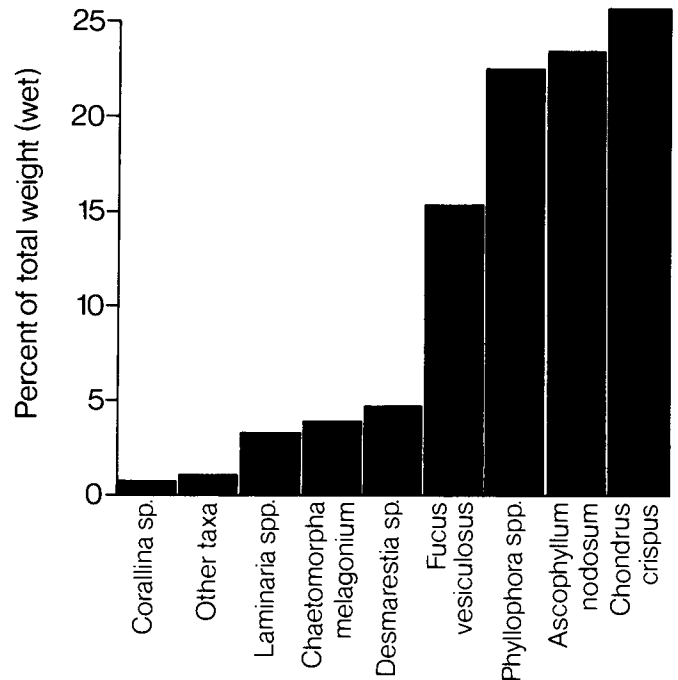


Fig. 9. Species composition of marine plants found in 1975 survey between Ledge Harbour and Pubnico Head, Nova Scotia.

Table 7. Sample size and percentage of *C. crispus* from commercial operations, 1975.

Area observed	Total Number of taxa observed	Sample weight (g)		Percentage of total sample weight	
		<i>Chondrus</i>	Other taxa	<i>Chondrus</i>	Other taxa
Western Prince Edward Island					
Miminegash	28	111,032	20,298	84.5	15.5
Tignish	19	20,657	4,155	83.2	16.8
Southwestern Nova Scotia					
	36	51,484	9,404	84.6	15.4

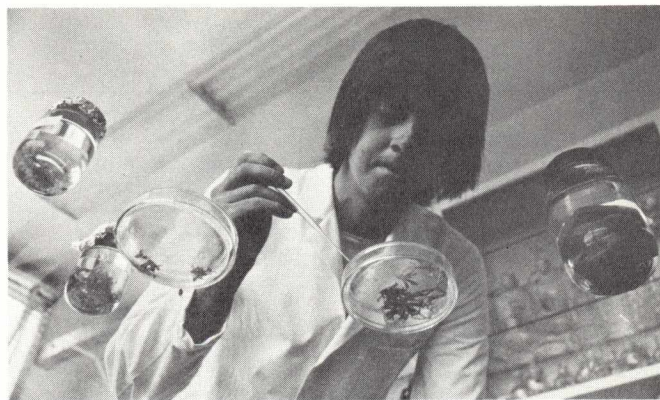
Phyllophora spp. were about equal in standing crop.

Throughout the *C. crispus* zone, the mean dry weight of this species per 0.25 m² was 108.9 g and, in a strip 0.5 m wide through the zone, approximately 15.3 kg of *C. crispus* was calculated to be present. Between 3 m and 4.5 m below zero tide, *Chaetomorpha melagonium* was closely associated with *C. crispus*, making the latter less desirable to the algal processors.

Although the standing crop of *Chondrus* per 0.25 m² was lower in the Miminegash area (24.5 g) than in the Tignish area (28.1 g), there is likely more, overall, in the Miminegash area, as the beds are believed to be larger. The standing crop is considerably greater (108.9 g) per 0.25 m² in the West Pubnico area, but the beds were observed to extend out only about 80-100 m from shore, whereas in Northumberland Strait, they can extend out about 1.5 km.

Phenology of *C. crispus*

Little is known about the periodicity of growth and reproduction of *Chondrus*. A start was made in 1974 to obtain data on these aspects, using an outplanting technique. This involves transplanting germlings from laboratory cultures to the natural environment, at or near commercially important beds. To carry this out, cement blocks, measuring 60 × 120 × 10 cm, were bolted to the ocean bottom between Miminegash and North Cape in Prince Edward Island, and between Ledge Harbour and Pubnico Head, Nova Scotia (Fig. 6). Fertile plants were obtained from each area, and both carpospores and tetraspores were inoculated onto clay substrates. The latter were then secured to the cement blocks. Periodic inspection will permit the calculation of growth rates and reproductive periodicity.



Gathering spores with pipette to seed culture plugs similar to those shown in the right of the photo.

Miscellaneous Activities

An herbarium was started, and a photographic record is being made of all taxa associated with the commercially important marine plants in the Maritimes Region. Daily records are being kept of radiant energy at both Miminegash and West Pubnico. An attempt is being made to develop a device to assist SCUBA-equipped divers to relocate experimental material in turbid waters.

The Marine Plants Experimental Station at Miminegash was renovated. The exterior was reclad and major alterations were made inside to create more office space. A large walk-in cooler was converted to a culture room. Various major and incidental laboratory and field equipment was purchased, including a Nikon Apophot microscope, a freezing microtome, a reach-in culture cabinet, a 5-m Boston Whaler, an underwater spectrophotometer and Unisuits.

J. D. Pringle

FISH HABITAT PROTECTION AND ENGINEERING SERVICES

The responsibility of the Fish Habitat Protection and Engineering Services Section is to safeguard the quality of the aquatic environment for the preservation of fish stocks and provide technical support for Branch capital works programs.

Significant staff effort was devoted to environmental assessment activities related to the Wreck Cove hydroelectric and Point Lepreau nuclear power developments in Nova Scotia and New Brunswick, respectively. In addition, a large number of projects of less potential environmental significance was examined for possible deleterious effects on fisheries, as part of an ongoing commitment under the Environmental Assessment, Review and Protection (EARP) program.

Late in 1975, the Ocean Dumping Control Act was proclaimed, designed to control the disposal of deleterious substances into the marine environment. Considerable staff effort was devoted to devising procedures for administering the regulations of the Ocean Dumping Control Act and participating on the Regional Ocean Dumping Advisory Committee.

The fish physiology and environmental chemistry components of the habitat protection program continued to research analytical problems and sublethal effects of chemical contaminants on fish, and to provide analytical support for other Branch activities.

Evaluation of fish passage facilities for both upstream and downstream migrants proceeded at three dam sites, and a new study was initiated at East River Sheet Harbour, where a fish deflector and bypass were assessed. This work is part of a continuing program to improve existing fish passage works and investigate the usefulness of new concepts in fish protection.

Engineering support was provided for major capital improvements at Mactaquac Hatchery and several smaller projects at Antigonish, Cardigan, Coldbrook and Mersey hatcheries. The main focus of attention was on the design and construction of improvements to the Mactaquac aeration tower, to alleviate a serious nitrogen supersaturation problem in the hatchery water supply.

Section staff chaired sessions or presented technical papers at local and international meetings of the Canadian Society of Environmental Biologists, the Chemical Institute of Canada, the American Society of Limnology and Oceanography, the Atlantic International Chapter of the American Fisheries Society, the Northeast Fish and Wildlife Conference and the Canadian Society of Civil Engineers Hydrotechnical Conference.

D. C. Riley

AQUATIC ALTERATION INVESTIGATIONS

A total of 375 requests for permission to conduct projects involving a myriad of proposed aquatic alterations was investigated in 1975 (Table 8). Although the total number of proposed alterations decreased slightly from last year, several large, complex development projects with potentially significant fisheries impact more than compensated for the decline.

The most prevalent types of freshwater aquatic alterations investigated were proposals for small dam construction in Prince Edward Island and erosion control and highway construction in New Brunswick. Estuarial dredging and aquatic alterations involving marine installations were common in Nova Scotia and New Brunswick.

Table 8. Quantity, category and location of aquatic alterations investigated in 1975.

Type of aquatic alteration	Number of investigations			Total
	New Brunswick	Nova Scotia	Prince Edward Island	
Erosion and sedimentation control	17	1	0	18
Gravel removal and channeling	5	7	0	12
Estuarial dredging	33	20	17	70
Small dam construction	6	9	14	29
Marine installations	16	51	4	71
Highway structures and public utilities	102	13	5	120
Water abstraction	6	7	2	15
Miscellaneous	22	16	2	40
Total	207	124	44	375

Two major development projects with potentially significant fisheries implications are currently under study. These are the Wreck Cove hydroelectric project in northwestern Nova Scotia and the Point Lepreau nuclear power development in New Brunswick.

During the year, the Water Resources Branch, New Brunswick Department of the Environment, in concert with other provincial departments and federal Fisheries, reexamined existing procedures for coordinating and administering the present stream alteration program, in light of the province's new Clean Environment Act. In view of pending stringent regulations under the new Act and expectations that a substantial increase in the number of alterations will result, a concerted effort was directed at streamlining existing procedures. As a result of these consultations, technical guidelines are currently being prepared for incorporation into a provincial permit system to govern the construction activities and operation of specific categories of projects.

The province of Prince Edward Island is presently considering similar legislation, in recognition of the potential adverse effects of uncontrolled and uncoordinated watercourse alterations. In total perspective, such provincial legislation is expected to result in a substantial increase in the number of requests for aquatic alterations.

Point Lepreau Nuclear Power Development

During 1975, the New Brunswick Electric Power Commission, a provincial utility, proceeded with construction of a 1,200-megawatt nuclear power plant at Point Lepreau on the Bay of Fundy coast, approximately 30 km southwest of Saint John. This project was approved in principle by a federal Environmental Assessment Panel, as required under the new Environmental Assessment, Review and Protection policy.

Section staff, in collaboration with other Services of the Department and provincial environment staff, were closely involved during the year in advising the proponent and consultants on the environmental aspects and adequacy of Point Lepreau plant design and operation standards for minimizing the deleterious environmental impacts. Efforts during the year were concentrated on siting and design of cooling-water intake and outfall structures, to reduce impingement, entrapment and entrainment of marine organisms, and to maximize the dispersion of the heated effluent. Design development documents and conceptual layouts of plant cooling-water facilities are currently being studied, and the potential impact on the marine environment associated with these design proposals is being assessed.

As presently envisaged, the cooling-water intake and outfall structures are to be located on the eastern and western sides of Point Lepreau (Fig. 10), 19 m and 15 m, respectively, below mean sea level. The locations of the intake and outfall structures were selected to prevent recycling of heated effluent and to minimize the impact on local fisheries. The cooling-water intake system includes a low-velocity (variable) capped intake structure and a fish guidance mechanism installed in a pump forebay located on land, 600 m from the intake structure. The design concept is aimed at minimizing the impinge-

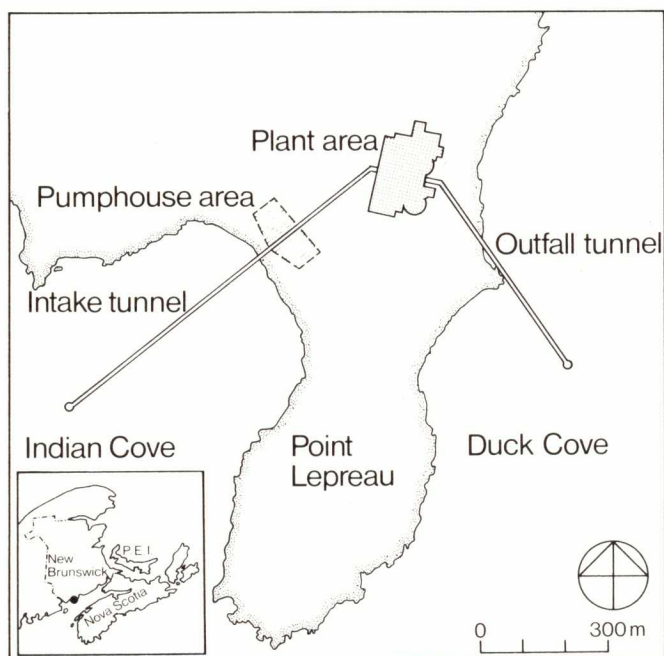


Fig. 10. Proposed cooling-water intake and outfall structures for the Point Lepreau, New Brunswick, nuclear power development.

ment and entrapment of marine organisms. A submerged high-velocity outfall is envisaged, to maximize the dispersion of heated effluent into the Bay of Fundy. Provisions are made in the preliminary design concept for diffusion of the effluent. The design criteria developed for heat dispersal are aimed at limiting the increase in surface water temperature of the receiving waters to 5°C above ambient.

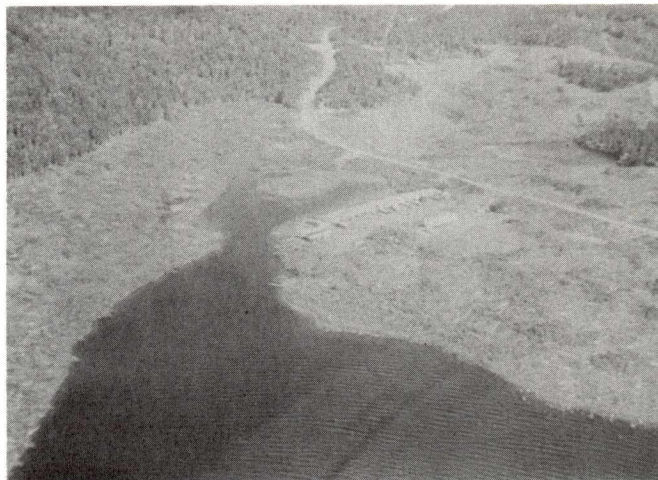
W. D. Watt and A. J. Cullen

Wreck Cove Hydroelectric Development

The Nova Scotia Power Corporation, a provincial utility, commenced construction in 1975 of a 200-megawatt hydroelectric development at Wreck Cove, in the Eastern Cape Breton Highlands (Fig. 11). The development involves the diversion of seven headwater streams, including Cheticamp Lake, by a system of canals and tunnels to an underground powerhouse. The impact of this project, particularly on freshwater-dependent fish stocks, is a major concern.

Early in 1975, a federal-provincial understanding was reached in support of a broad environmental assessment study of the Wreck Cove project. The scope and nature of this study were based on joint federal-provincial guidelines, coordinated by the Nova Scotia Department of Environment in collaboration with various service elements of the Department. In recognition of the federal statutory obligation for fisheries protection, emphasis was placed on studies aimed at quantifying the deleterious effects of the project on freshwater-dependent fisheries.

Subsequently, fisheries concerns and study requirements were identified and integrated into the guidelines for a broad environmental assessment study program. Because of delays in implementing this study program and the urgent need for meaningful fisheries related field data, bio-physical and hydrological surveys were carried out by Fisheries and Nova Scotia Power Corporation on a cost-shared basis. The Data collected from these field surveys will form a significant segment of the broad environmental study program that is currently underway, and will



Reservoir clearing for Wreck Cove hydroelectric development.

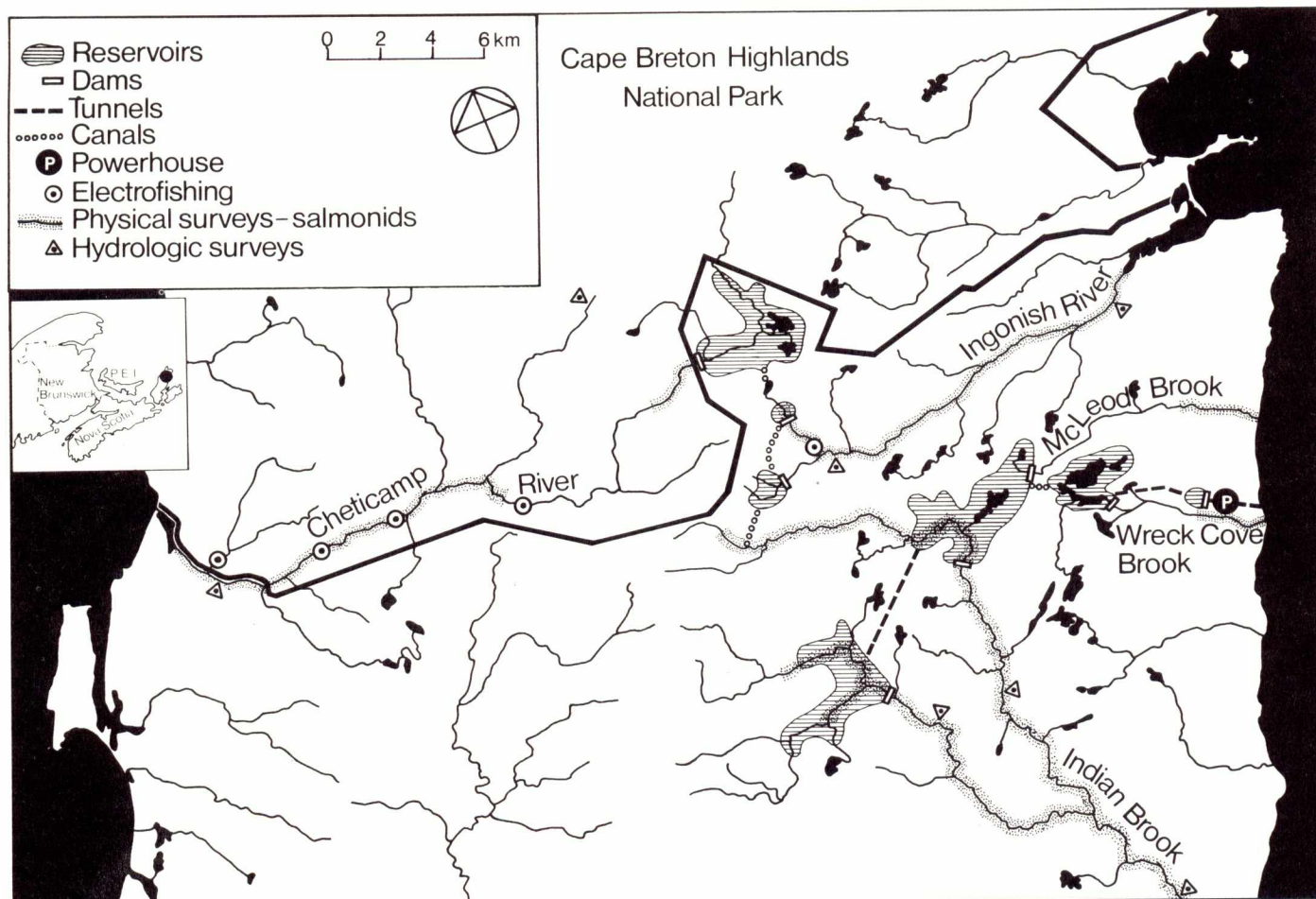
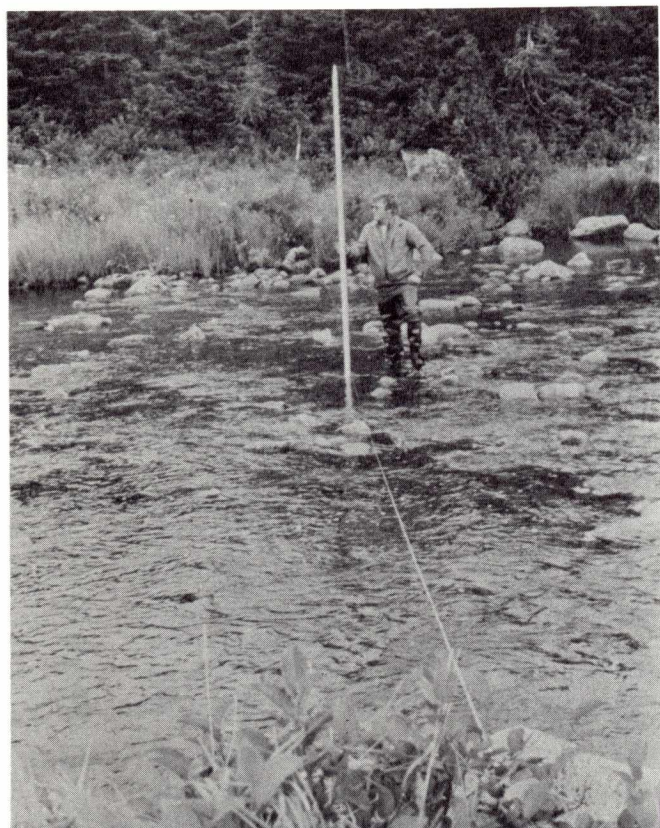


Fig. 11. Location map of hydroelectric development at Wreck Cove, Cape Breton, Nova Scotia.



Conduction of a hydrometric survey in the Wreck Cove hydroelectric development area.

assist Fisheries in quantifying appropriate conservation measures.

Fish habitat surveys were completed on streams that will be affected by the development, and information was collected at various locations (Fig. 11) on hydrology, fish species and abundance. A total of 104 km of stream was surveyed. Salmon spawning area was of fair quality, but poorly situated, widely scattered and limited. Better spawning areas existed for trout. Trout were observed in all areas surveyed; salmon observations were much more restricted.

To determine minimum maintenance-flow requirements for protection of fish habitat, measurements of cross-sectional area, wetted perimeter, water-surface width and river slope were made under different flows.

W. D. Watt, W. J. White, T. M. Humes and A. J. Cullen

Erosion and Sedimentation Control

A joint study to assess the cause and effect relationship of sedimentation in Dunk River, Prince Edward Island, continued in 1975. The University of Prince Edward Island, the Prince Edward Island Environmental Control Commission and several agencies of Environment Canada are participating in this comprehensive study, which will include qualitative and quantitative data on the effects of sedimentation on trout and fish food organisms.

Most of the 18 erosion control requests investigated during the year related to the protection of agricultural land from bank erosion. As has been the practice in recent years, the use of heavy quarried rock was stipulated to alleviate the erosion problem, in lieu of the normal practice of using stream gravel.

T. M. Humes, A. J. Cullen and H. E. Edwards

Gravel Removal and Channeling

Twelve requests for permission to remove gravel and conduct channelization work were assessed during the year. The purpose of these requests was principally for protection of agricultural land from flooding.

The fisheries implications of a large-scale, illegal gravel removal and stream channelization operation on River Tillard, Richmond County, Nova Scotia, were investigated, and resulted in stream restoration work being implemented. The illegal operation entailed



Gravel removal and channeling on River Tillard, Nova Scotia.

stream diversion and channelization, and removal of vegetation and overburden adjacent to stream banks for extraction of gravel for highway construction.

Because of major concerns expressed by Fisheries over the deleterious effects of this unauthorized operation, the Nova Scotia Department of Environment, in collaboration with Fisheries staff, undertook the supervision of stream restoration work, which was carried out by the instigator.

T. M. Humes and H. E. Edwards

Estuarial Dredging

Seventy estuarial dredging proposals, involving the extraction and disposal of approximately two million cubic meters of marine sediments, were reviewed in 1975 for possible deleterious effects on marine fisheries. These proposals were referred to Section staff under the Navigable Waters Protection Act referral procedures. In the new year, estuarial dredging requests will be administered under the new Ocean Dumping Control Act, which was proclaimed late in 1975.



Bucket dredging in the Jacquet River estuary, New Brunswick.

Major dredging proposals investigated during the year related to navigational channel maintenance and improvements and expansion of harbour facilities, at Dalhousie and Bathurst, northeastern New Brunswick, and at Courtenay Bay, Saint John. Dredging operations in Dalhousie Harbour, involving approximately 200,000 m³, were the most extensive and caused considerable concern to fisheries because of potential deleterious effects from marine disposal of contaminated dredged spoil. Dredging activities in Bathurst Harbour entailed the extraction of approximately 26,000 m³ of material from a nearby pulp-mill outfall. Fisheries concerns were focused on the potential deleterious effects on scallop beds resulting from marine disposal of dredged material. No significant deleterious fisheries effects were identified for the Courtenay Bay dredging proposal, that involved the extraction and marine disposal of approximately 65,000 m³ for expansion of harbour facilities.

T. M. Humes

Small Dam Construction

A total of 29 requests was received during the year for permission to construct low-head dams for a variety of purposes. Provisions for fish passage were incorporated into the structures where these could be justified.

Physical and biological surveys were completed on Hidden and Annis lakes, Queens County, Nova Scotia, to determine if construction of retention dams on the outlets and subsequent rise in water levels would adversely affect fisheries. Based on the analysis of survey data and the nature of the projects, approval was granted for the construction of these low-head retention dams without provision for fish passage.

A request was also received for the construction of a 15-m high, multi-purpose dam on South Rights River, Antigonish County, Nova Scotia. The lower 6 m of storage capacity is to be used as a water supply for the town of Antigonish, while the remaining 9 m is

to be used as a means to control flooding along the lower reaches of the river. Because of the potential broad implications of the project on fisheries, wildlife and land flooding, a preliminary environmental impact assessment has been recommended. Guidelines for the impact assessment were developed in collaboration with other Services of the Department, and these are currently being reviewed by project consultants, Maritime Resource Management Services.

H. E. Edwards, A. J. Cullen and T. M. Humes

Marine Installations

A variety of proposed projects involving marine installations was investigated to determine the impact on fisheries. Generally, requests for approval of these projects were received as Navigable Waters Protection Act referrals. The investigations carried out related to wharf construction (18), cable crossings (6), water pipelines (5), sewage outfalls (8), landfill (7) and requests principally involving the construction of lobster and oyster ponds and tidewater crossings such as causeways and bridges (27).

Each project was examined to determine the nature and magnitude of the fishery which would be affected. Assessments were made principally on the basis of information supplied by local fishermen, fish landing reports and comments from local Fisheries Officers.

T. M. Humes and W. J. White

Highway Structures and Public Utilities

Fisheries implications of 120 proposals involving the construction of highway structures and public utilities were reviewed during the year. Although the total was lower than in 1974, there was an upward trend in the number of applications received from private pulp companies seeking permission to install bridges and culverts, in conjunction with upgrading or new construction of logging roads. There was also an increase in requests to construct bridges in the dry and divert the stream upon completion of construction.

Primarily as a result of a proposal to build an oil pipeline from Irving Oil Refinery, East Saint John, New Brunswick, to the Lorneville thermal plant — which involved the crossing of several waterways — the number of project referrals in the public utilities category increased significantly over those of previous years.

H. E. Edwards, T. M. Humes and A. J. Cullen

Water Abstraction

Investigations were conducted on the potential adverse fisheries effects of 15 proposals to abstract water for domestic and industrial uses from lakes and streams. Thirteen requests were for diverting a portion of the natural stream flow for the operation of private multi-purpose ponds.

Each proposal was approved, contingent on the

provision of proper intake screening and residual flows downstream from the point of withdrawal.

H. E. Edwards, T. M. Humes and A. J. Cullen

Miscellaneous Aquatic Alterations

Proposals for 40 miscellaneous aquatic alterations were examined for possible adverse effects on fisheries. They included such things as establishment of hydrometric stations, lake reclamation, provision of salmonid nursery areas, restoration of trout and salmon pools, landfill, obstructions to fish migration (other than dams) and a few requests listed under flood control.

H. E. Edwards and T. M. Humes

Other Investigations

During the year, staff became intermittently involved in considering fisheries implications of two extremely large potential development projects. One of these, the proposed Dickey-Lincoln hydroelectric development, is located on the upper reaches of the Saint John River in northeastern Maine, and the other concerns the development of tidal power in the Bay of Fundy.

The Dickey-Lincoln Development involves the construction of two reservoirs with areas of 348 km² and 8.7 km² at Dickey and Lincoln respectively, on the main stem of the Saint John River above the confluence of the Allagash River. The respective dams would have maximum heights of 101 m and 26 m, and the combined reservoirs would have a gross storage capacity of nearly 9.9×10^9 m³.

Involvement in this project was limited to defining Canadian fisheries concerns and developing a strategy and response capability to deal with these concerns should the project go ahead.

As a result of a recent economic review of proposed Fundy tidal power development, interest in this massive project has been rekindled. A new 2-yr, \$3 million, federal-provincial cost-sharing study to reexamine in greater detail the economics and technical aspects of this project has been formally announced. Depending on the outcome of this review, environmental issues associated with Fundy tidal power may also be examined.

Involvement in the Fundy tidal power project was limited to the identification, scheduling and costing of specific fisheries-related studies that would be required in order to assess the impact on marine and freshwater-dependent fish stocks.

Section staff, in collaboration with other Branch staff, were intermittently involved in assembling and assessing resource and water-quality data for the Miramichi estuary, in anticipation of developing guidelines for a formal environmental impact study. Currently, technical studies are underway to determine the feasibility of constructing and maintaining a permanent, year-round shipping channel in the Miramichi estuary. If the current technical studies determine the project is feasible, massive dredging of the outer portions of the estuary of this important salmon stream will likely proceed.

Another project which was dealt with during the year concerned a preliminary environmental impact study of constructing and operating a fish culture station on the North LaHave River, Nova Scotia. Environmental impact assessment guidelines were prepared and a contract was awarded to outside consultants to perform the study. The consultants are expected to complete the study prior to March 31, 1976. This will fulfill the Department's obligation as far as the new federal Environmental Assessment, Review and Protection (EARP) policy is concerned.

J. R. Semple, W. D. Watt, W. J. White and T. M. Humes

ENVIRONMENTAL QUALITY PROGRAM

The environmental quality program combines laboratory and field investigations to specify environmental problems and to establish environmental parameters for protection of the fisheries resource. This includes direct investigation of pollution threats, the provision of professional advice to developers on the ecological implications of their proposals, and the preparation of guidelines for environmental impact assessments.

W. D. Watt

Gays River Baseline Study

In 1973, Imperial Oil Company began an exploratory drilling program to discover the extent of lead and zinc sulphide deposits near Gays River — a tributary to the Shubenacadie River — Nova Scotia. The establishment of a lead-zinc mine at Gays River, together with a plant for concentrating the ores, may cause serious heavy-metal pollution downstream from the development. This problem could arise from the effluent of the ore-concentrating plant or by a solution of metal ions leached from waste piles. Pollution from these sources is a major factor limiting production of salmon in some New Brunswick rivers.

In 1975, a weekly sampling program was undertaken at ten regular sites on the Gays and Shubenacadie rivers (Fig. 12). Samples of water, stream sediments, aquatic invertebrates and aquatic plants were collected and analysed for concentrations of metals and other relevant characteristics. In all, 338 water samples and 260 sediment samples were analysed. Aquatic plant and invertebrate samples were sorted and identified in preparation for heavy-metal analysis.

If a production mine is established at Gays River site, data collected from the baseline survey will assist in determining the extent of mine pollution which might be caused, and will enable the Branch to advise on waste treatment required.

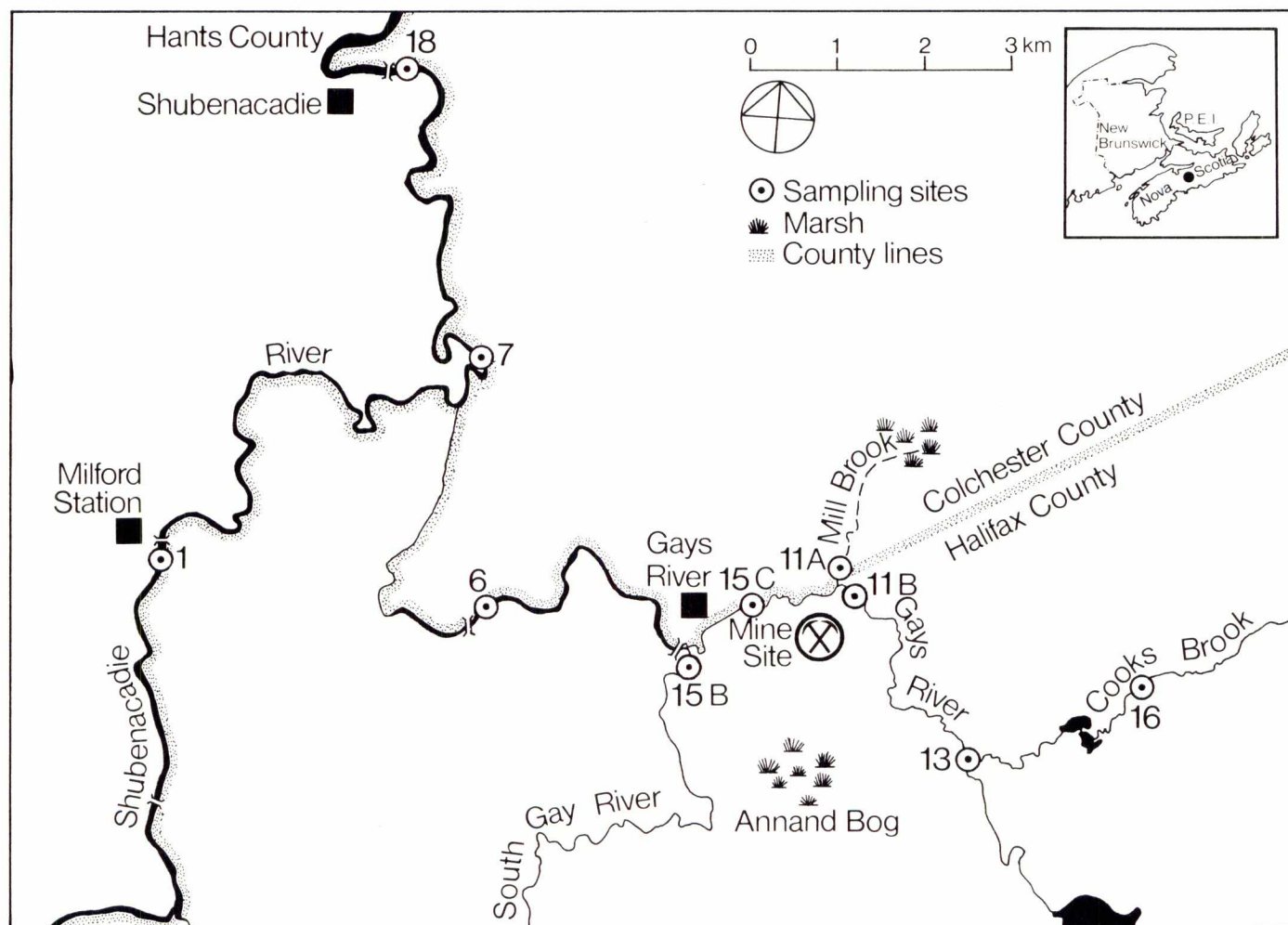


Fig. 12. Map of 1975 sampling areas on Gays and Shubenacadie river systems, Nova Scotia.

In the autumn of 1975, when it was learned that Imperial Oil Company and Cuvier Mines intended to sink a test-pit on the site, arrangements were made to continue the sampling program during the winter of 1975-76 while the test-pit is being prepared.

S. Ray and W. J. White

Osmoregulation in Atlantic Salmon and Rainbow Trout

Until recently, saltwater bioassays conducted by the Environmental Protection Service, Atlantic Region, have utilized rainbow trout parr, ranging in weight from 1 to 10 g. Experiments completed during the year have demonstrated the inability of parr of this size to acclimate to full sea water. Attempts are now being made to identify an alternative species for saltwater bioassay purposes.

Salmon smolts released from the Mactaquac Fish Culture Station are comprised of 1- and 2-yr-old individuals. Poor returns of salmon released as 1-yr smolts prompted the study of their osmoregulatory ability in sea water and an examination of various physiological changes occurring during smoltification. The objectives were to identify the minimum size fish must attain before they are able to successfully acclimate to sea water, to determine whether seawater acclimation was related to season, and to predict the best release time for hatchery smolts.

Groups of 1- and 2-yr-old pre-smolts and 1- and 2-yr-old smolts were exposed to gradually increasing salinity, and changes in the osmolarity of various body fluids were examined. The data indicate that both groups acclimate to sea water equally well and that smoltification is not a necessary prerequisite to sea-water acclimation. Of the several parameters measured during smoltification, changes in lipid, moisture and condition factor were most valuable in predicting the timing of this process. Smoltification was synchronous in both 1- and 2-yr-old fish, beginning during April and apparently completed by June. Post-smolt condition was studied during August and September. It was determined that only pre-smolts exceeding 16 g wet weight and 13 cm fork length should be selected for release.

G. J. Farmer and S. Ray

Sublethal Effects of Dissolved Zinc on Atlantic Salmon Parr

Long-term studies on the sublethal effects of dissolved zinc on the bioenergetics of Atlantic salmon parr held in soft water commenced during the year, in an effort to establish water quality criteria for mining areas of northeastern New Brunswick. Preliminary studies determined the lethal concentration of this metal for salmon parr. Utilizing concentrations of zinc ranging from background to one-half the lethal level, the appetite response of parr allowed to feed *ad libitum* was examined over a 60-day interval. The results demonstrate the ability of parr to acclimate to the various sublethal concentrations of the metal. Appetite was initially depressed, but returned to the level of control fish within two weeks. By Day 40, increased food consumption was observed for all

groups exposed to zinc. The elevated food intake continued until the cessation of the experiment. Presumably, an increased metabolic expenditure of the experimental fish associated with metal exposure was satisfied by an elevation of the daily food intake. Changes in the proximate body composition of the experimental animals and accumulation of zinc in their tissues was also monitored throughout the experiment.

Further experiments, currently being conducted, have been designed to determine the effects of sublethal concentrations of metals on the growth and changes in proximate body composition of salmon exposed to zinc, but maintained on fixed rations.

G. J. Farmer and S. Ray

Analytical Chemistry Services and Investigations

Nineteen seventy-five was the first full, non-interrupted year of operation for the chemistry laboratory. During the year, the laboratory continued to provide routine analytical services for other units of the Branch and input towards the formulation of water quality objectives for fish life and supporting ecosystems.

The past year saw a tremendous increase in the volume of analytical work as a result of demands within the Branch. Considerable attention was given to the Gays River Baseline Study in the vicinity of a proposed lead-zinc mining development in Nova Scotia, and to the Nepisiguit River in New Brunswick, which is the site of a proposed salmon development project that is threatened by heavy-metal pollution. A number of water samples from the Polly Cove aquaculture project and the Coldbrook, Antigonish and Mactaquac hatcheries was also analysed. The number of chemical analyses conducted on water, sediment and biological materials in 1975 exceeded 4,000.

In addition, a project on "Bioaccumulation of Cadmium with Relation to Zinc in Atlantic Salmon" has been completed and a report is in preparation. A modified method has been developed for total Kjeldahl nitrogen determination in water, waste and biological samples, using a gas-sensing ammonia probe electrode.

S. Ray

FISH PASSAGE PROGRAM

This program entails the design of new and improved fish passage works, bioengineering evaluation of new and existing fish passage installations, stream clearance activities, and fish passage maintenance and upkeep. During 1975, 17 significant projects were undertaken (Fig. 13).

Design and Construction

Most design and construction work during the year was for new fishways in Prince Edward Island. While the design of these structures was undertaken by Branch engineers, the capital cost of construction was borne either by the province or by private

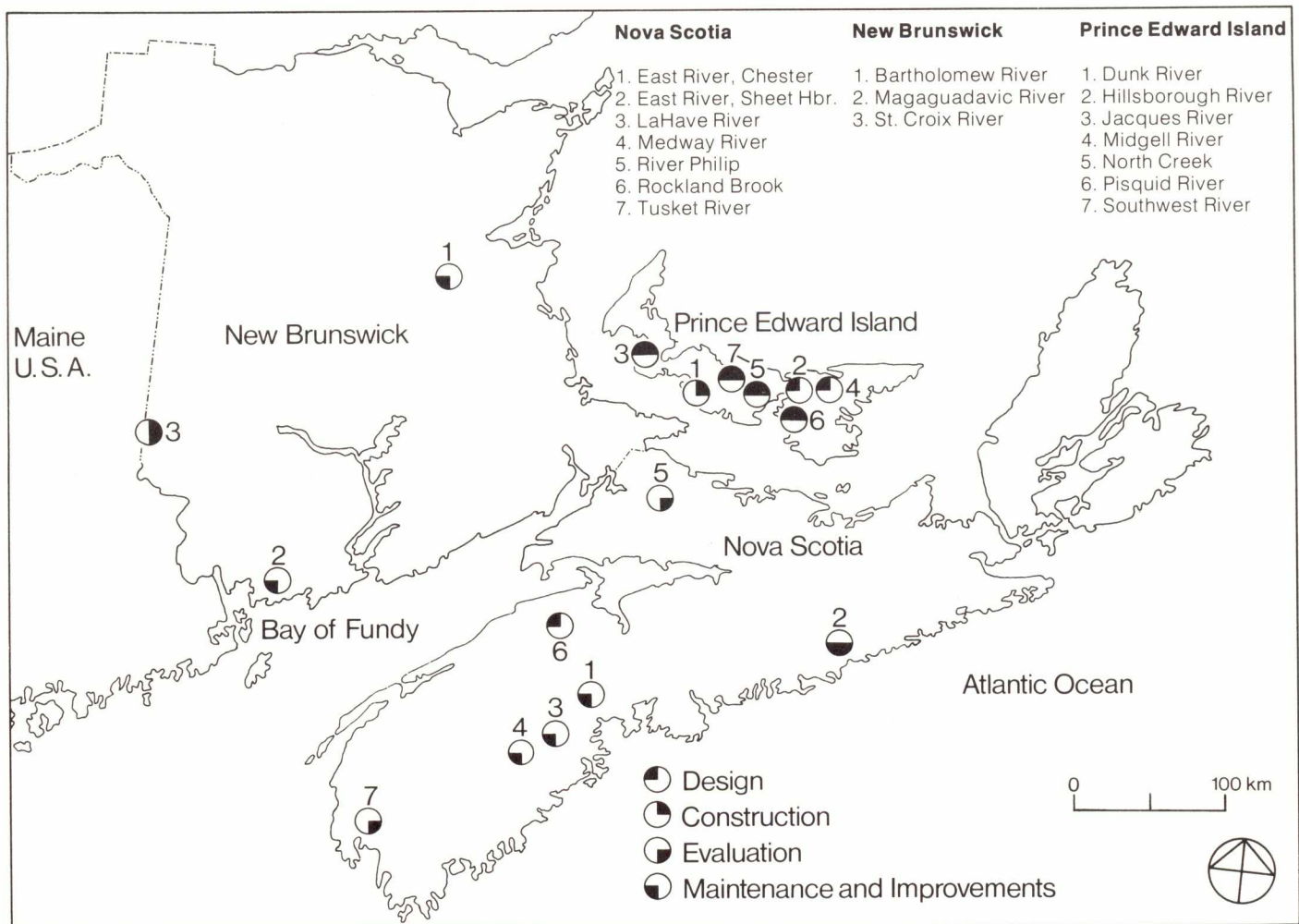


Fig. 13. Locations of fish passage work in the Maritimes Region, 1975.

interests.

Construction during 1975 included two vertical-slot fishways on Dunk River and Denil fishways on Jacques, Southwest and Pisquid rivers, Prince Edward Island. In addition, provisions were made for fish passage at North Creek water control structure and bypass channel. Design specifications were developed for fish passage at water control structures on Hillsborough River, Rochford Pond and Cardigan River, Prince Edward Island.



Newly constructed vertical-slot fishway at Scales Pond, Dunk River, Prince Edward Island.

The largest single fishway construction project was at Scales Pond on the Main stem of the Dunk River. It opened up 51 km of fish habitat, principally for salmon and brook trout, above the obstruction. A former hydroelectric dam without fish passage provisions prevented its utilization by anadromous fish. The new 16-pool vertical-slot fishway opens up the possibility of further fisheries development action.

Detail design proposals were developed to alleviate a fish migrational problem created by the construction of an illegal dam on Midgell River, Prince Edward Island. After repeated attempts to implement remedial measures as a result of pending legal action under the Fisheries Act, the owner undertook to breach the 18-ft-high earth-fill dam, which was constructed late in 1974. Breaching was carried out during late December, and the effectiveness of this action will be assessed during 1976.

Design specifications were provided for a fish passage facility to be incorporated into the Ducks Unlimited (Canada) water-control structure on Rockland Brook, Kings County, Nova Scotia. Design concepts were also developed for a Denil fishway to be incorporated into Jordan Lake Dam, Shelburne County and Tinker Lake Dam, East River Chester, Nova Scotia. A prefabricated, reinforced-fibregalss fishway has been proposed for the latter location.

V. Conrad

Tusket River Evaluation

Tusket River is located in southwestern Nova Scotia, near Yarmouth. A hydroelectric dam and powerhouse located at Tusket Falls near the head of tide and a diversion dam approximately 0.8 km upstream have been the subject of fish passage study since 1973, when a new fish bypass was constructed at the powerhouse dam. Studies during the current year focused on evaluation of upstream and downstream fish passage facilities, located both at the powerhouse and diversion dam.

A louvered ramp was installed at the entrance to the powerhouse bypass and tested at two different slopes, 15° and 30° to the horizontal. Tests were based on the theory that better visual cues would lead to better fish orientation and more efficient bypass usage. Results to date suggest that a ramp angle of 15° to horizontal provides better bypass efficiency for salmon smolts. Automatic, closed-circuit television recordings of bypass usage by spent alewives indicated approximately 865,000



Video tape recording and timing instrumentation for automatically counting downstream-migrant alewives through the bypass at Tusket Falls hydroelectric development.

made their seaward descent through the bypass, 51% between 1700 and 1900 hours.

A comparison of entrance rates of juvenile alewives to the powerhouse and diversion-dam fishway and new bypass was also investigated. An attempt will be made to relate alewife entrance rate to fish pass discharge and location of entrance. Depth of fish approach to the powerhouse bypass was monitored by a Furuno depth recorder and a bottom-mounted transducer located near the entrance.

Evaluation studies were also directed at assessing fish passage provisions for upstream migrants (salmon and alewives). Simultaneous 10-min counts were conducted for alewives at the powerhouse and diversion dam fishway exits. In addition, alewife fatigue (exertion) was examined at both sites through blood lactic-acid analysis, and fishway crowding and capacity tests were also conducted.

Traps were installed at the exits of both fishways in mid-July, after spilling had ceased at the diversion

dam, and continued in operation until November 21. Seventeen salmon were captured. Only one of these was taken at the diversion dam fishway. It is concluded that when spillage ceases at the diversion dam, flows from its fishway would be more beneficial at the powerhouse dam fishway.

J. R. Semple and V. Conrad

River Philip Evaluation

An evaluation initiated in 1974 of a new concept in fish passage design, a spiral fishway, continued during the year at River Philip, Nova Scotia. The facility is located on the lower reaches of River Philip, in the northern part of the province. Two fishways, a spiral and Denil, are situated at a 2.1-m high dam at Oxford Junction, 21 km from the river mouth.

Because of extremely poor results in passing Atlantic salmon through the spiral fishway in 1974, the facility was relocated in an abandoned pool-and-weir fishway adjacent to the Denil. Results of late spring and early summer trapping, primarily for brook trout, brown trout and alewives, and fall trapping for Atlantic salmon, for each fishway, are provided (Fig. 14).

During early season trapping, alewives, lampreys, white suckers, brook trout, salmon grilse and parr used both fishways. Shad and brown trout used only the Denil. In the fall, when the fishways were operated on alternate days, the spiral fishway was slightly more

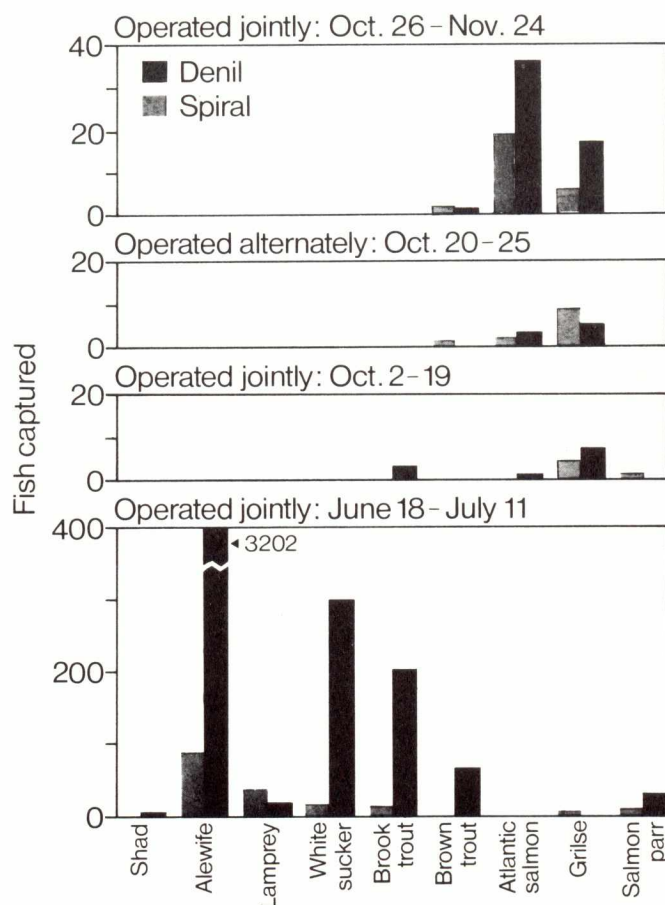


Fig. 14. Comparative evaluation of Denil and spiral fishways at River Philip, Nova Scotia, 1975.



Spiral fishway (in new location) and Denil fishway on River Philip at Oxford Junction.

efficient than the Denil, passing eleven salmon and grilse versus eight for the latter. Further fall trapping revealed that when both facilities were operated simultaneously, the Denil fishway was more efficient, passing 2.5 times more salmon and grilse than the spiral fishway.

J. R. Semple and V. Conrad

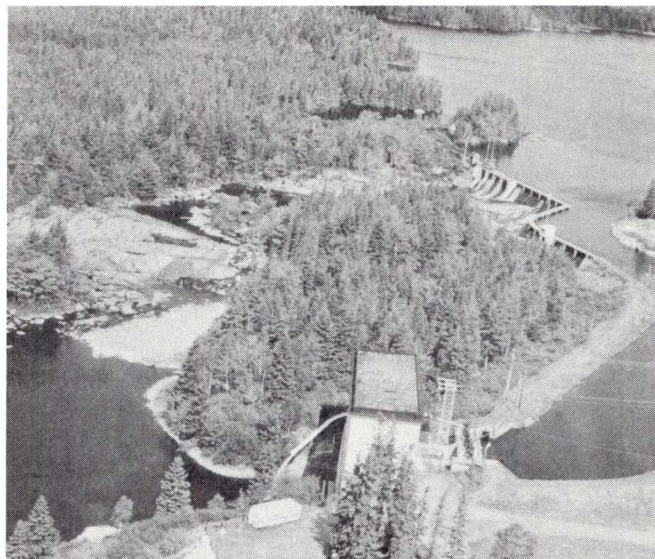
East River Sheet Harbour Evaluation

East River is located near the town of Sheet Harbour and empties into the Atlantic Ocean about 112 km northeast of Halifax, Nova Scotia. In the mid-1960's, a salmon rehabilitation program was initiated because of a rapid decline in salmon runs to the river as a result of hydroelectric development.

In 1974, a reinforced fibreglass flume was installed at Malay Falls, East River Sheet Harbour, to take fish safely around a hydroelectric station. A floating-screen deflector was installed to guide fish to the new bypass. These bypass facilities were evaluated in the spring of 1975 for Atlantic salmon smolts.

An attempt was made to install and maintain deflector screens at 45° to the natural flow. The screens extended the full width of the power canal and fished to a depth of 2.4 m. It was found that with deflector screens in operation, bypass efficiency for Atlantic salmon smolts was low, in the order of 20%. Without deflectors, however, bypass efficiency was improved, averaging approximately 50%. Tests with similar deflector facilities at Tusket River in 1974 gave bypass efficiencies as high as 72%, versus 40%-53% for control tests with no deflectors. Possible reasons for the dissimilarity are being analysed.

Data collected during these evaluation studies indicate the turbine mortality at Malay Falls hydroelectric installation averages 12% + 6% for salmon smolts. In addition, salmon smolts that pass directly through the turbines actually traversed the 2.4 km downstream to the Ruth Falls louver installation in a shorter time than those using the bypass. This finding



Malay Falls study site at East River, Sheet Harbour, showing water cascading from the fish bypass flume to the powerhouse tailrace.

could be related to greater entrainment of turbine smolts in predominant river flow.

J. R. Semple and V. Conrad

St. Croix River Evaluation

St. Croix River forms the southern portion of the international boundary between the state of Maine and province of New Brunswick. In the early 1800's, before it was harnessed for electric power and before its extensive forest resources were exploited, the river had significant runs of Atlantic salmon, shad and alewives. In recent years, shad and salmon runs have been virtually eliminated, and present alewife stocks (31,433 fish in 1974) are insignificant when compared with the river's potential production capacity.

During the current year, studies continued at the lowermost obstruction to fish migration, the Milltown Hydroelectric Dam. Objectives for the 1975 study were to determine the usefulness of additional



Fishway entrance (centre) at Milltown Dam on the St. Croix River, New Brunswick.

attraction water ($0.7 \text{ m}^3/\text{sec}$), to enhance the present fishway effectiveness and to define the direction and magnitude of water velocities in the tailrace of the dam for possible future fish passage improvements.

It was found that when all turbine units (seven) were operated simultaneously, as is the case for practically all of the alewife run, the additional water supplied to the fishway entrance failed to improve the passage rate. The additional flow actually resulted in a decreased entrance rate when tailwater levels were low. This condition prevailed when two generating units were operating and indicates that even if additional attraction water is provided, it could prove ineffective in improving alewife entrance rate if the ambient tailwater elevations are not satisfactory.

J. R. Semple

Maintenance and Improvements

Baffle sills were installed in Indian Falls fishway, LaHave River, Nova Scotia, to reduce turbulence and improve hydraulic performance of this structure. The Morgan Falls fishway exit channel was dredged, and flow deflectors consisting of large boulders were installed to improve hydraulic conditions and prevent fish fallback.

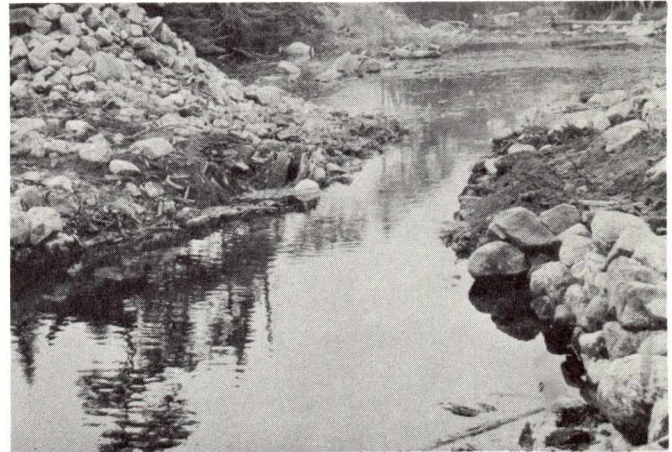
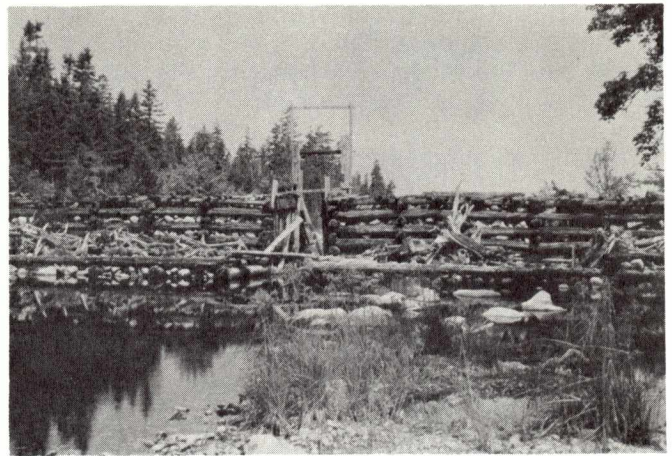
Extensive structural modifications and general repairs were carried out by the Nova Scotia Power Corporation on Harmony Mills fishway, aimed at making the facility more responsive to a wide range of headpond and tailrace fluctuations. This work was carried out early in 1975 and in accordance with Fisheries design specifications. Replacement of the lower portion of Milton Lake fishway, Yarmouth County, Nova Scotia, was carried out by the town of Yarmouth, in accordance with Fisheries stipulations.

Routine maintenance work was completed on Magaguadavic River fishway, St. George, New Brunswick, by Fisheries personnel. Investigations were carried out to determine the engineering feasibility of providing new or improved fish passage at Plaster Rock Dam, on the Tobique River; at Northwest Millstream Dam, Miramichi River, New Brunswick; and on several water control structures on Petite River, Lunenburg County, Nova Scotia.

V. Conrad

Stream Clearance

Considerable staff effort was devoted during the year to dismantling abandoned dams, to provide greater access to spawning and rearing areas for anadromous runs of fish. Six unused timber dams on East River Chester, Nova Scotia, were breached by the owners, in accordance with Fisheries specifications. This action provided access for anadromous runs of fish to an additional 45 km of stream and 17 km² of lake area for spawning and rearing. In addition, a low-head timber dam on Macdonalds Brook, tributary of Mira River, Cape Breton County, and two timber dams on the main stem of Medway River, Nova Scotia, were removed. Removal of these structures provided 101 km of additional stream and 20 km² of lake area for spawning and rearing of



Outlet of Connaught Lake, before and after removal of barrier dam, on East River, Chester, Nova Scotia.

freshwater-dependent fish stocks.

During the year, a concerted effort was made to resolve a long-standing fish migrational problem at Bartholomew River Dam, Blackville, New Brunswick. In view of the owner's expressed intention to abandon this dilapidated structure and the town of Blackville's desire to retain the dam for aesthetic and recreational use, negotiations continued during the year aimed at resolving this problem. Unless a concrete proposal by the town of Blackville is forthcoming to permanently resolve the present conflict of interest by early spring 1976, action will be initiated to have the existing structure dismantled.

V. Conrad and J. R. Semple

ENGINEERING SERVICES

The role of Engineering Services is to provide technical support for Branch capital works projects associated with fish culture and fisheries enhancement programs. It involves the determination of engineering feasibility, and design and construction supervision of proposed new and improved facilities and works.

Major emphasis during the year was focused on the construction of new works and major improvements to existing facilities at Mactaquac Hatchery. Extensive modifications to the Mactaquac aeration tower were virtually completed, to alleviate a serious nitrogen supersaturation problem in the hatchery

water supply. Construction of additional adult holding facilities at Mactaquac Hatchery and a new dump site on the Tobique River were necessary to accommodate the increased salmon runs in the Saint John River.

Additional engineering field surveys were conducted on Liscomb River, Guysborough County, Nova Scotia, in order to further refine design concepts and planning for a major fisheries enhancement project. A decision by the Nova Scotia Power Corporation to abandon a small hydroelectric installation on the Liscomb River has significantly increased the viability of this project.

A new trout broodstock pond was completed at the Antigonish Hatchery, and consultants were retained to determine the feasibility of providing 2,270 litres/min of ground water to augment the existing water supply at Coldbrook Hatchery. Preliminary engineering design work was completed to

determine the feasibility of expanding the rearing capability of Cardigan Hatchery, Prince Edward Island. This project entails the construction of additional rearing and water-supply facilities, and development of a potential ground-water supply.

The capability of Engineering Services staff to execute planned projects was hampered by promotional transfers of professional and technical support staff and difficulties encountered in acquiring replacements. To compensate for this deficiency, assistance from outside engineering consultants was solicited for high-priority projects.

Further detailed elaboration of Engineering Services' participation in individual projects is provided in the Freshwater and Anadromous Fisheries section of this report.

G. H. Jenkins, T. M. Humes, H. Jansen and A. K. Anderson

FRESHWATER AND ANADROMOUS FISHERIES

The Branch's freshwater and anadromous fish program has been characterized by continual change in response to the challenges of resource protection and enhancement in the Region. From a concentration of effort during the 1960's on the large New Brunswick salmon stocks threatened by over-fishing and hydroelectric development, the Branch has increasingly emphasized biological investigations related to the management of other anadromous species such as alewives, shad and striped bass, the development of recreational fisheries near urban centres, and the enhancement of Nova Scotia salmon populations. Budgetary cutbacks in the past two years have necessitated some reversal of this diversification, with many field projects being either terminated or curtailed. Among the victims in 1975 were the Kejimikujik Hatchery operation in Nova Scotia and the salmon escapement monitoring activity at Westfield on the Saint John River.

Despite the rather gloomy budget situation in 1975, decisions were made to reassign effort to certain urgent problems. Biological investigations on the Margaree River salmon and Annapolis River striped bass stocks were initiated. Increased emphasis was also given to bio-engineering investigations on the Nepisiguit River in northern New Brunswick, currently the largest salmon enhancement opportunity in the Region.

In 1975 the Section lost several key staff members. R. F. Hawkins, Supervisor of Hatcheries, retired for health reasons after 25 years of service with the Branch. Three senior hatchery managers, T. K. Lydon, R. G. Peverill and R. H. Webber, also retired in 1975. To the long-term benefit of the Branch, T. G. Carey, Head of the Fish Culture Program, was given a leave of absence in May to undertake an assignment with the aquaculture program of FAO in Rome. M. R. Robertson, senior management biologist, transferred to the Environmental Management Service of Environment Canada in Edmonton.

The loss of key fish culture personnel required new assignments for staff. G. B. Robbins was appointed Supervisor of Hatcheries. J. A. Ritter assumed the direction of the Section's Fish Culture Program for the period of T. G. Carey's leave of absence.

D. B. Lister

MIRAMICHI RIVER SALMON

Managing the salmon resources of the Miramichi River, a large river draining approximately 14,170 km² (5,457 mi²) of east-central New Brunswick, is an on-going job requiring collection and analyses of

data from a variety of field activities. These activities include trapping and tagging of smolt and adult salmon to gather information related to abundance, exploitation and migration; electroseining to determine spawning success and estimate juvenile salmon abundance; and collection of basic biological statistics on age, sex, average weight, length and condition. The variety of techniques used to monitor Miramichi salmon runs has also proved valuable in providing information on other anadromous species, such as alewife, shad and striped bass. Such information provides insight into relative run strength, run timing, and year-class strength of these other species.

Although the basic objective of the above mentioned activities is to provide information necessary to properly manage the salmon stocks of the Miramichi, other benefits have also been realized. Universities in Canada and the United States, as well as other government agencies, both provincial and federal, have utilized our expertise and gear to carry out various studies. These studies include work on nutrition, physiology, behaviour, etc. In addition, our own Fish Culture Group obtained its broodstock for both the Miramichi and Charlo hatcheries.

To round out a busy season, staff involved on the Miramichi have continued to work on such projects as the removal of the Bartholomew Dam or its provision with adequate fishway facilities to enable rehabilitation of the salmon run, a study of the interception of Miramichi stocks in the Newfoundland commercial fishery and possible ways of reducing that interception. Prediction of adult salmon returns to the river as a result of the restrictive regulations introduced in 1972 and the recommendation of locations for stocking hatchery-produced salmon smolts and underyearlings was also undertaken.

G. E. Turner

Adult Abundance, Timing and Exploitation

Indices of the strength, timing, composition and exploitation of the adult salmon run were obtained through operation of an estuarial sampling trap at Millbank. The trap was fished daily between mid-May and mid-November, a period which roughly corresponds with the open-water period on the Miramichi River.

In 1975, 1,208 large salmon (2-sea-winter or older) were caught at Millbank — approximately one-third less than in 1974, but essentially the same as the 1972 and 1973 catches. This 1975 catch was well below the long-term 1954-67 yearly average of 2,677 (Fig. 15). A dramatic decline of the late run began in 1968. Large salmon accounted for approximately 25% of the total sampling-trap catch in 1975, compared to approximately 31% in 1974 (Table 9).

The 1975 grilse (1-sea-winter) catch (3,548) declined approximately 12% from that of 1974, but was still significantly higher than recorded in 1972 and 1973. All grilse catches since 1972, the year the commercial salmon-fishing ban was instituted, have been well below the 1954-67 average (Fig. 15).

The most significant decline in catch of adult salmon at the sampling trap in 1975 was in the late

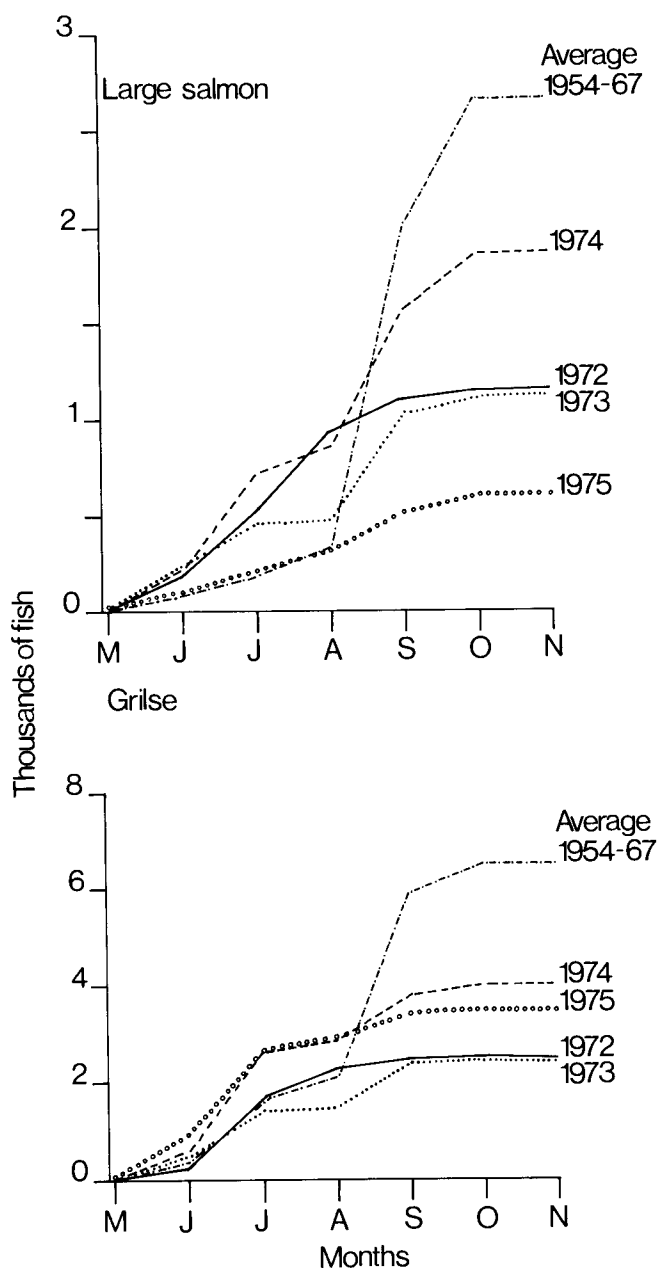


Fig. 15. Cumulative catch of adult Atlantic salmon at Millbank sampling trap in the Miramichi River estuary, New Brunswick.

run, which represented 40% of the total in 1975, versus 50% in 1974.

The average weight of large salmon taken at the sampling trap was down from 5.5 kg (12.1 lb) in 1974

to 4.9 kg (10.7 lb) in 1975. The average weight of grilse was up slightly, from 1.5 kg (3.3 lb) to 1.6 kg (3.5 lb). This decrease in size and the smaller number of fish have resulted in a decrease in potential egg deposition from 17.4 million in 1974 to 10.7 million in 1975. For large salmon, the percentage of females has remained the same. This 1975 level is well below the 17 million eggs which were calculated as being necessary at Millbank to indicate minimum river system spawning requirements. The late run contributed only 40% of the potential egg deposition, down 10% from that of 1974 (Fig. 16).

Between 1966 and 1974, 4,600 grilse and 3,252 large salmon were tagged at Millbank. In 1975, another 740 grilse and 265 large salmon were tagged. By October 31, 1975, 1,540 tagged grilse and 1,135 tagged large salmon had been recaptured from all sources.

Preliminary analyses of recapture data, used as an indicator of migration timing within the river (Table 10), showed marked differences in mean time to recapture between the early- and late-run grilse and the early- and late-run large salmon. With only one exception, those recovered at Curventon fence, grilse tagged during the early-run period took longer to reach the upriver recapture location than those tagged in the late-run period. Commercial and

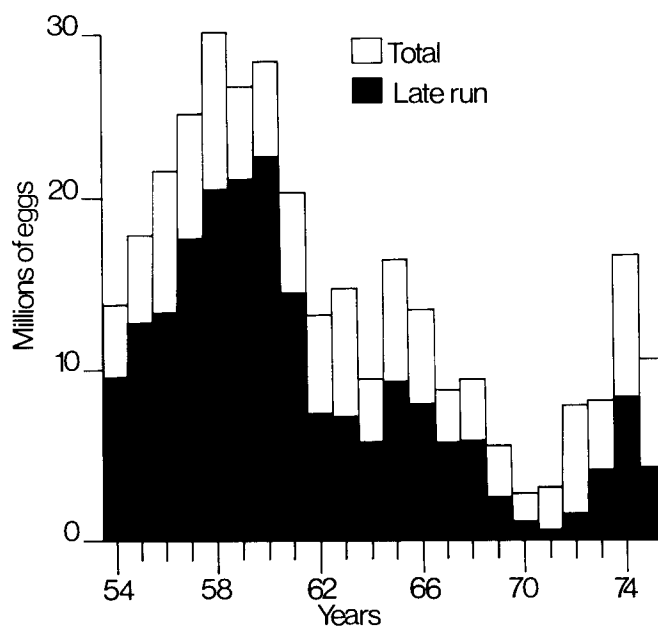


Fig. 16. Potential egg deposition to Miramichi River system of grilse and large salmon trapped at Millbank, 1954-75.

Table 9. Total sampling-trap catch and run-composition data, Miramichi estuary.

Year	Large salmon			Grilse		
	Annual catch	Catch per fishing day	Percent of total catch	Annual catch	Catch per fishing day	Percent of total catch
1954-60 av.	3,632	23.7	52.1	3,727	24.3	47.8
1961-70 av.	1,431	9.3	17.9	7,614	49.7	82.1
1973	1,132	7.1	31.6	2,450	15.3	68.4
1974	1,791	11.7	30.7	4,038	26.4	69.3
1975	1,208	6.9	25.4	3,548	20.1	74.6

Table 10. Mean recapture time for 1- and 2-sea-winter Atlantic salmon migrating into the Miramichi River. (Fish were tagged at an estuarial sampling trap — Millbank — between 1966 and 1974. Only those returns taken upriver of this site the same year were considered. Figures in parentheses indicate sample size.)

Location	Distance — tagging site to recapture site (mi)	Recapture method	Mean time to recapture (days)					
			1 sea-winter (grilse)		2 sea-winters (large salmon)			
			Early-run ¹	Late-run ²	Early-run	Late-run		
Main Miramichi	7.5	Commercial	17.7 (26)	5.5 (21)	10.8 (19)	11.3 (6)		
Forks of NW & SW Miramichi	9.0	Commercial	11.8 (68)	4.6 (35)	10.9 (32)	6.8 (14)		
Southwest Miramichi	16.5	Commercial	16.1 (11)	4.1 (36)	26.2 (18)	6.9 (15)		
	22.5	Angling	23.4 (28)	6.9 (10)	34.6 (9)	4.0 (6)		
	33.0	Angling	24.2 (49)	8.1 (9)	31.0 (26)	4.6 (5)		
	45.0	Angling	17.1 (21)	16.4 (5)	25.4 (10)	5.0 (3)		
	59.3	Angling	19.5 (23)	7.8 (6)	32.7 (14)	6.2 (5)		
	75.8	Angling	31.6 (13)	11.7 (3)	31.7 (4)	13.0 (1)		
Northwest Miramichi	10.5	Commercial	8.7 (15)	7.8 (25)	20.8 (13)	10.6 (14)		
	22.5	Angling	13.2 (27)	3.5 (2)	12.6 (16)	11.3 (4)		
	30.0	Fence	18.4 (30)	41.0 (4)	67.5 (10)	35.3 (4)		

¹May-August 15, inclusive.

²August 16-November 15, inclusive.

angling recaptures of tagged large salmon at the same sites demonstrated an identical pattern. That is, with one exception, those recovered at South Nelson, early-run tagged large salmon took considerably longer to reach upriver locations than did late-run large salmon.

Tag return data from the recapture traps operated on the Southwest and Northwest Miramichi rivers in 1972 and 1973 demonstrated the same pattern observed in commercial and angling returns discussed earlier. Without exception, early-run grilse and large salmon took longer to reach upriver recapture traps on both tributaries than did late-run grilse and large salmon. Further analyses of data showed that, with few exceptions, tagged early-run large salmon took longer to reach recapture sites than tagged early-run grilse.

G. E. Turner

Smolt Migration and Exploitation

During 1975, 25,753 wild smolts were trapped at two sites on the river — Millbank, in the estuary and Millerton, on the Southwest Miramichi. Of this total, 10,103 were tagged as part of the Branch's continuing studies on migration and exploitation of Miramichi Atlantic salmon in distant and home waters. Information from Branch smolt tagging on the Miramichi, which began in 1968, has been presented in various publications and is now being utilized by a technical committee comprised of representatives from the Maritimes, Quebec and Newfoundland. This committee is attempting to assess the magnitude, location



Use of a microscope in reading age and spawning data on Atlantic salmon scales.

and timing of interception of Maritime stocks in Newfoundland waters, and to determine the practicality of restrictions aimed at reducing the degree of interception.

Wild smolt trapped at Millbank and Millerton had an average sex ratio of 34 male:66 female. The average fork length was 13.0 cm.

G. E. Turner

Juvenile Salmon Abundance

Juvenile salmon population densities throughout the Miramichi River system have been measured annually since 1969 by means of electroseining. This year the electroseining program covered 89 stations on 26 selected tributaries.

Average fry density in 1975 (31.6/100 m²) was 1.4 times higher than estimated for 1974 and was the highest recorded since detailed Branch studies began on the system (Fig. 17). This reflects increased spawning escapement for the third successive year since the full commercial salmon-fishing ban was established and angling restrictions introduced in 1972. Fry levels this year exceeded the

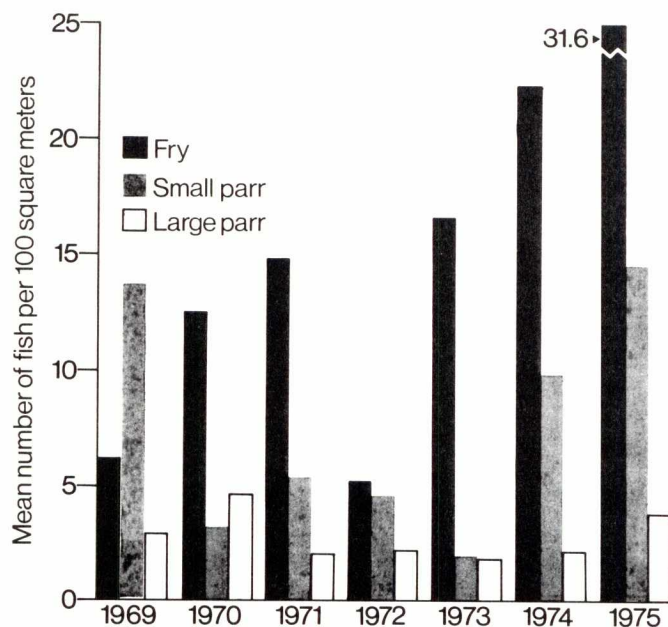


Fig. 17. Average yearly juvenile salmon densities for the Miramichi River system, 1969-75.

average recorded by the Fisheries Research Board in the 1952-61 period. Small parr density (14.6/100 m²) was 1.5 times that found in 1974 and was the highest since 1969. This, in turn, reflects the increased fry density found in 1974. Large parr density (3.8/100 m²) remained low, as expected. Overall improvements in the Miramichi salmon parr populations during the past two years should result in increased adult salmon runs beginning in 1977.

J. L. Peppar

Black Salmon (Kelt) Angling Study

Current New Brunswick fishery regulations permit the individual angler to land as many as five kelts per day but to retain only one. Data collected by the Resource Development and Conservation and Protection branches of the Fisheries and Marine Service indicate that the incidence of hook and release is significant, particularly with respect to grilse. The survival of released kelts has recently become an issue of concern for both conservation and economic reasons. The question has, however, remained unresolved, as kelts used in an earlier angling study



Typical hook (fly) placement in periphery of mouth, during salmon kelt hook-and-release study.

were exposed to previous handling and artificial hooking¹.

The fate of released black salmon was examined this spring in a hook and release study during late April and May. Sport fishermen and field staff angled 105 kelts in tidal and non-tidal reaches of the Southwest Miramichi and Renous rivers. Hook placement and stress were examined as primary factors relating to mortality, with live box studies and tag return data providing supporting information.

Results from angling efforts indicate that approximately 72% of hook placements were in the perimeter of the mouth cavity, in the maxillary, jaw angle and mandible areas (Table 11). Tissue damage was light, and blood loss negligible in virtually all cases. Only about 16% or 17 of the kelts successfully angled were hooked inside the mouth. About half of these experienced considerable tissue damage and hemorrhaging.

Decidedly moribund fish constituted only about 3% of the total catch at the time of angling. Holding studies, however, showed that angling or angling-related pressures cause a more significant mortality in hooked and released fish. Two kelts, or 12% of the group, held for periods of observation up to six days, expired one and three days after capture. All five kelt mortalities had been hooked towards the back of the buccal cavity, in vulnerable gill-arch, esophageal and tongue areas.

Preliminary tag returns from angling and commercial fisheries support the argument that hook placement inside the mouth does cause undetected mortality in released black salmon. Of eight returns to date, from local and distant water fisheries, not one has previously experienced primary hook placement within the buccal cavity.

Data collected during the study suggests that hook placement may be related to the onset of heavy feeding on forage fish in tidal waters as black fish

¹Klassen, G. A. 1975. Coronary disease in Atlantic salmon — some clues to human heart disease. *Atlantic Salmon Journal* No. 4: 16-17.

Table 11. Hook placement in Atlantic salmon kelts (grilse and large salmon) angled in the Southwest Miramichi and Renous rivers.

Hook placement	Number of fish	Percent of sample
Maxillary	19	18.1
Angle of jaws	11	10.5
Mandible	21	20.0
Maxillary-mandible	25	23.8
Roof	5	4.8
Gullet	2	1.9
Gill arches	4	3.8
Floor & tongue	6	5.7
Other combinations	4	3.8
Snag	8	7.6

migrate seaward. If this is the case, the total mortality of salmon kelts due to hook and release, estimated in this study at about 15%, has to be taken as an upper limit for the overall fishery, as much of the angling takes place in non-tidal water where salmon kelts do not feed.

T. G. Lutzac

Bright Salmon Angling Study

Bright salmon angling studies were initiated this year to determine the effect of hook and release on adults in their annual upstream spawning migration. Current New Brunswick fishery regulations do not permit hook and release of bright salmon.

The July study examined the effects of hook and release on early-run bright grilse fly-fished in Quarryville Pool, above the head of tide on the Southwest Miramichi River, where bright fish ascending this branch first encounter angling pressure.

Peripheral hook placement occurred for about 86% of the 28 bright grilse angled. About three-quarters of these were in the maxillary and angle of jaw areas, locations expected in normal behavioural response by salmon to insects at or near the water surface. The resulting tissue damage and bleeding was minimal and did not constitute serious injury to the fish.

The possibility of stress-related mortality, however, as indicated by blood lactic acid determinations, cannot be overlooked. Levels for 28 grilse averaged 32.5 mg/100 ml of blood and ranged between 24.5 and 47.1, for an average angling time of 7.3 minutes and range of 3-15 minutes. Blood samples were taken immediately subsequent to capture, as most fish were landed by anglers and were not available for peak blood lactic acid determinations. Some additional data from this study and work done on coho salmon in the Pacific, however, suggest that blood lactic acid levels increase at least 2- to 3-fold and peak about two hours after exercise.

If the critical level for potential mortality of 125 mg/100 ml blood for three species of Pacific salmon applies to Atlantic salmon, a tripling of blood lactic acid would put about 20% of the bright grilse angled



Landing a salmon kelt in the hook-and-release study, on Renous River.

in this study in danger of not surviving after release. This hazard would have applied to almost 60% of the fish if blood lactates had quadrupled. The question of potential angling mortality of released bright salmon requires further examination.

T. G. Lutzac

Hatchery Contributions

Approximately 32,700 smolts were produced by the Miramichi Hatchery for spring releases in 1975. About 18,100 of these were stocked as a supplement to reduced wild smolt runs from specific tributaries within the Miramichi system, while the remainder were allowed to migrate from the hatchery adult holding pond. About 10,100 stocked smolts supplemented runs from the lower reaches of the Northwest Miramichi River. The remaining 8,000 stocked smolts, together with 61,400 fall fingerlings from Miramichi Hatchery and 3,400 yearlings from Charlo Hatchery were distributed to three Miramichi tributaries currently undergoing salmon restoration.

RESTIGOUCHE RIVER SALMON

The Restigouche River has been one of the most famous for Atlantic salmon fishing for decades and has served both sport and commercial fishermen. That portion of the system located in the province of New Brunswick accounts for about 456 river kilometers of salmon water and approximately 27% of the total drainage area of northeastern New Brunswick. The system was second only to the Miramichi in the production of Atlantic salmon in Canada before a commercial fishing ban and angling restrictions were imposed in 1972. In New Brunswick, the Restigouche River system refers to the complex of the rivers Restigouche, Upsalquitch, Patapedia and Kedgwick.

Branch activities in the Restigouche River system, initiated in 1972, continued in 1975 to provide data necessary for the management of salmon stocks of this quality early-run stream. These activities have paralleled those on the Miramichi but are of much

more recent origin. Projects have concentrated on assessing effects of the commercial salmon-fishing ban and angling restrictions. Data have been collected on abundance, exploitation and migration of tagged adult salmon and wild smolt. Juvenile salmon abundance in the system has been monitored and basic biological data have been gathered on age, sex, average length and weight. Results of these activities to date have helped and will continue to help in assessing the effects of fishing restrictions on Atlantic salmon populations.

J. L. Peppar

Adult Abundance, Timing and Exploitation

Enumeration and tagging of a sample of Restigouche River adult salmon continued in 1975, utilizing a Chaleur Bay floating salmon trap, set just south of Bon Ami Rocks, Dalhousie. The trap allowed capture of both grilse and large salmon components of the ascending adult run. During the period May 12 - October 14, 1,430 large salmon (52.9%) and 1,275 grilse (47.1%) were captured (Table 12). Of these, 1,718 were tagged and released.

Timing of the large salmon run this year was similar to that recorded in 1974. Largest catches were obtained in the latter-June to mid-July period, with the peak (or highest catch/fishing day) recorded in the latter half of June. The catch of large salmon was the second highest recorded since sampling began in 1972; up 50% over the 1974 catch.

Timing of the grilse run was similar to previous years of trapping. Largest catches were obtained in July, with the peak (or highest catch/fishing day) recorded during the first half of July. The total catch of grilse was the highest recorded at the trap, up 82% over the 1974 catch.

During the 1975 sampling period, 172 large salmon and 249 grilse were sampled for sex ratio, length and weight. Average fork length was 83.7 cm for large salmon and 52.8 cm for grilse. Average weights were 6.5 kg and 1.5 kg for large salmon and grilse, respectively. Large salmon were 73.3% female

Table 12. Grilse and large salmon catch statistics, Restigouche sampling trap, Dalhousie, New Brunswick, 1972-75. (Dashes indicate trap not fishing; zeros indicate trap fishing, but no catch.)

Semi-monthly period		Total catch							
		Grilse			Large salmon				
		1973	1974	1975	1972	1973	1974	1975	
May	1-15	—	—	0	—	—	—	0	
	16-31	0	0	0	4	5	4	24	
June	1-15	2	0	0	81	385	127	115	
	16-30	33	61	277	806	496	419	653	
July	1-15	184	434	676	555	252	348	502	
	16-31	94	181	256	104	22	44	103	
Aug	1-15	9	12	39	3	3	3	10	
	16-31	0	2	10	3	0	0	6	
Sept	1-15	4	6	7	—	3	0	11	
	16-30	0	3	7	—	4	3	6	
Oct	1-15	—	1	3	—	—	1	0	
	16-31	—	0	—	—	—	1	—	
Totals		326	700	1,275	1,556	1,170	950	1,430	

and grilse, 4.4% female.

The increase in average weight, the higher percentage of females amongst the large salmon, and the increase in the number of large salmon in 1975 resulted in a higher potential egg deposition than in 1974 and 1973. The potential egg deposition for 1975 is probably the highest since the commercial salmon-fishing ban was instituted in 1972. Grilse were not captured in 1972; thus, the extent of the grilse run and potential egg contribution for that year is not known.

As in previous years, most recaptures of tagged large salmon and grilse by sport fishermen occurred in the main Restigouche River (Table 13).

Table 13. Sport-fishery recoveries of Restigouche River salmon, tagged as bright grilse or large salmon in 1975 at the Dalhousie sampling trap.

Recovery river	Grilse recoveries		Large salmon recoveries	
	No.	% of total	No.	% of total
Nepisiguit	1	4.2	0	0.0
Jacquet	1	4.2	0	0.0
Grand Cascapedia	0	0.0	3	4.8
Main Restigouche	10	41.7	25	39.7
Matapedia	3	12.5	9	14.3
Upsalquitch	6	25.0	5	7.9
Patapedia	0	0.0	1	1.6
Kedgwick	2	8.3	4	6.4
Little Main				
Restigouche	1	4.2	1	1.6
Other ¹	0	0.0	15	23.8
Totals	24		63	

¹Tags found on dead fish during Restigouche River fish kill, June-July, 1975.

J. L. Peppar

Smolt Timing and Migration

Wild-smolt tagging, initiated in 1973 to provide information on migration routes, timing and exploitation rates, was continued in 1975. During the period May 21 - June 20, 3,568 smolts were captured; 3,127 were subsequently tagged and released.

The smolt catch per fishing day peaked in early June and dropped off dramatically by mid-month, as in 1974.

Total reported adult recaptures to date have been primarily from smolts tagged in 1973. To date, eight of the 771 wild smolts tagged in 1973 have been recaptured as 1-sea-winter salmon (2-Newfoundland and 6-Greenland), and four as 2-sea-winter salmon (2-Newfoundland, 1-home water Restigouche and 1-Nova Scotia), for a total of 12, or 1.56% of the tagged releases. To date, two of the 1,139 wild smolts tagged in 1974 have been reported recaptured as 1-sea-winter salmon (1-Newfoundland and 1-home water Restigouche).

J. L. Peppar

Juvenile Salmon Abundance

Juvenile salmon population densities throughout

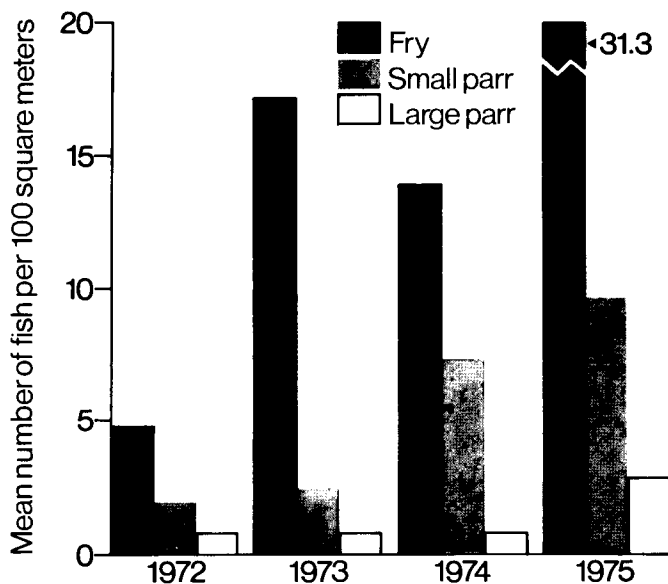


Fig. 18. Average yearly juvenile salmon densities for the Restigouche River system, 1972-75.

the Restigouche River system have been measured annually since 1972 by means of electroseining. This year the electroseining program covered 31 stations on 12 selected tributaries.

Average estimated fry density in 1975 (31.3/100 m²) was 2.3 times higher than in 1974, and was the highest recorded in the history of Branch activities on the system (Fig. 18). This reflects increased spawning escapement to the system since the full commercial salmon-fishing ban and angling restrictions were introduced in 1972. Small parr density (9.7/100 m²) was 1.3 times that recorded for 1974 and was the highest since 1972. Large parr density (2.8/100 m²) remained low, as expected. Overall improvements in the Restigouche salmon parr populations in the last two years should result in increased adult salmon runs to the system in the late 1970's.

J. L. Peppar

Adult Salmon Mortality

A survey of fishing camps, and federal and provincial agencies indicated an estimated 450-500 adult salmon were found dead in the Restigouche River system during the summer. The causative agent responsible for these mortalities was identified as the bacterium *Aeromonas salmonicida*, which causes the disease commonly known as furunculosis. The bacterium was isolated and identified by biologists and research scientists of the Resource Development Branch and Halifax Laboratory. Diseased specimens were collected and supplied by New Brunswick Fish and Wildlife Branch personnel.

First reports of dead fish originated from the main Restigouche River during mid- to late June and from the tributaries in early July. With the exception of one fish reported as late as August 5, few dead fish were reported after July 24. The disease appeared to have a greater effect on large salmon than on grilse.

Since this was the first isolation of furunculosis in the Maritimes Region, control procedures included the recommendations that anglers eviscerate their

catches on site, that mortalities be buried, that no broodstock be collected from the river, that broodstock trapped at Dalhousie be isolated from hatcheries and stocks in other systems, and that intense egg disinfection and disease inspection be undertaken of broodstocks and hatchery stocks in the Restigouche and Miramichi salmon management areas. Furunculosis was not diagnosed in Maritime river systems other than the Restigouche.

J. L. Peppar and J. M. Weber

Hatchery Contributions

A total of 10,000 salmon smolts of Restigouche origin was stocked in the system in 1975 from the Charlo Hatchery. The main Restigouche River, above and below the mouths of the Upsalquitch and Kedgwick rivers, received those smolts in equal proportions.

SAINT JOHN RIVER SALMON

The Saint John River is both international and interprovincial. Large hydroelectric developments and impoundments (Fig. 19) affect the quantity and quality of the freshwater habitat and migration routes of juvenile and adult Atlantic salmon. A brief outline of the history of power development on the system will assist in providing an understanding of the present physical nature of the Saint John River, and the rather difficult and technically complicated operations involved in maintaining and increasing its salmon resource.

Hydroelectric development began in the Saint John basin as early as 1906, when the large Aroostook River tributary in Maine was dammed near its mouth. Fish passage facilities are not in operation at this dam and the river is not presently utilized for Atlantic salmon production. The first hydroelectric dam in the Canadian portion of the Saint John basin was constructed in 1928, on the main stem at Grand Falls. A natural, impassable waterfall always existed at this site; and, because salmon were never historically able to ascend above Grand Falls, no fish passage facilities were installed in this dam. Tobique Narrows Dam, located near the mouth of the Tobique River, contains a large pool-and-weir fishway, which became operational in 1953. Beechwood Dam, on the main stem, was completed in 1957, and fish passage facilities are provided through a collection gallery and mechanical hoist or elevator.

The most recent hydroelectric dam on the Saint John was constructed in 1967 at Mactaquac, about 3 km (2 mi) above tide-head. Since Mactaquac Dam has no fishway as such, but rather a fish-collection system, salmon are trucked to upriver release sites to gain access to spawning grounds above. As this dam is the most downstream and largest of those mentioned above, it was natural for Fisheries authorities to be extremely concerned about its additive effects on natural reproduction of Saint John River salmon. Consequently, the Mactaquac Hatchery, which is located about 2.5 km (1.5 mi) below the dam, was also built in 1967. It plays a significant role in the fishery conservation provisions for the Mactaquac

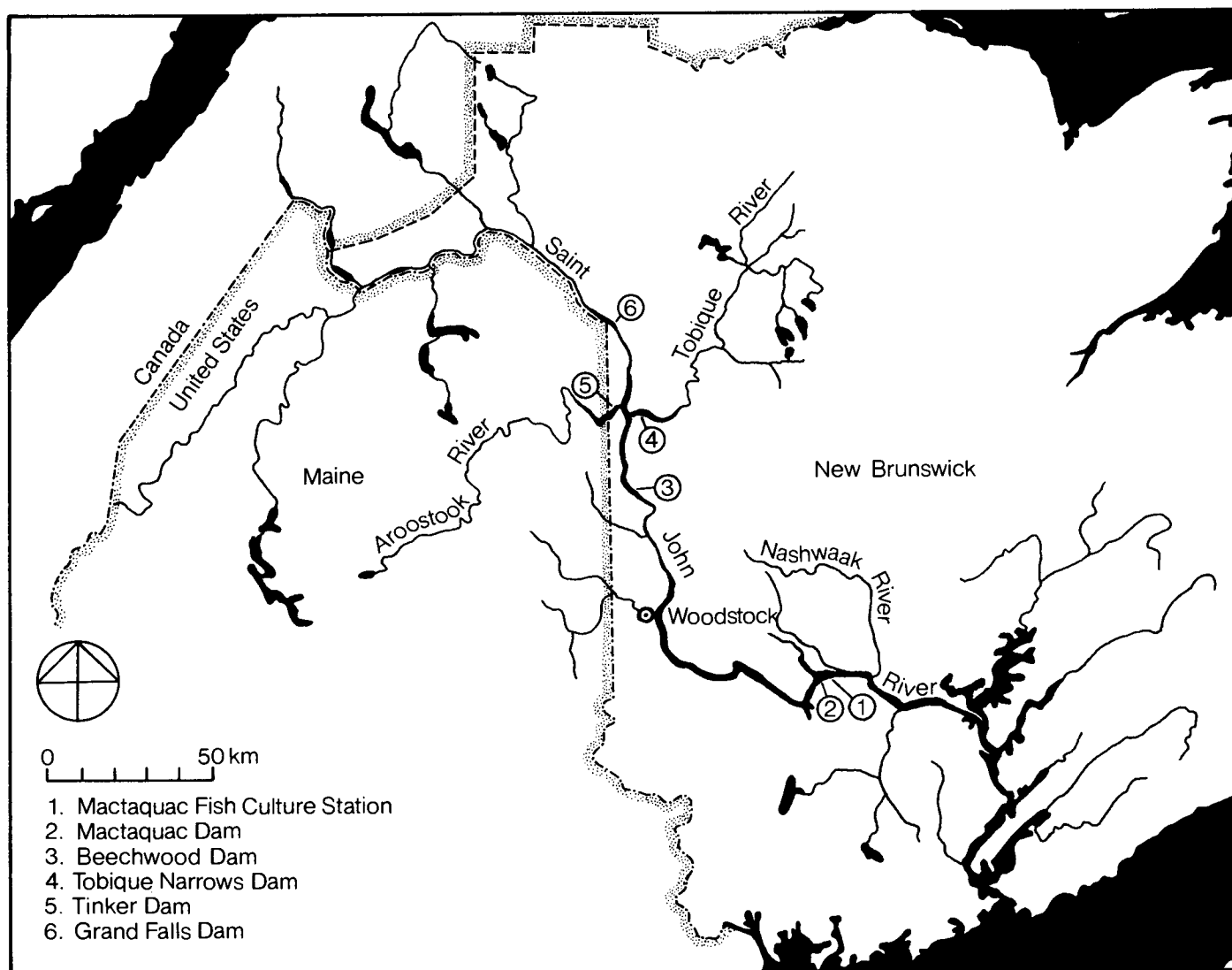


Fig. 19. Locations of hydroelectric developments on the Saint John River system, New Brunswick.

hydroelectric development, and in rehabilitation of Saint John River salmon stocks.

The Resource Development Branch has carried out various studies on both adult and juvenile salmon in the Saint John River each year since 1952, to obtain data necessary to effectively manage this species. The continuous collection and assessment of biological data, coupled with commercial and angling catch statistics, clearly demonstrated the serious decline in Saint John River Atlantic salmon stocks. Spawning escapements became dangerously low in the late 1960's and early 1970's. The need was evident for immediate and effective regulations designed to provide adequate spawning stocks and thereby perpetuate future generations of this valuable resource. Therefore, from 1969 to 1971, fishing restrictions in the form of a shortened season were imposed in the river and in the adjacent Bay of Fundy commercial salmon fisheries. A complete commercial fishing ban, to last for at least five years, began in 1972. Also, beginning in 1972, angling restrictions were imposed by implementing a shorter angling season in selected areas of the Saint John River, and in 1973 the daily bag-limit was reduced from four to two fish.

As a result of these fishing regulations, coupled

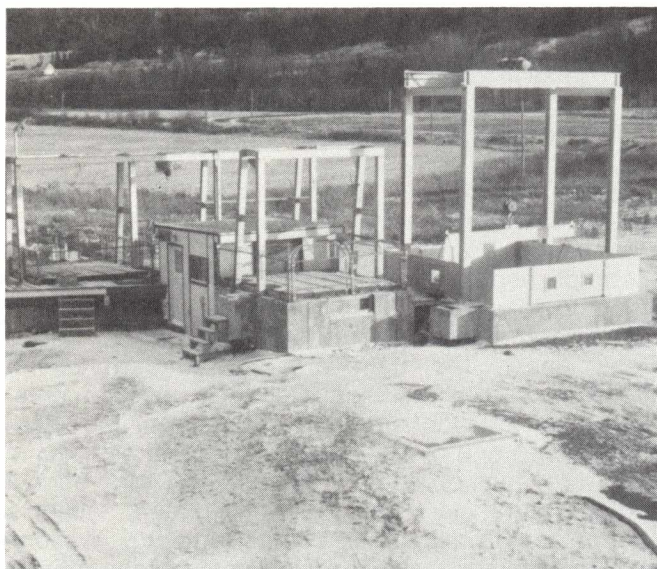
with the significant contribution by the Mactaquac Hatchery, escapement levels and resultant natural juvenile productions have improved dramatically in recent years.

There is now enthusiastic optimism that in the near future Saint John River salmon stocks will attain their present potential, enabling them to support a sustained yield for both commercial and sport salmon fisheries and, at the same time, provide required spawning escapement levels. Current activities in water-pollution abatement, present and anticipated future regulation and/or management of both the commercial and sport fishery for salmon, along with large-scale artificial propagation are expected to collectively triumph in revitalizing the Saint John River salmon stocks.

G. H. Penney

Adult Abundance and Migration

Adult salmon monitoring is carried out in the Saint John River each year to determine the abundance level of large salmon (2 or more sea-yr fish) and grilse (1-sea-yr) of both wild and hatchery origin returning to the river. Those fish not ascending estuarial



Expansion to secondary fish sorting facilities at Mactaquac Hatchery.

tributary streams or harvested through angling, incidental catches and special Indian food-fishing permits are intercepted and collected at Mactaquac — the first main stem hydroelectric dam. Of those fish collected at Mactaquac, a relatively small number are retained for hatchery broodstock. The remainder are trucked to selected upriver locations where they should most effectively reproduce in the wild environment. A small proportion of the fish trucked upriver are harvested by recreational angling.

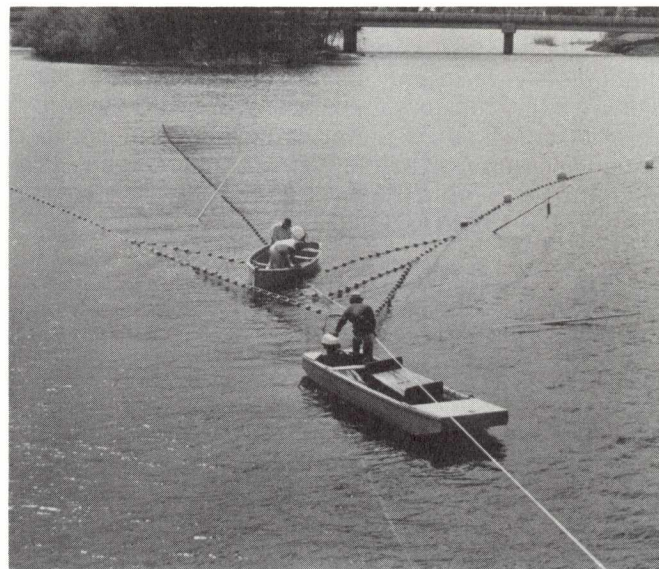
Since 1967, yearly adult counts at Mactaquac serve as a measure of wild adult returns from natural reproduction upriver, as well as a measure of returns from hatchery-produced smolts. Mactaquac is now the focal point for monitoring adult returns. However, additional adult monitoring in selected tributaries and at upriver hydroelectric dams is desirable and sometimes necessary to obtain information required for management of a particular tributary, and for assessing farther upstream movement of adults trucked to various release locations above Mactaquac.

A brief account of 1975 adult studies and preliminary results, along with various trend or comparison data follows. Conservation and Protection Branch angling-catch data and other local harvest information are also shown.

Nashwaak River Adult Trapping

The Nashwaak River (Fig. 19) is located below Mactaquac and contains extensive spawning and rearing areas for Atlantic salmon. Because of hydroelectric dams on the main stem of the Saint John and because of the location of the Nashwaak River, it has in recent years assumed increasing importance to the salmon angler and in contributing to the total of wild adult returns to the system.

Adult salmon trapping was not attempted in the Nashwaak River, 1974. However, in 1975, a floating trapnet was placed in the Nashwaak near the river's mouth. This was an attempt to determine the timing and magnitude of the early portion of the salmon run,



Spearhead trap, used to sample early-run adult salmon near mouth of the Nashwaak River.

until spring runoff conditions permitted installation of a conventional counting fence about 19 km (12 mi) upstream. The floating trapnet was in operation from May 16 to June 28, when the counting fence began fishing.

Adverse current conditions in the mouth of the Nashwaak resulted in ineffective operation of the trapnet. Consequently, only 15 salmon were captured, with the first being caught on May 16.

Fence counts in 1975 and 1973 (last year of fence operation prior to 1975) are summarized by month (Table 14). Yearly differences appear to be evident in the run size, timing and in proportions of salmon and grilse. These differences are not quantitatively comparable because of different dates of fence installation (June 28 in 1975 and June 13 in 1973), differences in duration of operation and differences in times when the fence was inoperative due to mid-season freshet conditions — during which times fish are free to ascend without being detected or counted. Low water conditions in one year and not in the other also account, in part, for differences in monthly counts between years.

Table 14. Monthly totals of adult Atlantic salmon in 1975 and 1973 at the Nashwaak River counting fence.

Month	1975 ¹			1973 ²		
	Salmon	Grilse	Total	Salmon	Grilse	Total
June	29	37	66	382	17	399
July	357	967	1,324	363	156	519
August	19	92	111	157	111	268
September	378	100	478	382	158	540
October	253	27	280	561	149	710
November	0	0	0	110	5	115
Totals	1,036	1,223	2,259	1,955	596	2,551

¹Fence removed on October 29.

²Fence removed on November 5.

Mactaquac Area

Total returns to Mactaquac of salmon and grilse of

wild and hatchery origin are shown (Fig. 20) for each year since 1967. Total returns have increased dramatically, from only 2,452 fish in 1967 to 19,085 fish in 1975. The salmon component in total returns is of most significance because of their egg carrying capacity compared to that of grilse. Salmon returns to Mactaquac have increased from a critically low level of only 770 in 1968 to 8,040 in 1975.

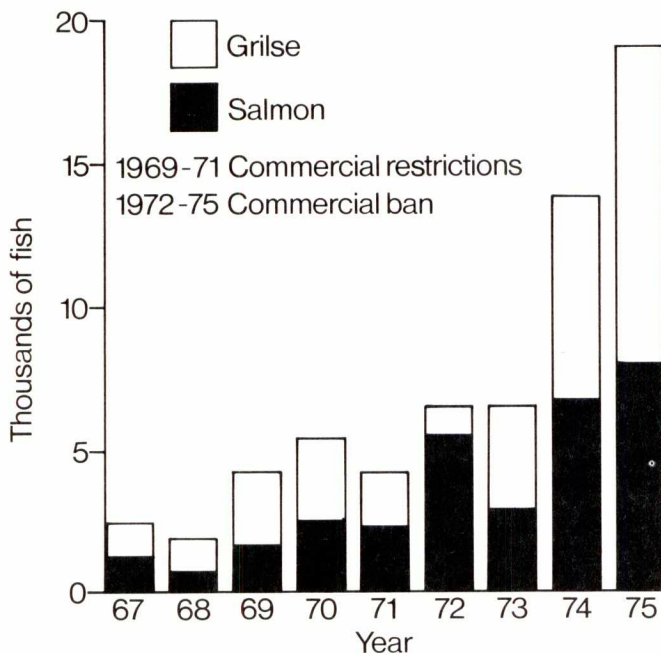
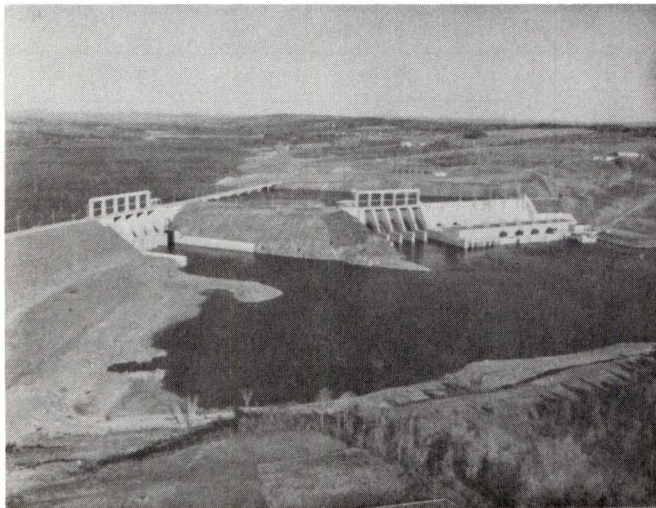


Fig. 20. Returns to Mactaquac of salmon and grilse of both wild and hatchery origin.

Highest counts at Beechwood Dam were in 1963, when 8,334 fish (1,130 salmon and 7,204 grilse) were passed over the dam. The highest count at Tobique fishway was in 1964, when 5,301 fish were counted through the fishway.

The commercial salmon fishing restrictions during 1969-71, followed by the complete commercial fishing closure, beginning in 1972, undoubtedly contributed to the recent increase in adult returns. Those originating from the Mactaquac Hatchery have made significant contributions by accounting for 39%



Aerial view of Mactaquac Dam.

of the total adult returns to Mactaquac (1973-75 average). Hatchery contributions will be dealt with in more detail in a later section.

Area Above Mactaquac

Beginning in 1967, when construction of Mactaquac Dam was nearing completion, distribution of adult salmon to the various areas above has been accomplished by trucking, mainly to the main stem at Woodstock and to the Tobique River. Distributions of salmon and grilse collected at Mactaquac to various areas above the dam are now undertaken in accordance with the estimated egg requirements. Also taken into consideration in determining locations, timing and numbers to be released at specific sites are the present demands for recreational angling, particularly with respect to the salmon's natural accessibility to traditional angling locations prior to Mactaquac. Juvenile year-class abundance found in various areas is also a consideration.



Release of juvenile hatchery-reared salmon in Little Tobique River.

Distributions to various areas since 1967 (Table 15) show the major changes evolved in the distribution pattern as being: (a) beginning in 1972, about a 70% reduction in numbers of fish retained for hatchery broodstock; (b) a larger proportion of fish now being released in the Tobique than at Woodstock, because of the much greater reproduction

Table 15. Distribution of salmon and grilse from Mactaquac, 1967-75.

Year	Broodstock selection	Trucked to Tobique	Trucked to Woodstock	Trucked to tributaries
1967	1,073	612	615	0
1968	889	420	681	0
1969	1,117	2,531	538	69
1970	1,007	3,245	1,105	0
1971	849	2,156	1,269	0
1972	319	2,747	3,095	0
1973	231	2,838	2,954	0
1974	253	8,301	4,166	1,045
1975	229	12,422	5,277	1,131

potential of the former; and (c) beginning in 1974, spawners being released directly into smaller tributary streams to ensure salmon production from these areas.

Fish counts are made each year at the Beechwood Dam, and percentages of salmon and grilse released at Woodstock and ascending to Beechwood are therefore available. Yearly percentages are variable (Table 16), with a 1967-75 annual average of 29% for salmon and grilse combined. Yearly variations are probably due in part to water quality and flow levels at release times and throughout the season, and to the genetic composition or make-up of fish released at Woodstock.

Table 16. Beechwood fishway counts 1967-75 and percent of Woodstock releases ascending Beechwood.

Year	Salmon		Grilse		Total	
	No.	%	No.	%	No.	%
1967	31	10	12	4	43	7
1968	25	40	39	6	64	9
1969	55	57	125	28	180	33
1970	30	9	166	22	196	18
1971	116	36	338	36	454	36
1972	573	23	241	40	814	26
1973	348	29	719	41	1,067	36
1974	725	45	967	38	1,692	41
1975	530	24	671	22	1,201	23
Means		28		30		29

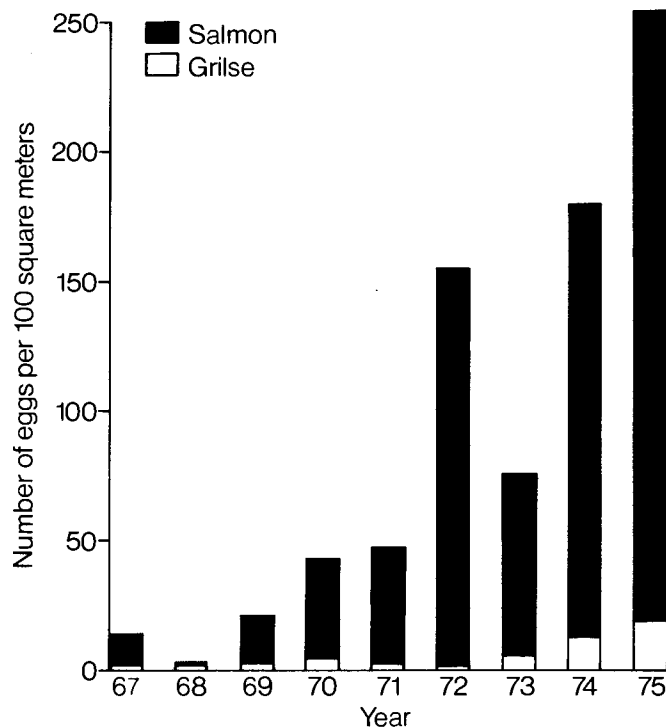


Fig. 21. Estimated salmon egg deposition per unit of production area in the Saint John River system above Mactaquac, 1967-75.

The precise numbers of salmon and grilse trucked each year to various areas above Mactaquac are known. By subtracting the reported angling catches, the theoretical numbers of salmon and grilse in the yearly spawning escapements can be calculated. By applying selected guidelines for sex composition and fecundity values of salmon and grilse, egg deposition per unit of estimated salmon production area can also be calculated.

The spawning escapement above Mactaquac has in 1975 reached a 15-fold increase over the very low levels in 1967 and 1968 (Table 15). Present estimates call for a minimum yearly spawning escapement above Mactaquac of 15,000-20,000 fish (1975 total = 17,722), depending on the proportions of salmon and grilse and their sex composition. A substantially increased yearly level of egg deposition per unit of area above Mactaquac has been achieved (Fig. 21). The comparatively small contribution by grilse compared to that of salmon is evident.

Adult Exploitation

With the commercial salmon fishery closure still in effect for the Saint John River, present exploitation of stocks occurs by angling; by incidental catches while commercially fishing for other species, such as alewives and shad; and by native Indians, who have special permits granting food-fishing privileges. Catch data are obtained from reports by the Conservation and Protection Branch.

Total angling catches of salmon and grilse in the Saint John River system (1967-75) are illustrated (Fig. 22). Since angling catches were first recorded in 1952, the lowest annual catches were taken in 1967 and 1968. As stock levels began to increase — as a result of the commercial fishing restrictions and closure, and hatchery contributions — angling catches also increased. In the past couple of years, angling catches below and above Mactaquac have been about 60% and 40% respectively of the total catch. Of the fish released above Mactaquac, the average annual reported angling harvest is only 7%. Salmon and grilse are on the average harvested in about equal proportions of 9% and 7%, respectively.

Incidental catches of salmon occur principally in commercial alewife and shad fisheries located in the

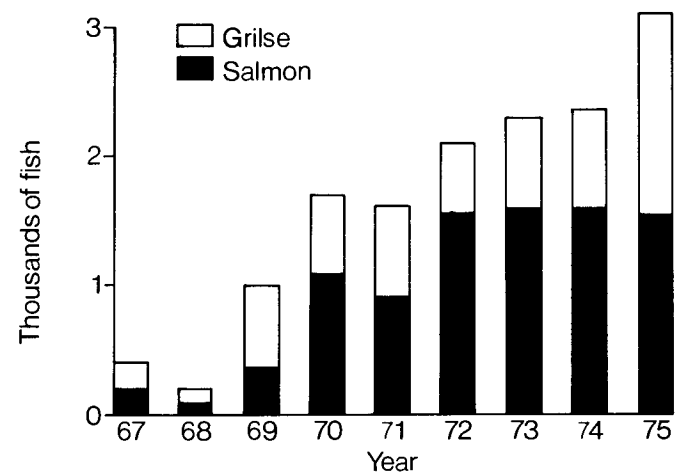


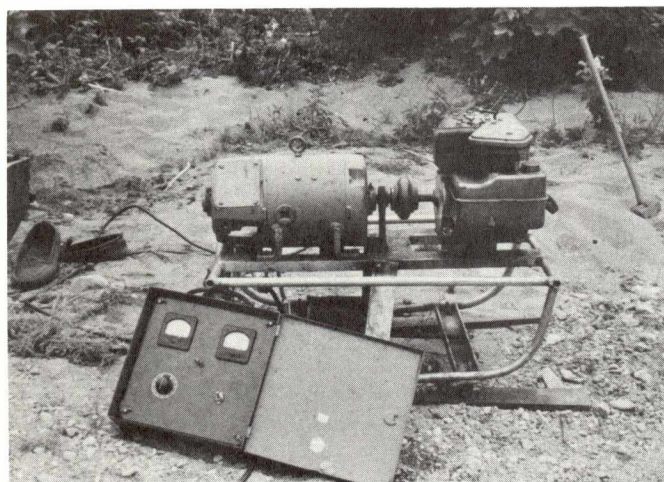
Fig. 22. Saint John River salmon angling catches, 1967-75.

estuarial area. Reported incidental catches for 1975 were 842 kg (1,872 lb).

In 1974, and again in 1975, the Kingsclear Indian Band was granted food-fishing privileges in the Saint John River waters adjacent to their reserve, located between the Mactaquac Dam and the Mactaquac Hatchery. As reported by officers of the Conservation and Protection Branch, this catch during August-October, 1975, totaled 325 salmon. The 1974 catch was reported as 140 salmon.

Juvenile Abundance

Juvenile abundance levels or densities are determined by electrofishing, which began in the Saint John River system in 1968 and has continued each year since. Sampling is carried out through the July-September period in various tributaries throughout the system to obtain quantitative and qualitative information on juvenile salmon populations. About 50 sites are sampled each year.



Electrofishing unit, used in sampling juvenile salmon populations.

Electrofishing results are not always precise indicators of juvenile abundance in a tributary or system due to factors such as water conditions at the time of sampling and instream movements of juveniles throughout the summer-autumn period in response to changing water levels and temperatures. The results do, however, indicate year-to-year differences in relative production throughout the system and can be related generally to a known spawning escapement. Electrofishing is also very useful in determining general levels of abundance following stocking of hatchery-produced juveniles, or of fry production resulting from releasing adult spawners directly into smaller tributary streams. Results also provide guidance in determining required numbers of hatchery juveniles or adult spawners to stock in specific areas.

An example of relating juvenile abundance levels to known spawning escapements is shown from electrofishing results in the Tobique River. Spawning escapements in the Tobique were very low from 1967 to 1973 and increased substantially in 1974. Fry densities resulting from low escapements were correspondingly very low until 1975, thus reflecting

the escapement levels (Table 17).

Mean fry densities of 26.3/100 m² in the Tobique River in 1975 are considered to be generally good. Mean fry density in 1975 in other tributaries above the Mactaquac Dam was 24.9/100 m², and in tributaries below Mactaquac it was 25.8/100 m².

Table 17. Spawning escapements in the Tobique River, 1967-1975 and fry densities in year following spawning.

Spawning year	Escapement (large salmon)	Fry densities (no./100 m ²)
1967	195	0.5
1968	86	< 0.1
1969	627	7.0
1970	1,025	7.9
1971	1,271	6.6
1972	2,567	12.1
1973	1,328	4.8
1974	4,268	26.3
1975	5,085	— ¹

¹To be determined in 1976.

Hatchery Contributions

Efforts to supplement the natural salmon production on the Saint John River through artificial propagation have been very successful in recent years. Adult returns originating from the Mactaquac Hatchery now provide a significant proportion of the total returns to Mactaquac (Table 18). The average yearly hatchery contribution over the past three years is 39% of the total returns. However, since 1973, of the hatchery-origin adult fish returning to Mactaquac, 72% were grilse, whereas the wild fish consist of only 45% grilse.

Table 18. Wild and hatchery-reared adult salmon returning to Mactaquac, 1967-75.

Year of return	Wild		Hatchery		Total run
	Number	Percent	Number	Percent	
1967	2,452	100.0	0	0.0	2,452
1968	1,973	100.0	0	0.0	1,973
1969	4,321	100.0	0	0.0	4,321
1970	5,323	98.3	94	1.7	5,417
1971	3,840	91.2	373	8.8	4,213
1972	5,691	87.2	838	12.8	6,529
1973	4,099	63.4	2,371	36.6	6,470
1974	8,215	59.3	5,632	40.7	13,847
1975	11,914	62.4	7,171	37.6	19,085

Included in the adult returns to Mactaquac in 1975 were 1,969 fish that were captured directly in the hatchery migration channel from which smolts are released. Ninety-nine percent of the adult captures in the migration channel were from smolts reared in the hatchery. In 1974, a total of 1,333 adult fish was captured in the hatchery migration channel and, again, 99% originated from hatchery-reared smolts.

Survival or return-rates of hatchery-reared smolts released directly into the Saint John River have improved considerably (Table 19). There is more than a threefold increase in percentage of adult returns to Mactaquac from hatchery smolts that were released

Table 19. Summary of adult returns to Mactaquac from hatchery-reared smolts released into the Saint John River each year, 1969-75.

Year of release	Number released	% returns to Mactaquac		
		Grilse	Salmon	Total
1969	170,182	0.055	0.021	0.076
1970	412,860	0.081	0.145	0.227
1971	352,933	0.067	0.139	0.206
1972	683,646	0.257	0.276	0.533
1973	361,711	1.035	0.512	1.547
1974	337,281	1.577	— ¹	—
1975	324,186	— ¹	— ²	—

¹First returns expected in 1976.

²First returns expected in 1977.

in 1973 and 1974, compared to returns from 1972 smolt releases. The higher return rates can be attributed generally to a much improved quality of smolts being released, beginning in 1973. Additional improvements in quality of smolts being reared can be expected to produce a still higher return rate in the future.

G. H. Penney

NOVA SCOTIA SALMON

Nova Scotia's salmon are produced in over 70 individual river systems distributed throughout the province. The province's commercial fishery and, to a fair extent, the sport fishery are also widely dispersed. The majority of salmon populations are small, numbering only a few hundred individuals. These factors make management of individual stocks extremely difficult.

During the past three years the Branch has increased its effort to determine the status of individual stocks, and to thus generate recommendations to improve the long-term yield to fisheries. The following sections provide a brief review of the fisheries and the results of recent investigations.

D. B. Lister and M. R. Robertson

Commercial Fishery

From the earliest times, the Atlantic salmon has played a notable role in the domestic and commercial history of Nova Scotia. Apart from a considerable aboriginal salmon fishery — which was carried out with the spear and the weir on such river systems as the Margaree, Shubenacadie and Medway — French fishermen, traders and entrepreneurs were reaping periodic harvests of salmon at Guysborough, St. Mary's, LaHave, Annapolis and around the shores of Cape Breton in the early years in the seventeenth century. Examination of nineteenth century documents shows that Nova Scotians were exporting as many as 8,000 barrels of pickled salmon annually,

representing 2.5 million pounds of fresh fish, of which approximately half was locally caught. Even as late as 1930, the commercial yield of salmon was reported to be almost a million and a half pounds.

By the late 1960's, the salmon fishery of the province had declined in both catch and effort to only a small fraction of the former magnitude; and, in 1971, a record low catch of 70,000 pounds was recorded, less than 5% of that reported for 1930. Since this latter date, however, a small but general improvement has been evidenced in the local commercial fishery.

Besides a trend toward an increase in commercial salmon catches over the past four years (Fig. 23), several other distinct trends have been noted in the fishery: increasing average weights of commercially caught salmon; increasing fishing effort since 1973, despite a reduction in the amount of salmon gear licensed; and a movement of the catch and effort pattern in the fishery toward the earlier part of the season.

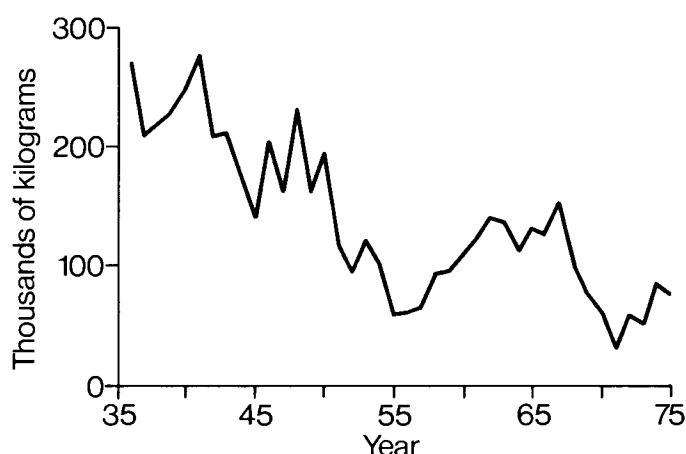


Fig. 23. Commercial catches of Atlantic salmon in Nova Scotia, 1936-75.

Sport Fishery

Although not as old as the commercial fishery, the sport fishery of Nova Scotia nevertheless goes back almost two and a half centuries in the history of the province, when angling for both salmon and trout was periodically undertaken throughout the latter half of the 18th century.

Although scattered records of angling catches for rivers in Nova Scotia may be found in various sources dating from the 1860's, no comprehensive system for collecting or recording such data was in effect until 1951. Fairly complete records for most rivers, however, have been assembled from 1936 (Fig. 24); and, for some of the more important rivers, more or less continuous records are available from 1868. Since 1935, the Nova Scotia angling figures reveal that the catch has fluctuated between 1,600 and 8,500 salmon and grilse per season, with the average seasonal catch for the period being 4,362.

An assessment of catch data and other material indicates that angling results for the 1867-1934 period might be expected to fall within the same general range of values as those reported for the 1934-1975 period. Apparent in those data for the

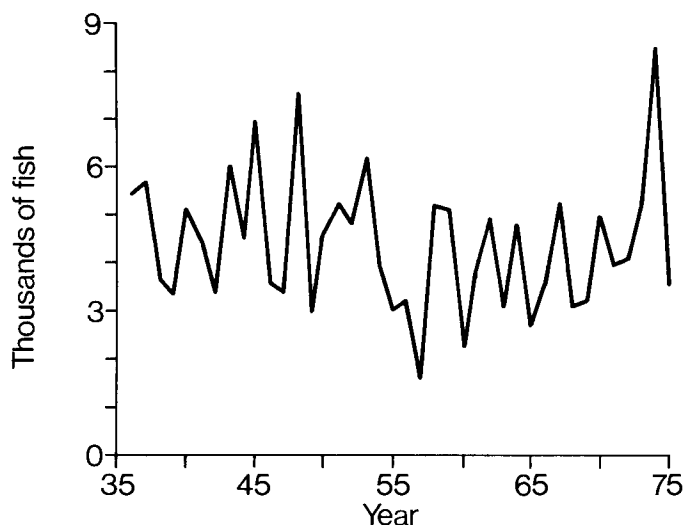


Fig. 24. Sport catches of Atlantic salmon in Nova Scotia, 1936-75.

latter period is that the overall sport fishery does not show the general decline which has been evident in the commercial fishery over the same period; in fact, the angling catch of 1974 was the best on record, and previous catches show very little in the way of an upward or downward trend over the long term.

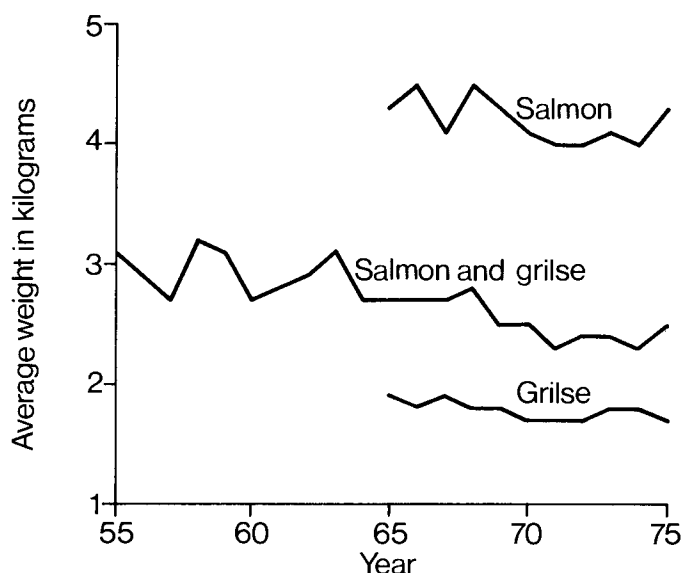


Fig. 25. Average weight of grilse and large salmon taken in the sport fishery of Nova Scotia, 1955-75.

Changes, however, have occurred in the sport fishery, one of the more significant being changes in the relative contribution of various rivers to the total catch. For example, of the 76 salmon angling rivers recorded in Nova Scotia, some have now ceased to attract the angler, others have failed to produce the catches of former times, and less than half a dozen streams now account for the majority of the province's catch. Striking examples of rivers which have declined in importance and angling productivity are the Tangier, Musquodoboit, Ingram, Mersey and Lawrencetown, which at one time collectively accounted for over 20% of the province's angling take. On the other hand, the LaHave, Medway, and the

salmon streams of Cape Breton have generally sustained good catches, although suffering short periods of recession. The St. Mary's and, in particular, the Stewiacke rivers are two streams which have increased their production of angled fish over the past 40 years. In 1975, the angling catch of the four rivers specifically mentioned above, comprised 64% of the total provincial figure.

A second trend which has occurred in the angling fishery of Nova Scotia is a trend to lower average weights in the angling catch (Fig. 25), a situation which reflects both a general increase in the percentage of grilse comprising the catch, and decreasing average weights of both the large salmon and grilse components.

R. W. Dunfield

West River, Sheet Harbour

The Atlantic salmon population in West River, Sheet Harbour, has been declining for at least a decade. Biological investigations on the river identified an annual production potential of 13,000 smolts, which would result in a return of at least 800 adults. Declining angling catches and commercial landings commensurate with low juvenile-salmon densities in the nursery area (Fig. 26) indicated that the salmon

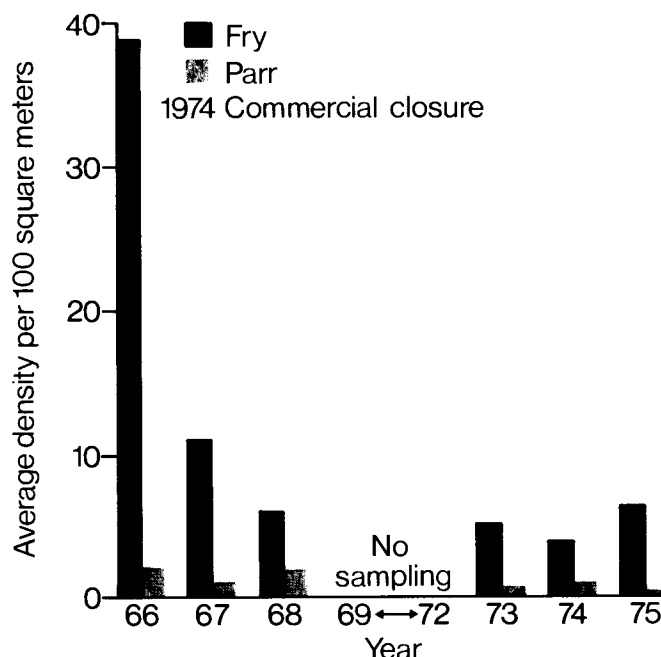


Fig. 26. Atlantic salmon juvenile densities in West River, Sheet Harbour, Nova Scotia.

population was in difficulty. Heavy exploitation by the sport and commercial fisheries critically reduced the potential egg deposition (Fig. 27). Hence, in 1974, measures were taken to restrict the commercial fishery. Following meetings with the Nova Scotia Salmon Association and the Eastern Shore Wildlife Association, this program was complemented in 1975 by an early closure of the angling fishery on July 7.

While benefits from the management strategies outlined above are long-term, it is evident that more

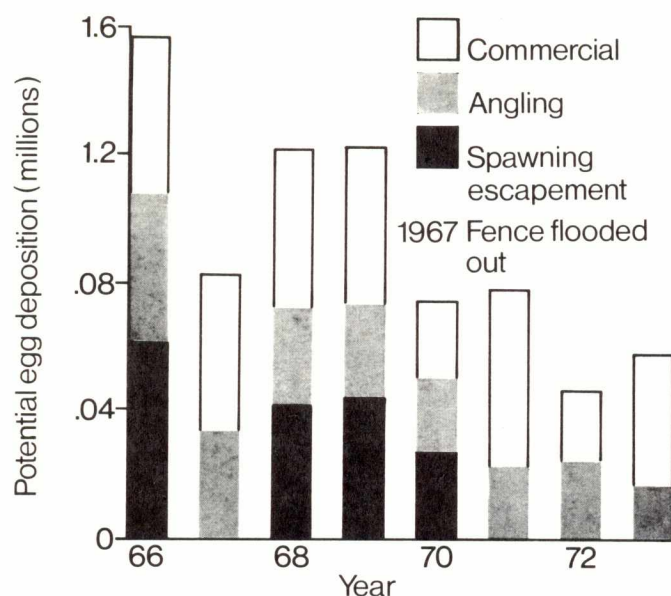


Fig. 27. Effects of exploitation on potential Atlantic salmon egg deposition, West River, Sheet Harbour, Nova Scotia. (Counting fence operation discontinued during years 1971-73.)

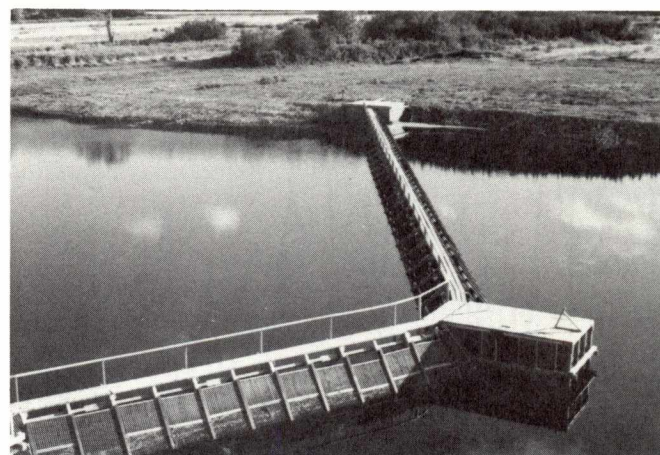
salmon are reaching the spawning grounds in West River. In 1975, electrofishing surveys indicated that fry densities had increased over those of recent years (Fig. 26). The 1975 angling restrictions to protect the salmon escapement were offset in large measure by the development of a new saltwater angling fishery not covered in the closures. As a result, an estimated 171 grilse and 4 salmon destined for spawning were taken; of these, 142 grilse and 3 salmon were angled in salt water. In order to control exploitation of this stock and maximize the number of spawning adults in the river, a review of the total program will be made before the 1976 season begins. To complement these restrictive regulations, a hatchery-stocking program — using East River, Sheet Harbour, stock — will be initiated to increase juvenile densities and maximize utilization of the West River nursery area.

R. W. Gray

St. Mary's River

The St. Mary's River, one of Nova Scotia's premier salmon-angling rivers, is located 208 km east of Halifax. Extremely low water conditions in the river during the summer of 1975 disrupted upstream salmon migration, as it did in most other rivers in the province. As a result, only 235 Atlantic salmon were angled in comparison to 1,478 in 1974. Commercial salmon landings in the district, however, increased to 2,018 kg in 1975 from 838 kg in 1974.

As a result of investigations carried out on the river in 1974, several conservation measures were recommended to increase the large-salmon component of the river, which has been steadily decreasing in recent years. It was recommended that a section of the East Branch of the St. Mary's River be closed to angling in 1975, to effect increased escapement of large salmon. Following meetings with the Nova Scotia Salmon Association, the latter recommenda-



Adult counting fence, St. Mary's River.

tion was implemented on July 7.

Although biological concerns were focused on the decreasing proportions of large salmon in the river, particularly the virgin 3-sea-yr salmon inhabiting the East Branch, electrofishing was undertaken at 15 sites to assess juvenile densities as a general indication of overall population strength. The data from these surveys are compared to information collected in 1969 (Table 20).

Table 20. A summary of average juvenile salmon densities per 100 m² found in the St. Mary's River in 1969 and 1975.

Location	1969 ¹	1975
East Branch		
Fry	46.0	25.6
Parr	17.6	5.0
West Branch		
Fry	11.1	10.8
Parr	5.1	8.2

¹J. R. Semple, pers. comm.

Although the data indicate that juvenile-salmon densities are below expected maximum sustainable levels for salmon nursery area, the influence of extreme low water on the results is unknown. While juvenile-salmon densities in the West Branch appear not to have changed significantly, densities in the East Branch have decreased substantially from those recorded in 1969.

Biological sampling of the commercial and angling fisheries was continued in 1975 for the second year. In order to manage salmon stocks in the river more effectively, more information is required on exploitation of St. Mary's stocks in distant and Atlantic fisheries.

R. W. Gray

Margaree River

Prompted by low sport catches of salmon, particularly in 1971, 1972 and 1974 (Fig. 28), the Resource Development Branch initiated investiga-

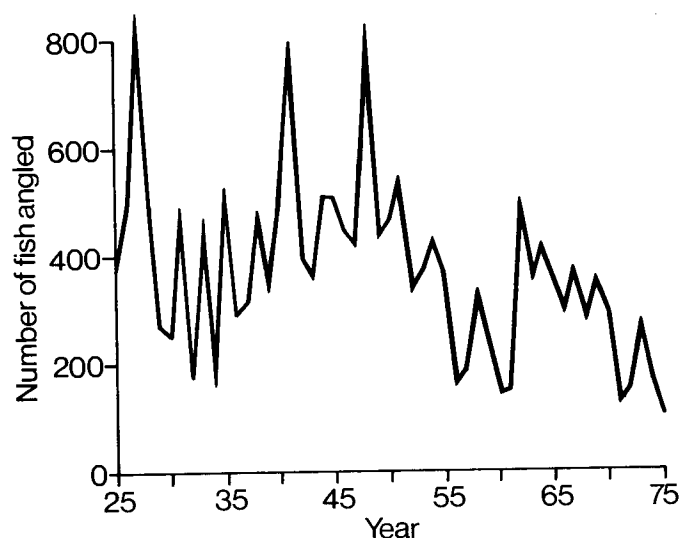


Fig. 28. Angling catches of Atlantic salmon from the Margaree River, Cape Breton, Nova Scotia, 1923-75.

tions to derive management recommendations for restoring the Margaree to its former prominence as one of Nova Scotia's best salmon rivers.

Past management strategies, aimed at reversing the general down-trend in harvest by sport fishermen during the past 25 years, have included an extension from 1961 to the present of the fall angling season, experimental bird control during 1963-68, and infusions of hatchery-reared juvenile salmon of various genetic backgrounds. Reevaluation of the results of these and earlier studies and management schemes, combined with a 2-yr assessment of the existing status and exploitation of the stock, are expected to culminate in the implementation of an effective management policy.

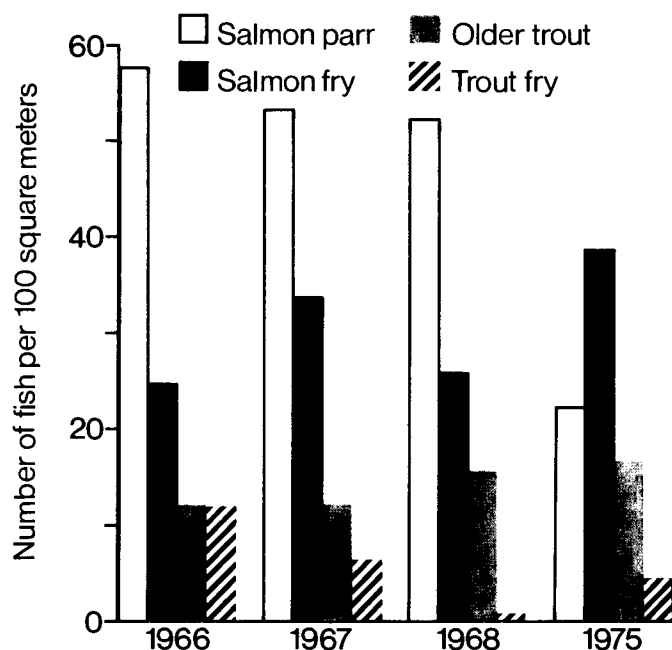


Fig. 29. Densities of juvenile Atlantic salmon and speckled trout, as indicated by electrofishing 15 sites on the Northeast Margaree River, Cape Breton, Nova Scotia. (Data for 1966-68 provided by Dr. P. F. Elson, formerly of the Biological Station, St. Andrews, New Brunswick.)

Field investigations in 1975 concentrated on the assessment of populations of juvenile salmon and trout at 22 stations on the Northeast Margaree and four stations on the Southwest Margaree. An overview of the present production is afforded by comparing results from 15 stations fished by the staff of the Biological Station, St. Andrews, (in conjunction with merganser control) as late as 1968 with results from the same stations in 1975 (Fig. 29). Statistical tests failed to indicate significant annual differences between the 1966-68 and 1975 mean densities of salmon fry, trout fry and older trout. However, the mean value of 22.4 salmon parr/100 m² in 1975 proved to be significantly lower ($p = < 0.01$) than the mean densities of 56.8, 52.4 and 52.6 parr/100 m² for the years 1966, 1967 and 1968, respectively.

The similarity in mean annual densities of salmon fry may be evidence of short-term stability in the spawning escapement of adult salmon. The difference in parr densities may indicate that bird control was effective in maximizing the production of salmon parr. The evidence of declining sport catches under previously high levels of parr production suggests the need to examine the success of parr in transforming to smolts, as well as the historical effects of local and distant commercial fisheries and past hatchery-stocking practices in effecting a change in the stock components and their run timing.

T. L. Marshall

SALMON DEVELOPMENT AND REHABILITATION

The basic objective of the development program is to achieve, where technically and economically feasible, full utilization of the spawning and nursery area suitable for Atlantic salmon production. Numerous opportunities exist in the Maritimes to develop self-sustaining salmon runs in inaccessible areas or in areas where impediments to natural production, such as mining pollution, have been removed. Project implementation most often requires background biological and engineering assessments, design and construction of fish passage facilities, and the initiation of a run through stocking with hatchery-reared salmon. The Branch's commitment of resources to such projects generally spans a 5-10 year period. Development activities conducted in 1975 are described below.

G. E. Turner, D. B. Lister and M. R. Robertson

Morell River

Biological investigations carried out in 1975 confirmed that an excellent salmon rearing potential exists in the Morell River, Prince Edward Island. However, the availability and particularly the quality of the spawning gravel is poor, due to the angular nature of the cobbles, siltation and the presence of dense aquatic vegetation.

Approximately 65% of the Morell River drainage basin remains forested and the water is practically free of domestic and agricultural contamination. No obstructions prevent salmon migration. Historically, the Morell was one of the best salmon streams on the

Island and, though the stocks have dwindled, it still has the best immediate potential for salmon production; hence, it was selected for development work.

Salmon habitat in the Morell River was estimated at 2,000 rearing units (100 m²), with a spawning to rearing area ratio of 1:7.5. Forage and protective cover for juvenile salmon were plentiful throughout. If conservative juvenile survival estimates are applied, the area has a production potential of 4,700 smolts annually. Juvenile salmon population studies revealed the absence of fry and a low parr density (Table 21). Ninety-seven percent of the parr sampled were age 1 +, ranged from 12.0 to 19.5 cm and averaged 14.2 cm in length.

Table 21. Fish population densities in the Morell River, Prince Edward Island, 1975.

Species	No. of fish/100 m ² (average of 5 stations)
Fry	0.0
Parr (1 +)	3.4
Speckled trout	8.0
Eel	13.3
Stickleback	4.6

In late May, 8,873 hatchery-reared smolts were released in the headwaters of the Morell. Trapnet recaptures at the mouth of the river showed that 79% of the stocked fish left the river within ten days of release (Fig. 30). Based on information acquired during the 1975 investigations, it is proposed to begin plantings of 20,000 smolts annually and seeding the river with underyearlings as soon as possible, in an effort to fill the presently under-utilized ecological niches. Preparations are being made at the Cardigan Hatchery to accommodate this expanded commitment.

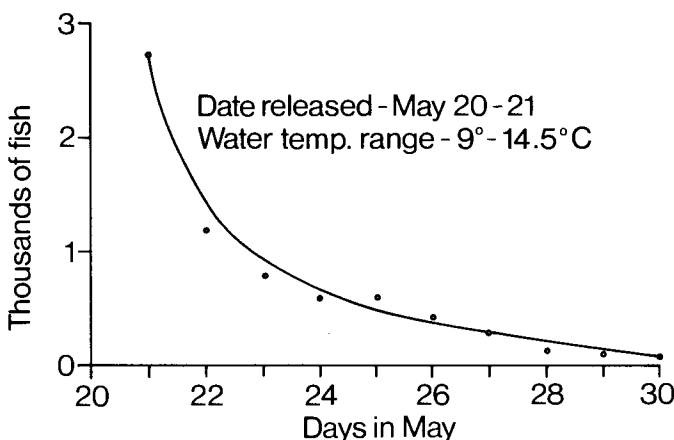


Fig. 30. Recaptures of Atlantic salmon smolts, six miles below their release point in the Morell River, Prince Edward Island, 1975.

L. J. A. Ducharme

Tetagouche River

The Tetagouche River, flowing due east into

Bathurst Harbour, New Brunswick, drains 364 km² of heavily forested country. With a meander length of 69 km, a stream gradient of 7.5 m/km and a bottom composition of clean gravel and small boulders, the entire stream is excellent Atlantic salmon habitat. However, Atlantic salmon are unable to negotiate a 10.5-m natural falls located 14.5 km from saltwater.

Since nearly 80% of the total salmon rearing grounds in the river lie above the obstruction, plans for the development of a salmon run to the area above Tetagouche Falls were made in the early 1970's. A feasibility study report — bearing mainly on the physical, biological and water quality aspects of the river — is now completed.

In 1975, engineering field surveys were carried out to finalize site details for future fishway construction. The functional and structural design of the fishway to be constructed at Tetagouche Falls was also completed. The cost of construction is currently estimated at \$300,000 and the cost:benefit ratio is estimated at 1:2.2. Construction could proceed in 1976, should funds become available.

L. J. A. Ducharme

Nepisiguit River

The Nepisiguit River, with a drainage basin of 2,340 km², represents the largest single salmon development opportunity in northeastern New Brunswick. Salmon production in the Nepisiguit is presently limited to a 29-km section of the river below the 33-m obstruction at Grand Falls. This obstruction consists of a 23-m natural falls, crested by a 10.5-m concrete hydro dam. Salmon waters above Grand Falls consist of 88 km of main stream and approximately 160 km of tributary streams, capable of supporting an adult run of 8,000-10,000 fish.

Pollution, in the form of heavy-metal contamination from mining activities and effluents from a pulp mill, has compounded the problem of development; however, ongoing pollution-abatement programs have reduced contamination to tolerable levels. The most recent favorable development in controlling pollution was the agreement obtained in 1975 from Cominco Limited for the permanent filling and sealing of the Wedge Mine open pit. This pit had been

Table 22. Distribution of Atlantic salmon juveniles in the Nepisiguit River system, 1975.

Release site	No. of fish released		
	0 +	1 +	2-yr smolts
Main Nepisiguit above			
Indian Falls	35,154	0	0
Forty Mile Brook	10,230	0	0
Nine Mile Brook	17,670	0	0
Pabineau River	0	6,000	0
Main Nepisiguit below			
Pabineau Falls	0	0	10,000
Totals	63,054	6,000	10,000

created by the collapse of the mine's main stope roof in 1970, and seepage from it has intermittently contaminated the nearby Nepisiguit River.

In 1975, biological field activities included the release of 10,000 2-yr-old hatchery-reared smolts of Restigouche River origin and of nearly 70,000 juvenile salmon in the fall to various parts of the watershed (Table 22).

Population-density investigations in the 29-km river section below Grand Falls revealed near complete depletion of juvenile salmon stocks.

A comprehensive feasibility report on the project will be completed in 1976 to support a proposal for the opening of the river above the falls; in the interim, the seeding of fall under-yearlings will be continued on a larger scale to take immediate advantage of the enormous rearing potential of the river.

L. J. A. Ducharme

Bartholomew River

The Bartholomew River flows into the Southwest Miramichi at Blackville, almost 16 km above the head of tide. It is conservatively estimated that this stream could produce a run of 1,300-1,600 adult salmon. About 56% of the 48 km of main stream below the forks of the North and South branches is fully open to public angling. A further 27% is open to the public for one-half the stream width. If an exploitation rate of 25% is assumed, a fully restored salmon run to this stream could produce an annual angling catch of 325-400 adult fish. This potential surpasses the actual catch of approximately 60% of the New Brunswick streams and almost 90% of the Nova Scotia streams in which salmon were angled in 1975. The Bartholomew River, unfortunately, has not realized such a run for at least the past century.

A sporadically functioning timber fishway, associated with a deteriorating rock-ballast timber dam just above the mouth of the river at Blackville, has proven to be a major factor in the failure of previous attempts at salmon restoration. For example, salmon fry produced from the 1974 adult run were over 200 times more numerous below the dam (127.4/100 m²) than above.

With plans for the removal or replacement of the dam and fishway scheduled for 1976, a salmon restoration program was initiated this year. Included was the enumeration and tagging of adult salmon at the fishway, expansion of juvenile studies, stocking of about 8,000 tagged smolts and 54,300 hatchery-reared fry and the assessment of returns from hatchery-reared smolt plants of 1973 and 1974. Data



Bartholomew River dam, Blackville, New Brunswick, during spring freshet conditions.

from adult returns at the fishway suggest that the selection of parental stocks from certain specific home streams may help to produce a significantly better return of planted smolts than parental stock of a more general origin. Projected adult returns from hatchery-reared smolts of North Pole Brook early-run parentage are expected to be 20-30 times greater than from those of main Miramichi River late-run parentage (Table 23).

Continued hatchery and wild smolt production from selected stocks, including Bartholomew River adults, is expected to provide an adult salmon surplus available to angler harvest beginning in about 1979.

T. G. Lutzac

Northwest Millstream

The Northwest Millstream flows into tidal waters of the Northwest Miramichi near the community of Whitney. This stream has the potential to produce a run of about 600 salmon. The lower 40% of the stream, consisting mostly of private waters or surrounded by private land, is suitable for harvesting salmon by conventional angling methods. Because of a concrete dam at km 3.5, which was constructed in 1947 without a fishway, only the lower 12% of the main stream has the potential to receive adult salmon.

As more than 80% of the salmon-producing potential is situated above the dam, and as the headpond is required for the operation of a local kraft mill, Branch engineers will be examining the problem

Table 23. Adult salmon returns to the Bartholomew River from hatchery-reared smolts planted in 1973 and 1974.

Parental generation				Returns		
Collection site	Stock origin	No. smolt planted	Year planted	Grilse	Large salmon	% of no. stocked
Main Miramichi	Late	8,144	1973	5	3	0.1
North Pole Brook	Early	2,366	1974	28	—	2.0-3.0 (est.)

with a view to providing fish passage facilities.

Restoration work in 1975 included stocking of about 7,100 hatchery-reared fall fingerlings, the expansion of juvenile studies, and the stocking of a small number of bright large salmon immediately prior to spawning.

Electrofishing studies indicated that a good proportion of the 3,000 juveniles stocked as 5-cm fingerlings in August, 1974, overwintered above the dam and showed an average 2-fold increase in fork length.

During late October, twenty-four late-run large salmon, including equal numbers of males and females, or about one-fifth of the estimated seeding requirements for the system, were trucked to the stream and stocked above the dam in the vicinity of good sections of spawning gravel. Juvenile studies and assessment of adult returns in future years are expected to provide data on the suitability of adult and juvenile transplants in the restoration of salmon runs to smaller late-run streams flowing into tidal and estuarial reaches of the Miramichi system.

T. G. Lutzac

Tomogonops River

The Tomogonops River flows into the Northwest Miramichi approximately 54 km above the head of tide. The release of base-metal mining wastes in the 1960's was directly responsible for the elimination of the traditional fall salmon run to this stream. In recent years, however, effluents have been reduced to the extent that waters in certain areas of the Tomogonops contain copper-zinc levels generally less than the reported avoidance levels for Atlantic salmon. The portion of the stream currently accessible to adult fish could produce as many as 200 returns, about half of which would be in excess of the required spawning escapement and could be harvested in salmon fisheries below the confluence of this river with the Northwest Miramichi.

An attempt at salmon restoration, using selected hatchery-reared stocks, was initiated in 1974. Five-cm fingerlings were stocked in late August in an unpolluted headwater area known to have an abundance of stream benthos important in the diet of juvenile salmon. These plants gave rise to a 1975 parr density of 43.1/100 m² in the stocking area, and the movement of some of these individuals as far as 16 km downstream into an area continuously subjected to sublethal levels of mine effluent. Electrofished parr grew to an average fork length of 9.5 cm, nearly doubling their size after one year in the stream. In the fall of 1975, approximately 3,400 tagged yearling pre-smolts were stocked above and below the entry point of mining effluent to the main stream. These stocks are expected to contribute to adult salmon runs of future years.

T. G. Lutzac

East River, Sheet Harbour

The East River is located 128 km east of Halifax. An Atlantic salmon restoration program was initiated

in 1966 to rehabilitate the salmon population endangered by extensive hydroelectric development on the river. In 1974, a hatchery stocking program was initiated to supplement the adult transplantation program. Currently, the restoration program involves collection and distribution of returning salmon to the headwater spawning areas, and release of hatchery-reared juveniles in the river. The commercial salmon fishery in the estuary and the salmon angling fishery in the river have been closed to protect returning spawners.

The freshwater survival of progeny from naturally spawning salmon in East River has been excellent — $1.60 \pm 0.61\%$ for the broodyears 1966-71. The highest wild smolt run on record for East River occurred in 1975, when 4,600 were counted in the Ruth Falls louvers. In addition, over 1,500 smolts resulting from plantings of yearling hatchery-reared parr in 1974 were enumerated at the louvers. Survival of these fish in the wild from the yearling parr to the smolt stage, assuming complete smoltification, was 20.4%. Of 22,000 hatchery-reared 2-yr smolts of St. Mary's River stock, 16,000 were released in the river below the louvers, and 6,000 were tagged and released above Malay Falls to assess fish passage facilities.

The adult return rate of the wild East River stock has improved substantially since the commercial salmon fishery closure in 1974 (Table 24). A total of 86 1-sea-winter wild salmon, one 2-sea-winter wild salmon, and three wild repeat spawners returned in 1975; in addition, 31 1-sea-winter hatchery-reared salmon returned to the Ruth Falls collection facilities.

Table 24. Wild smolt to adult return rate for East River stock, 1969-74.

Year of emigration	Estimated no. of smolts reaching the sea	No. of adult returns		Adult return (%)
		1-sea-yr	2-sea-yr	
1969	3,797	31	1	0.84
1970	980	19	0	1.94
1971	3,276	111	2	3.45
1972	1,475	29	0	1.97
1973	1,770	87	1	4.97
1974	2,143	86	n/a	4.01 ¹

¹2-sea-winter salmon will return in 1976.

R. W. Gray

LaHave River

In 1970, a salmon enhancement program was initiated on the LaHave River, located 77 km west of Halifax. Currently, the program involves assessing the salmon run in the main and north branches of the river, stocking hatchery-reared smolts in the river, sampling the angling and commercial salmon fisheries of the river and estuary, assessing the gaspereau population at two fishway traps in the main and north branches of the river and controlling the ascent of lampreys at these traps. To accelerate the development of a self-sustaining salmon run to the upper LaHave River, an area from the pool immediately below Morgan Falls to the headwaters —



Juvenile salmon reared from eggs from recycled kelts are released in the LaHave River.

including all tributaries of the main branch — was closed to salmon angling, thereby protecting adult spawners.

In 1975, a total of 503 1-sea-winter and 71 2-sea-winter salmon, resulting from hatchery plantings of yearling parr and smolts, ascended the Morgan Falls fishway. In addition, 39 1-sea-winter and five 2-sea-winter wild salmon were counted in the fishway trap. Forty-three 2-sea-winter and six 1-sea-winter salmon, mainly hatchery-return fish, were collected from the trap as broodstock for the hatchery stocking program. Returns to the fishway from this stocking program have been encouraging — 1.02%-1.26% of the juvenile salmon which emigrated as smolts. Spawning escapements above Morgan Falls from salmon of both hatchery and wild origin are illustrated (Fig. 31). Salmon continued to fall back at Morgan Falls in 1975, despite the fact that an artificial resting pool was created at the fishway exit. Actual run size was calculated from recaptures of tagged adults which had dropped back and reentered the fishway trap one or more times.

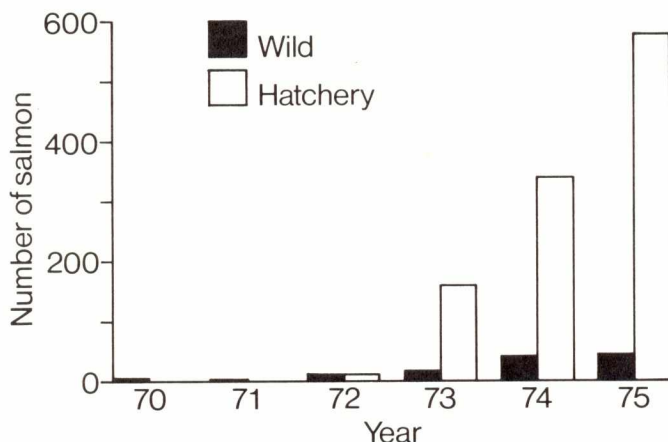


Fig. 31. Atlantic salmon of wild and hatchery origin counted at the Morgan Falls fishway, LaHave River, 1970-75.

At Morgan Falls in 1975, 6,789 lampreys (*Petromyzon marinus*) were collected; those not

donated for scientific research and laboratory study were destroyed. In addition, 12,723 gaspereau (*Alosa pseudoharengus*) were enumerated and released upstream for spawning; ten speckled trout (*Salvelinus fontinalis*) and 18 salmon parr also ascended the fishway.

A fishway trap was operated at Indian Falls on the North Branch of the LaHave River in 1975, for the second year. Low water conditions and poor entrance characteristics delayed upstream movements of salmon through this fishway. In 1975, 269 1-sea-winter and 49 2-sea-winter wild salmon ascended the fishway, compared to 232 1-sea-winter and 51 2-sea-winter wild salmon in 1974. Biological data on age composition, length and sex were collected from salmon in the fishway trap. Although many salmon were observed attempting to leap Indian Falls at certain times during the summer, no estimate of success was made.

Through regular daily sample counts at Indian Falls in 1975, the gaspereau run was estimated at 660,000. Tagging and release experiments did not identify any fallback or reentry of gaspereau in the fishway. A total of 187 lampreys was collected in the trap and destroyed to prevent upstream spawning.

R. W. Gray

Liscomb River

The Liscomb River, located in Guysborough County, Nova Scotia, drains an area of 400 km². The river is completely obstructed by a natural falls and hydro dam on its crest, 3.2 km above tidewater. Above the falls, 828,800 m² of excellent salmon nursery habitat and 764,000 m² of fair nursery habitat exists. This area has an annual production potential of 40,000 - 50,000 salmon smolts, with a projected return of at least 2,400 - 3,000 adults. In addition, the inaccessible portion of the river can support an annual run of 400,000 gaspereau, as well as other species such as sea-run trout and the American eel (*Anguilla rostrata*).

Since the small hydroelectric generating station at Liscomb Falls was to be phased out, meetings were



Liscomb Falls hydroelectric station, where fish passage facilities are to be constructed in 1976.

held in November, 1975, with the Nova Scotia Power Corporation and the Nova Scotia Department of Environment to discuss fisheries requirements after its abandonment. All previous planning with regard to fish passage presupposed the continued operation of the hydro plant; hence, the decision to close down the station necessitated the development of a new plan. To obtain the essential engineering field data, the Resource Development Branch coordinated and conducted field surveys, with manpower assistance from the Nova Scotia Power Corporation and the Nova Scotia Department of Environment. Following analysis of this data, several alternatives, involving river diversions to bypass the 7.5-m natural falls, were examined. A decision was made to modify the side channel by removal of rock and by construction of concrete drop-structures to provide suitable fish passage conditions. Removal of the existing dams will be coordinated with the Nova Scotia Power Corporation, so as to be phased in with the channel modification. Work is scheduled to begin in early summer, 1976.

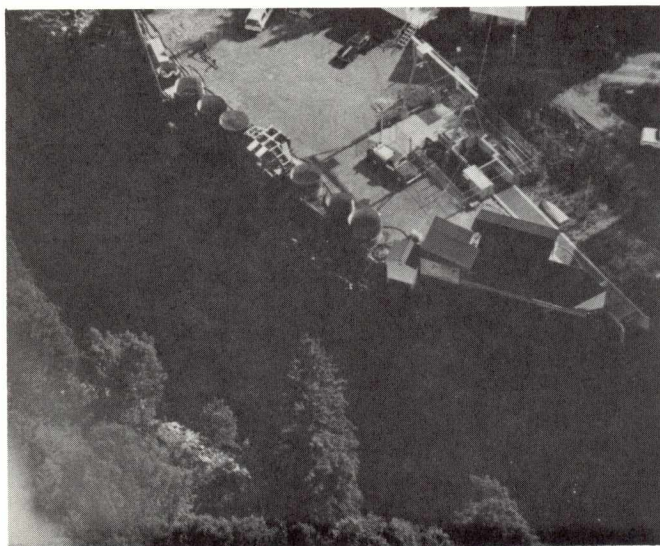
H. Jansen and R. W. Gray

Atlantic Salmon Kelt Study

Investigations were continued in 1975 into the feasibility of reconditioning Atlantic salmon kelts in captivity at East River, Sheet Harbour, to improve the utilization of scarce genetic broodstock strains. Experiments were designed to utilize water supplies available at the Ruth Falls fishway. Post-spawned salmon or kelts were collected for the experiments from downstream smolt-guidance facilities, adult traps or from spent hatchery broodstock.

Three different salmon stocks — from Medway, LaHave and East rivers — were studied over a 2-yr rearing period. A moist-pellet diet, prepared at the site, was fed to the kelts twice daily at the satiation level. Within 4-5 weeks after being acclimated to saline water, at 7.5° - 10°C, kelts had almost regained their original condition.

The survival rate of each stock was high; 75% -



Ruth Falls facilities used to recycle and spawn Atlantic salmon kelts, East River, Sheet Harbour.

80% of the 1-sea-winter and 2-sea-winter LaHave River kelts survived in good condition over the 2-yr recycling period from virgin spawning. The maturity rate varied in relation to genetic stock, age, sex and salinity regime. For LaHave River stock, 83% of the recycled 1-sea-winter female kelts spawned after two years, while 100% of the recycled 2-sea-winter female kelts matured after the same period; recycled males matured at an equal or higher rate than females.

Egg collections were made from recycled kelts each year since 1973 (Table 25). Fecundity data, including information on egg size, number and coloration for each female, were collected. Specific spawning crosses were made to study growth and survival characteristics of the resulting progeny and, hence, relate these to the experimental conditions under which the parents were reared.

Table 25. Summary of egg collections from recycled Atlantic salmon kelts, 1973-75.

Year	Genetic stock	Location of incubation	Number of eggs
1973	Medway River	Cobequid Hatchery	54,443
	East River	Cobequid Hatchery	2,853
	Total		57,296
1974	Medway River	Cobequid Hatchery	18,525
	East River	Cobequid Hatchery	5,186
	LaHave River	Cobequid Hatchery	49,938
	Total		73,649
1975	East River	Cobequid Hatchery	55,742
	LaHave River	Mersey Hatchery	228,512
	LaHave River	Stream-side incubator (Morgan Falls)	49,851
	Total		334,105

Data were summarized on the survival rates to hatching of separate egg lots, to study the effect of using wild versus recycled males for fertilization (Table 26). Eggs fertilized by wild males generally exhibited better survival. A comparison of survival to hatching between eggs from wild parents and eggs from recycled kelts (Table 27) suggests that the mortality of recycled kelt eggs, although still high, is within the range which can be expected for wild salmon eggs at Cobequid and Mersey hatcheries.

Table 26. Comparison of survival rates to hatching of egg lots fertilized by wild males vs those fertilized by recycled males, 1974 and 1975.

Year	Spawning crosses	No. of eggs spawned	Mortality to hatching	Survival to hatching (%)
1974	LaHave River Stock			
	Recycled ♀ × Recycled ♂	10,000	6,000	40.0
	Recycled ♀ × Wild ♂	12,320	4,900	60.2
	Wild ♀ × Recycled ♂	2,831	2,100	25.8
	Wild ♀ × Wild ♂	4,170	1,760	57.8
1975	East River Stock			
	Recycled ♀ × Recycled ♂	3,828	339	91.1
	Recycled ♀ × Wild ♂	4,549	447	90.2
	Wild ♀ × Recycled ♂	12,107	3,585	70.4
	Wild ♀ × Wild ♂	9,457	1,085	88.5

Table 27. Comparison of survival rates to hatching between Atlantic salmon eggs from wild parents and eggs from recycled kelts, 1975.

Genetic stock	Egg source	
	Recycled kelts	Wild salmon
LaHave River¹		
Number spawned	228,512	177,011
Number of mortalities	60,258	18,893
Percent survival	73.6	89.3
East River		
Number spawned	55,742	25,564
Number of mortalities	6,278	5,935
Percent survival	88.7	76.8

¹An additional 49,851 eggs were incubated at Morgan Falls.

The growth and survival of the progeny from recycled kelts from the end of the first summer to the smolt stage is comparable to that of wild salmon progeny reared in hatchery facilities. From 54,443 Medway River kelt eggs spawned in 1973, approximately 22,000 marked 2-yr smolts will be released in the LaHave River in the spring, 1976.

R. W. Gray

SALMON CATCH STATISTICS

The collection of data relating to the sport and commercial catch of fish has been a responsibility of the Fisheries Service since Confederation. Collection of the data is made by officers of the Conservation and Protection Branch and the Fisheries Statistics Branch on a regular basis, with the assembly and publication of the data principally the responsibility of the latter. In recent years, the Resource Development Branch has become involved in this operation insofar as it relates to the sport and commercial fisheries for Atlantic salmon. Through the assistance of the two branches previously mentioned, certain modifications have been made in the system of data collection in order to obtain more information suitable for biological use. Basic primary catch, effort and related data are now made available to Resource Development Branch personnel for compilation and assessment. This procedure has resulted in the more effective use of the statistical material in the development of salmon management programs. This compiled data on the salmon fishery is available in a series of annual data reports published by the Resource Development Branch.

Commercial Fishery

The total salmon catch of the Maritime commercial fishery in 1975 approximated 200,000 pounds and was a slight reduction (3.3.%) from the previous season's total (Fig. 32).

Nova Scotia's commercial fishery yielded 171,000 pounds of salmon as compared with 192,000 pounds

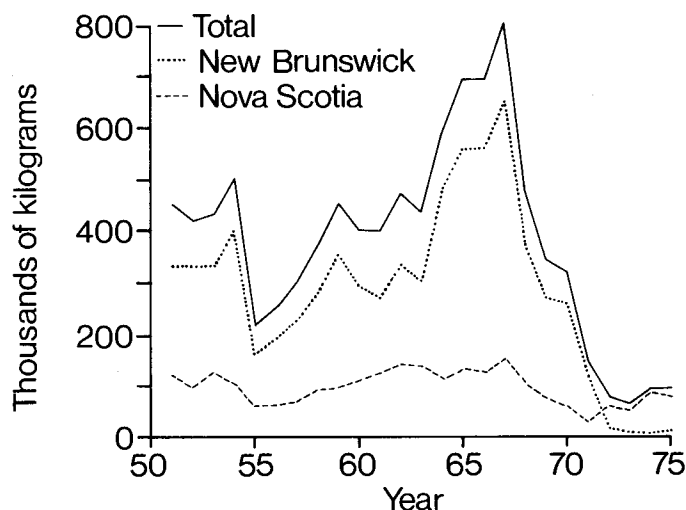


Fig. 32. Commercial catches of Atlantic salmon in the Maritime Provinces, 1951-75.

in 1974 — a decline of 11%. Three hundred and seventy-two commercial salmon fishing licenses were issued and, although this represents fewer units licensed than in the previous year, the actual salmon fishing effort was marginally greater than in 1974. Approximately 75% of the province's catch was made in gill, trap and drift nets specifically licensed for salmon; the remaining 25% was taken principally in commercial sea-fish traps, weirs and groundfish gill nets. The salmon catches of the Antigonish-Pictou and Cape Breton Island fisheries fell by 48% and 22% respectively; this represents a notable decline for these areas, which generally comprise between 75% and 80% of annual provincial yield. Increased catches, however, were evidenced along the Atlantic shore from Guysborough to Digby, with unusually high catches reported in the St. Margaret's Bay area. The Bay of Fundy catch showed a slight general improvement over 1974, although the fisheries of the Annapolis, Minas and Cumberland basins were not as productive.

The commercial catch of salmon in Prince Edward Island was similar to that of 1974, slightly over 3,000 pounds. Although seven commercial salmon licenses were issued in 1975, the entire catch was taken incidentally in cod and herring nets set off the north and east shores of the island.

Incidental captures of salmon in New Brunswick totalled 26,000 pounds in 1975 and 11,000 pounds in 1974. Approximately 12% of the 1975 catch came from the Bay of Fundy region, with the remainder taken principally in cod and mackerel nets on the Gulf of St. Lawrence coast; approximately 100 pounds of salmon were also taken in the licensed shad and salmon fishery of Shepody Bay.

Sport Fishery

Salmon angling in all three Maritime Provinces produced fewer fish in 1975 than in 1974 (Fig. 33). This situation is largely due to the extreme dryness of the season, which disrupted the salmon runs and discouraged the angler.

In Nova Scotia, 3,560 salmon and grilse were angled, almost 5,000 fewer fish than in 1974. The

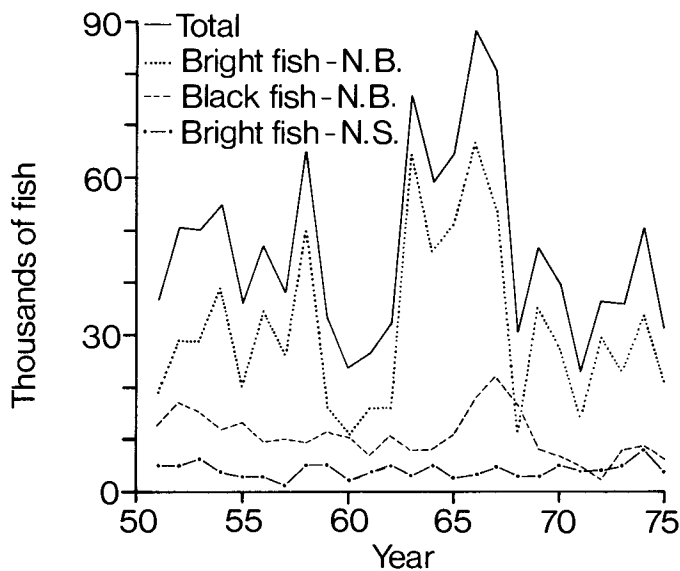


Fig. 33. Sport catches of Atlantic salmon in the Maritime Provinces, 1951-75.

depressed state of the sport fishery was also reflected in the fishing effort; nearly 47,000 rod-days were expended on the sport in 1974, and only 20,000 in 1975. No salmon were reported angled in Prince Edward Island.

The relative decline in the bright salmon fishery of New Brunswick was not as severe as that of Nova Scotia; fishing effort dropped from approximately 80,000 rod-days in 1974 to 55,000 rod-days in 1975 (31% decline), and the catch dropped from 33,570 to 21,138 salmon and grilse (37% decline). All angling streams in the province excepting the Bartibog, Kedgwick, Magaguadavic, Middle (Gloucester County), Nepisiguit, Tetagouche, Tracadie and Saint John produced fewer fish to the angler. Most noteworthy in the above exceptions was the Saint John River, which yielded 2,426 fish in 1974 and 3,310 in 1975. Black salmon fishing yielded 6,455 fish, 2,212 less than during the previous spring.

R. W. Dunfield

SAINT JOHN RIVER ALEWIFE AND SHAD

In 1975, investigations were continued for the third and final year on the biology of the alewife (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*), and on the impact of commercial fisheries on these stocks in the Saint John River system. Fish were sampled weekly at Mactaquac Dam and at four commercial fishery sites below. The sites at upper and mid-Grand Lake and at Belleisle Bay, sampled in 1974, were discontinued in 1975.

The 1975 return of 2.6 million alewives to Mactaquac Dam was almost double the 1974 return of 1.3 million (Table 28). It is expected that the return will increase further in future years, to between 2.7 and 4.6 million fish. As in past years, fish released into the headpond were trucked to a point about 1 km above Mactaquac Dam. In 1975, an estimated 1,038,000 alewives and blueback herring were trucked and released at this site. The remainder of the run (1,527,000 fish) was harvested by the

Table 28. Estimated annual alewife and American shad returns to Mactaquac Dam, 1968-75.

Year	Number of alewives	Number of shad
1968	22,100	38,800
1969	106,300	37,400
1970	84,500	36,400
1971	394,500	16,800
1972	1,204,600	1,500
1973	1,399,800	7,400
1974	1,319,100	2,400
1975	2,564,600	700

commercial fishery at the dam.

This fishery, instituted in 1974, was designed to harvest those alewives deemed surplus to estimated spawning requirements for the headpond area. The fisherman, who had successfully bid for the right to receive the surplus fish, obtained them directly from the hopper of the fish lift. This prompt removal of fish prevented the continuous and excessive build-up experienced at the collection facilities in past years, which had undoubtedly delayed fish passage. Sale of the 322,180 kg of fish brought a small income and appreciably reduced tank-truck operating costs.

Alewife mortality at the fish lift was approximately 0.3% of the estimated run. Mortality during transportation above the dam and immediately after release was negligible.

In 1973 and 1974, 17,757 adult alewives were tagged. The 1973 alewife tagging project was designed primarily to estimate the extent of recycling of fish released above the dam (fallback via spillway or turbines and return to the fish lift) and secondarily, to provide data on the homing of alewives. The 1974 tagging objective was to determine whether alewives captured at Mactaquac Dam and transported 120 km downstream for tagging and release would home again to the dam. The results (Table 29) suggest that alewives do home to specific locations, although considerable straying may occur enroute. They also show that consecutive annual spawning occurs. Further studies are required to fully evaluate the homing phenomenon, particularly to major tributaries of the river system.

No alewives were tagged during 1975. However, returns from taggings in 1973 and 1974 appeared at Mactaquac Dam and in downstream commercial fisheries.

Table 29. Recovery of alewives tagged at Mactaquac fish-pass facilities.

Tagging date	No. of fish	Recapture date	No. recaptured by location		
			Mactaquac Dam	Washademoak Lake	Other locations
1973	8,230	1974	21	0	2
		1975	4	0	1
1974	9,527	1974	75	63	5
		1975	46	few	3

American shad (*Alosa sapidissima*) returns to Mactaquac Dam have generally declined since 1968 (Table 28). Shad ascending the fish lift in 1975 were generally in fair condition, if not better condition than in previous years. The commercial alewife fishery, which reduced crowding in the holding pool and reduced delay before upriver release, also harvested 18% of the 669 shad entering the collection facilities. Efforts to separate and retain shad in a holding box for later upriver release were unsuccessful. Further efforts will be made in 1976 to reduce the inadvertent harvest of shad with alewives.

B. M. Jessop

ANNAPOLIS RIVER STRIPED BASS

In response to expressed concern by fish and game associations and the Annapolis Valley Board of Trade regarding the status of the striped bass stock in the Annapolis River, Nova Scotia, the Branch initiated in 1975 an investigation to determine the need for restrictive regulation of the sport fishery. The principal objective was to estimate the total striped bass catch and fishing effort by anglers during the May-September period. All important fishing areas were examined for systematic variation in catch and effort with time by employing a randomized sampling scheme. Additional factors investigated included the life history of the stock, the species composition of the estuarial fish population and certain environmental parameters.

Creel Census

Analysis of the striped bass catch and effort data provides an estimated angling total for the sampling period (May 13 - September 17) of $1,100 \pm 500$ fish (95% confidence interval). The Conservation and Protection Branch estimate of the catch between May and September is over 25,000 fish. This difference suggests that the Conservation and Protection Branch catch statistics for 1975, and probably previous years, may considerably over-estimate the magnitude of the harvest.

Observations indicate that from April through mid-to late June striped bass fishing on the Annapolis River is conducted almost exclusively in upriver areas; while, from July onwards, it is concentrated at the causeway. Approximately 86% of the observed

Table 30. Fishing location and residence of striped bass anglers as a percentage of total anglers interviewed, Annapolis River, 1975. (n = 1,280)

Residence	Fishing location (%)		
	Causeway	Upriver	Total
Nova Scotia	64.3	14.2	78.5
Other provinces	7.3	0.0	7.3
U.S. and other countries	14.2	0.0	14.2
Totals	85.8	14.2	100.0

fishing effort occurred at the causeway and 79% of anglers interviewed were from Nova Scotia (Table 30).

The proportion of anglers of each origin differed significantly from that observed in a 1972 Branch survey ($G = 6.65$, $p = < 0.05$), there being an increase in the proportion of Americans and a reciprocal decline in residents fishing at the causeway. Total angler effort appears to have increased, however.

Relatively little effort was expended fishing at Allain River, a tributary to the lower Annapolis River, or at Bear River, which flows into the Annapolis Basin.

Biological Studies

The mean fork length of 215 angled striped bass was 66.0 cm and the mean weight of 191 fish was 3.95 kg. Mean lengths and weights varied between months, with the largest fish caught in June and August. Sixty percent of angled fish were between 3 and 7 years old and ranged in mean length from 44.5 to 64.2 cm. The maximum age recorded was 18 years, at a length of 106 cm. Length-frequency analysis of the catch shows two peaks, one each at 55.0-57.9 cm and 76.0 - 78.9 cm (Fig. 34). These peaks perhaps result from the development of certain dominant year classes, a phenomenon common with striped bass.

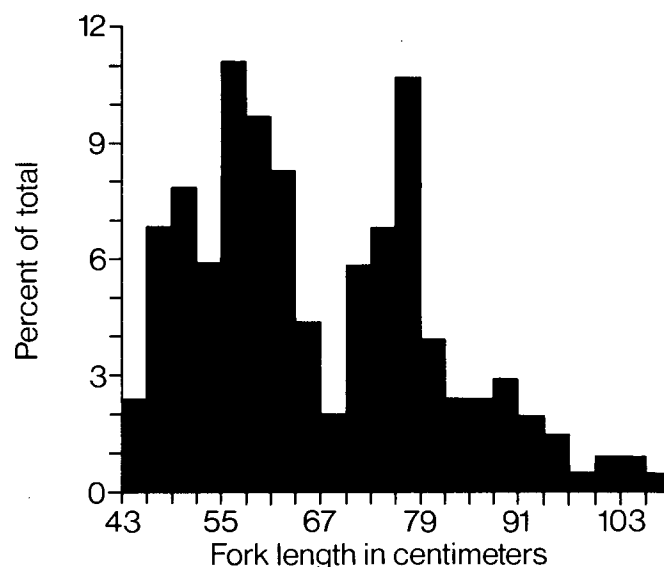


Fig. 34. Length frequency of striped bass samples angled in the Annapolis River, Nova Scotia, 1975. (No. of samples = 205.)

Approximately 24% of the fish were male. Males averaged 7.4 and females 8.3 years old. With age, female fish tended to become larger and heavier than males; and the largest, heaviest fish were invariably females. Two small fish were definitely sexually immature; most fish appeared mature or in the process of maturation, but some difficulty was found in assigning categories. Few fish showed definite signs of having spawned this year. One fish was hermaphroditic and one fish appeared to have three ovaries.

Biweekly egg sampling between June 19 and

August 11 at five sites — using towed or stationary meter nets — and at two of the five sites using a bag seine succeeded in collecting striped bass eggs on only one occasion in late June. The eggs were taken in brackish water. No larval or young striped bass were collected, although large numbers of unidentified eggs and larvae were taken, as well as juveniles and/or adults of 16 other species.

A temperature and salinity profile of the lower 32 km of the river during mid-August revealed that the estuary is highly stratified, with a wedge of saline water lying beneath outflowing low-salinity water. Salinities at 1-m depths in the upper stratum (about 2 m deep) ranged from $> 25\text{‰}$ just upstream of the causeway to 0‰ at Bridgetown. Corresponding salinities in the lower stratum ranged from $> 27\text{‰}$ to $< 20\text{‰}$. Water temperatures ranged from 22° - 26°C in the upper stratum to $< 17^{\circ}$ - 21°C in the lower stratum. Vertical stratification is probably seasonally stable because of low tidal fluctuation, a deep channel and a sheltered middle reach of estuary. Saline water extends about 2 km above Bridgetown during the summer low-flow period.

Mercury and Pesticide Levels

The mercury and pesticide levels in certain fish have caused much concern in recent years. Mercury analyses of the caudal musculature of seven Annapolis River striped bass, ranging in weight from 1.75 to 5.24 kg, averaged 0.20 ppm (range 0.13 - 0.34 ppm). These levels are within the established guideline for consumer protection of 0.5 ppm.

Ovary samples from 18 striped bass, averaging 72.8 cm in length (range 47 - 103 cm), were analysed for PCB and DDT (including DDE and DDD) content because of concern over the effect of these chemicals on reproductive success. The samples contained an average of 3.66 ppm (wet weight) of PCB's (range 0.15 - 12.8 ppm) and 1.75 ppm of DDT (range 0.005 - 6.67 ppm). These organochloride levels are within the range known to affect the development of striped bass eggs, and may be associated with the apparent absence of larval and young bass in the Annapolis River.

Contract Study

Information suitable for making management decisions on the striped bass population of the Annapolis River is limited. To aid the Branch study, a 2-yr contract has been awarded to Acadia University to study the success of striped bass spawning activities and the subsequent growth, movements and feeding of young bass during their stay in the river. This and other proposed studies, i.e., an adult tagging program, should help answer the question of whether the Annapolis River stock is wholly local in origin or consists of both local and non-local migratory fish.

B. M. Jessop

TROUT FISHERY DEVELOPMENT

Completed trout-assessment projects clearly

show that under the past hatchery-stocking program anglers received the greatest benefits from large 1-yr-old trout released in heavily fished areas. Consequently, hatchery-yearling trout production is being increasingly directed to high population centers such as Halifax-Dartmouth, Saint John and, anticipated in the near future, Sydney-Glace Bay.

There is a continuing need to maintain or improve trout fisheries in less intensively fished areas. The Branch inventory program has shown that many lakes stocked in the past were unsuitable, but fingerling trout distributions to some carefully selected waters may be essential in fisheries management. Trout used for this purpose must be selected for better survival in the wild than are stocks presently available in the hatchery system.

The 1975 field program was designed to improve and expand recreational fisheries near population centers, to continue the inventory program needed for selection of lakes for fisheries management, and to initiate development of an improved broodstock for use in maintenance stocking programs.

Halifax-Dartmouth Fishery

As in previous years, four small Dartmouth lakes were heavily stocked with the largest available hatchery-produced trout for the express purpose of providing an immediate return to the angler. Although the yearling rainbow trout which proved to be so successful in 1974 were not available, large yearling brook trout — supplemented by stocking approximately 5,000 2-yr-old brook trout — were used to maintain the spring fishery. A few dozen rainbow trout, remnants from the 1974 spring stocking, were also caught.

A significant innovation in 1975 was the removal of the customary angling closure on September 30. This closure was considered unnecessary, since natural reproduction is not essential to this fishery. It is now legal to angle in Albrow, Maynard, Penhorn and Oathill lakes year-round, with the provision that holes may not be cut through the ice for the purpose of fishing. In order to successfully extend this recreational fishery, 5,000 fall-yearling trout were liberated during the last week of September. Although no evaluation was undertaken, observations indicate that anglers expended several thousand hours of effort after September 30. Liberation of 475, 2- and 3-yr-old surplus rainbow trout broodstock (weight range 4-9 lb) resulted in a tremendous fishing effort during the last week of October. A final fall distribution of about 1,500 spent brook trout broodstock, released in mid-November, should contribute to the 1976 spring fishery as well as the extended fall fishery.

Lake Inventory

The 1975 lake inventory program consisted of 15 lake surveys in the Sydney-Glace Bay area of Cape Breton. Results from the gill netting indicate a substantially higher ratio of trout to coarse fish in these lakes compared to lakes surveyed on mainland Nova Scotia. Yellow perch (*Perca flavescens*) were not present in any of the lakes surveyed, although

white perch (*Morone americana*) were present in at least four, and are believed to constitute the majority of the fish biomass in three of the lakes.

From these surveys, Browns Lake in Sydney and Number 20 Dam (impoundment) in Glace Bay were identified as having high potential for the development of catchable trout fisheries. Consideration is being given to intensive stocking of these lakes in 1976, using large yearling brook trout and rainbow trout supplied from mainland hatcheries.

In the near future, a designated trout-lake program will be initiated. Under such a program, designated lakes will receive highest priority in the stocking of fingerling trout if required, and special fishing regulations may be imposed. Three of the lakes surveyed in 1975 were identified as potentially suitable for use in this type of program, although additional field work is required.

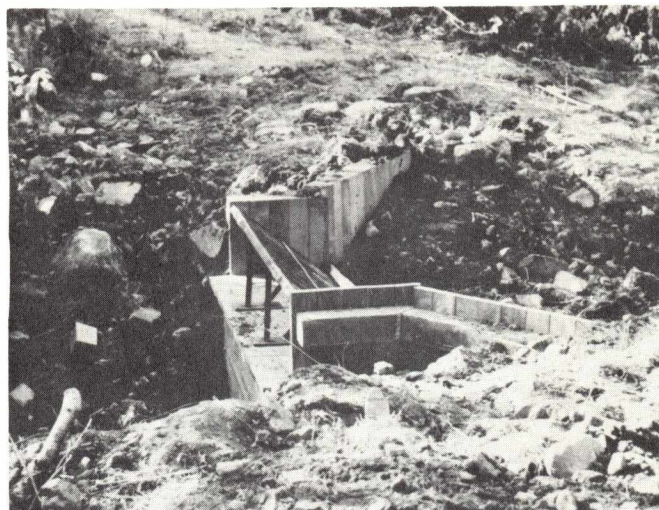
Broodstock Development

Two projects have been initiated for development of an improved trout broodstock for maintenance trout stocking. Giant Lake (45°23' ; 61°53'), Guysborough County, will be used to impose some degree of natural selection on the domestic trout stock. Hatchery trout resident in the lake for two or more years presumably will have been selected for improved survival in the wild, while retaining those desirable characteristics previously selected in the hatchery environment. These fish would then be used as broodstock to supply eggs for production of fingerling trout. Development and evaluation under this project spans eight years. If the results are positive, the first fingerling trout will be available for stocking on a production scale in the fall of 1983.

Giant Lake was selected from among 11 lakes surveyed in the Antigonish-Guysborough area during 1973. Surface area is 57 ha (hectares), maximum depth is 15 m and thermal stratification is complete during the summer. Although Giant Lake was stocked with thousands of rainbow trout almost annually in the periods 1931-40 and 1959-63 and has been stocked with brook trout in many years until 1974, trout fishing has reportedly been poor. The 1973 survey results indicated that an abundance of small yellow perch (*Perca flavescens*), numerous common suckers (*Catostomus commersoni*) and the presence of eels (*Anguilla rostrata*) was causing intense competition for food and space, plus predation, which would seriously limit the survival of hatchery-produced trout. This fish population appears to be typical of many lakes in Nova Scotia.

In preparation for the broodstock development project, it was considered essential to remove the competitor fish species. It was also desirable to estimate the fish-carrying capacity of this lake. To these ends, a mark and recapture experiment was combined with chemical reclamation. Magginist Lake (9.9 ha) and Sullivan Lake (6.2 ha), both tributary to Giant Lake, were included in the reclamation.

During the 1975 field season, a fish migration barrier was constructed on Giant Lake outlet, in order to prevent immigration of undesirable species following reclamation. Before being returned to the water, 404 perch and 833 suckers taken in trap nets



Fish migration barrier constructed at outlet of Giant Lake.

were finclipped for later identification.

Detailed bathymetric maps were prepared from echo soundings. From these, total water volume was calculated to be $280.3 \times 10^4 \text{ m}^3$ (6.7 million gal). A review of the literature and on-site tests indicated that an application of 0.6 - 0.7 mg/litre of commercially available "Chem Fish Special O.F." — containing 5% rotenone — would be adequate to eliminate the fish population. Application of 440 gal of rotenone to the three lakes and streams was completed over a 2 - day period in mid-September. Back-pack fire pumps were used to apply a diluted rotenone mixture to the small lakes and to the shallow portions of Giant Lake. In deeper water, the chemical was spread directly into the wake of boats.



Application of rotenone from back-pack sprayer to shallow area of Giant Lake, Guysborough County, Nova Scotia.

In all cases, fish began rising to the water surface within 1 hr of treatment and dying shortly thereafter. On Giant Lake, all dead fish were collected from five representative 50-m shoreline stations, separated by species, examined for fin-clips, weighed and a sub-sample measured. Using a combination of data from sample stations and a "Peterson" population estimate for perch and suckers, the total number of fish killed was estimated for use in calculating total biomass (Table 31). The large American smelt population (*Osmerus mordax*) was unexpected but

Table 31. Summary of fish killed during reclamation of Giant Lake, 1975.

Species	Mean length ± SD (cm)	Mean weight ± SD (g)	Population estimate ± SD	Biomass (kg/ha)
Yellow perch	12.4 ± 1.49	27.3	36,979 ± 2,257	17.7
Common sucker	21.2 ± 9.43	106.5	9,849 ± 130	19.8
American smelt	6.9 ± 2.25	2.8	150,021	7.4
Banded killifish	6.0 ± 2.01	3.1	44,993	2.4
Eel	—	45.4	994	4.5
Brook trout	32.7 ± 5.0	467.2 ± 242.11	> 44	> 0.4 ¹
Golden shiner	—	—	present	0.0
Total biomass				> 52.2

¹Includes trout previously removed and those killed during treatment.

was considered to be of little value to fisheries in the presence of perch.

Although only 15 trout were observed at the time of treatment, 29 trout, weighing 13.55 kg, had been removed from the lake during prior trap netting. Undoubtedly, some trout sank and were not observed after reclamation but, nevertheless, the trout population was small.

In Magginit and Sullivan lakes, no population estimates were attempted. Fish species killed were similar to those in Giant Lake, with the exceptions that yellow perch were not observed and golden shiners (*Notemigonus crysoleucas*) were far more abundant.

Bioassay tests proved that the two smaller lakes were non-toxic within three weeks of chemical application. In Giant Lake, however, the water remained toxic for about eight weeks. In late November, 12,000 fin-clipped fall-fingerling brook trout (av fork length = 14.7 cm; total weight ≈ 528 kg) were released in the three lakes. Some limitation on angling harvest will undoubtedly be required to prevent over-fishing. These lakes will be closed to angling in 1976 and will likely be subject to reduced creel limits in future years.

In a second broodstock improvement project, wild male brook trout are being used to fertilize eggs from domestic females. The hybrid progeny (F1) are expected to be more suitable than wild strains for cultural purposes, and to survive to contribute more to the creel than do domestic trout stocked as fingerlings. Development and testing of these trout has been planned for a 4-yr period. If successful, fish of the F2 generation would be produced for use on a production scale by the fall of 1980.

In the initial phase of this project, nine wild male trout were collected from a relatively remote Guysborough County lake in mid-October, 1975. Spawning of domestic trout at Antigonish Hatchery normally commences during the first week of November, and it was felt that this approximated the timing of natural spawning in that area. However, the wild male trout were almost totally spent when collected, and only about 2,000 eggs could be fertilized. This will result in a 1-yr delay in the testing phase of the project. Wild trout collection in 1976 will be scheduled for early September.

The early spawning date of wild brook trout in eastern Nova Scotia also suggests that a September

30 angling closure may be ineffective if the intent of the closure is to protect trout during spawning activity.

D. R. Alexander

FISH CULTURE PROGRAM

The past year presented several challenges to the Branch's fish culture program. Manpower reductions and the effects of inflation forced curtailment of some hatchery operations and the closure of Kejimikujik Hatchery in southern Nova Scotia. The retirement of seven permanent staff in 1975 highlighted the importance of our stepped up effort to recruit and train qualified fish culturists.

Kejimikujik Hatchery had played a key role in the LaHave River salmon development project. In an attempt to compensate for the closure, modifications were made at the nearby Mersey Hatchery to improve its salmon rearing capability. The installation of a deep water supply from the reservoir at Mersey alleviated the problem of extremely high summer water temperatures. Salmon reared there in 1975 experienced excellent growth and survival.

One of the highlights of 1975 was the continued improvement in the quality of salmon smolt production from Maritime hatcheries. The quality index was up 26% from the 1974 level. This effort by fish culture staff in the past four years to improve the quality and resultant survival of hatchery-produced salmon has produced outstanding results.

Planning for a proposed new hatchery in southwest Nova Scotia continued in 1975. A consultant was hired to assess the environmental impact of a hatchery at one location, and a study was also initiated to document the fish disease and parasite situation at that site. The proposed salmon and trout hatchery would replace three older stations and provide for increased output and improved economic efficiency. Implementation of this proposal will depend on funding.

D. B. Lister and T. G. Carey

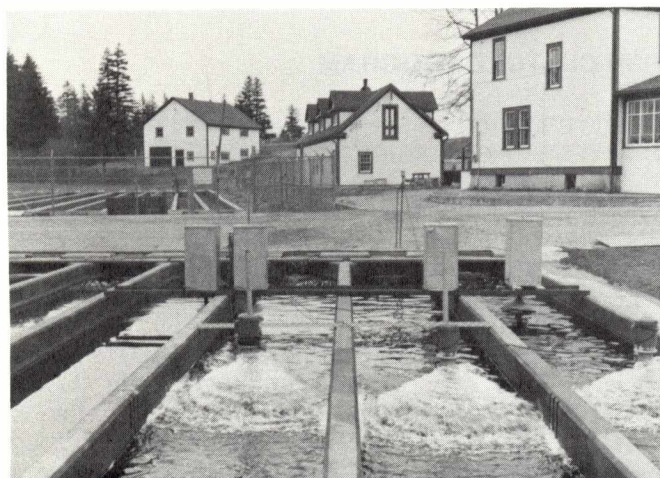
Hatchery Operations

It is the objective of the hatchery operations staff

to produce viable salmon and trout juveniles which will contribute to the sport and commercial fisheries. There are 12 hatcheries or fish culture stations in the Maritimes Region working toward this objective, along with the various fishery development programs of the Branch. This commitment is becoming increasingly difficult to carry out, as there has been a continued reduction of old facilities without replacement.

During the year, a plan to reduce general stocking of fry and 1.5-in. fingerling speckled trout in public waters was implemented. The reasons for this reduction were twofold: (a) fingerlings planted in lakes with large populations of predators suffered high mortality, and (b) the high cost in manpower and money required to transport these fish was straining current resources.

This year, a need has been identified by management biologists for increased production of underyearling (fall-release) Atlantic salmon parr, to reestablish adult runs in several rivers in northeastern



Long ponds at Saint John Hatchery, showing aerators and automatic feeders.

New Brunswick. To implement this program, the number of salmon eggs collected for the Charlo and Miramichi stations was increased from 335,474 in 1974 to 730,800 in 1975, to permit the maximum production of underyearling parr for stocking in the fall of 1976.

The policy of maintaining low densities in Atlantic salmon rearing was continued, and the results may be seen in the increased average weight (Table 32) and condition of the smolt at liberation (Table 33).

Hatchery operations were affected in 1975 by the retirement of four key people — the supervisor and three station managers. This has aggravated a situation which has been present since 1973, that is, a reduction of experienced staff. As of December 30, 1975, there were 11 vacancies in the permanent staff. This necessitated a large number of acting positions and having term (casual) employees doing the work of fish culturists. These have been difficult times, but the staff has risen to the occasion and maintained a high standard of quality in fish production.

During 1975, a reclassification of all permanent positions was completed, and a series of staffing actions have begun which will see the hatchery

Table 32. Salmonid distribution statistics for Maritime hatcheries, 1973-75.

Species	Total number	Total weight (kg)	Average weight (g)
Atlantic salmon			
1973	1,026,358	37,126	36.2
1974	914,454	46,053	50.4
1975	780,038	42,482	54.5
Speckled trout			
1973	1,729,405	74,564	43.1
1974	1,521,137	62,655	41.2
1975	1,258,280	60,537	48.1
Rainbow trout			
1973	54,485	6,604	121.2
1974	49,152	1,582	32.2
1975	29,004	2,310	79.6
Brown trout			
1973	23,620	290	12.3
1974	3,681	74	20.1
1975	0	0	0.0
Totals			
1973	2,833,868	118,584	
1974	2,488,424	110,364	
1975	2,067,322	105,329	

Table 33. Quality comparison of Atlantic salmon smolts released from Maritime hatcheries, 1972-75.

Year	Total smolts released ¹	Good quality smolts	
		Percent of totals released	Number
1972	933,213	29.6	276,392
1973	542,060	51.1	276,815
1974	491,890	56.5	277,918
1975	411,686	71.4	293,944

¹Reductions in the numbers of smolts released since 1972 are attributable to both reductions in fish densities and elimination of three production units.

service at full strength by the summer of 1976. During the past year, two technical personnel — A. J. Stannix and B. H. Ives — were taken on strength as replacements for persons who had retired from the Yarmouth and Cardigan hatcheries, respectively.

G. B. Robbins and J. A. Ritter

Fish Production

The 1975 liberation of Atlantic salmon changed little from that of 1974, reflecting the establishment of a rearing program which is producing an increasingly higher percentage of acceptable quality smolts (Table 34). The total numbers are down 15%, whereas the average weight has increased 8% (Table

Table 34. Relationship between smolt quality and adult return rates at Mactaquac on the Saint John River, New Brunswick.

Year of release	Total smolts released	% good quality	No. of adult returns	Adult return rate (no./1,000 smolts)		
				1-sea-winter	2-sea-winter	Total
1972	695,340	23.0	3,615 ¹	2.6	2.6	5.2
1973	362,000	47.8	5,556 ¹	10.0	5.1	15.1
1974	338,430	52.2	5,335 ²	15.8	—	—

¹Total number of adult returns of hatchery origin to Mactaquac.

²1-sea-winter adult returns of hatchery origin to Mactaquac.

32).

Speckled trout liberations have been reduced by 17% and the average weight increased by 17%, reflecting the policy of reducing the stocking of fry and fingerlings of less than 1.5-in. length.

Rainbow trout liberations from stations in the Maritimes Region are limited in number, since most of the production is supplied to research. However, this year there were a number of spent broodstock, two and three years of age, liberated in the put-and-take fishery in the Halifax-Dartmouth area. These fish weighed between 2.3 and 4.2 kg each. There were 502 in total, which accounts for the 147% increase over the previous year in average weight of rainbow trout released (Table 32).

Of the salmonids released from Maritime hatcheries in 1975 — either by Branch staff or by provincial government agencies — 1,878,063 (91%) were liberated in public waters. Research or private fish culture operations utilized 189,259, or 9% of all stocks provided (Table 41).

The summer of 1975 was extremely dry, presenting problems of low water supplies and lethal water temperatures at several hatcheries. Antigonish experienced low water and lethal temperatures for speckled trout. All production speckled trout were transferred to other stations, and the broodstock were placed on the limited supply of ground water in order to survive. The Atlantic salmon (both year-classes) were able to survive the high temperatures without losses. Following the fall rains, when the temperatures and water flow had returned to normal, the trout stocks were returned to Antigonish to be

reared to the yearling stage.

Florenceville Hatchery also experienced low water supplies and was forced to liberate 20% of its stock. However, the 1976 yearling production will not be affected, as it was resupplied from the Saint John Hatchery when flows returned to normal.

Both Miramichi and Coldbrook hatcheries were concerned that their water supplies would be depleted before the fall rains came. Coldbrook Hatchery was forced to liberate fall-fingerling (3-in.) speckled trout earlier than was originally planned, but was able to retain sufficient stock to remain on program for yearling stocking.

Yarmouth Hatchery did not experience low water. However, water temperatures in the high seventies resulted in higher than normal losses, particularly in the 2-yr broodstock where the mortality was 64%.

Low water on all salmon rivers prevented early upstream migration, and resulted in late collection of broodstock on the LaHave, St. Mary's and Bartholomew rivers. The St. Mary's saltwater Atlantic salmon broodstock collection from a fisherman's trap was not successfully completed, and it was necessary to seine the river after the fall rains. Several more fish were collected from the Ruth Falls collection facilities at East River, Sheet Harbour to ensure an adequate supply of eggs for Antigonish Hatchery.

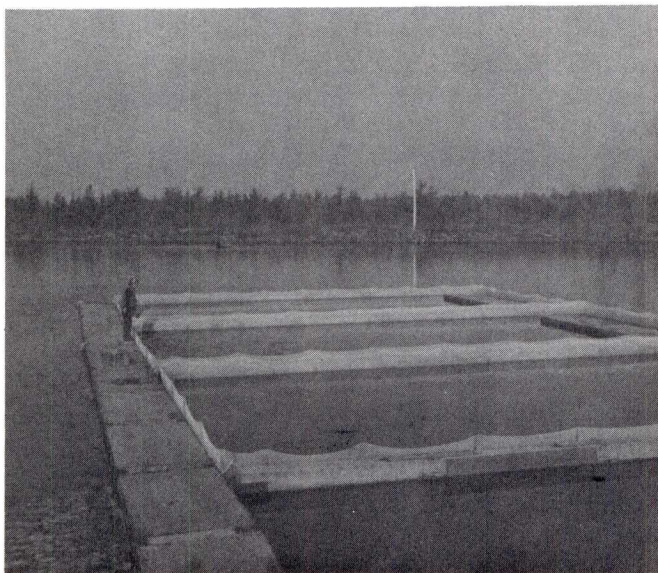
Because of an outbreak of furunculosis (*Aeromonas salmonicida*) on the Restigouche River, no salmon broodstock was collected from that source in 1975. The broodstock for Charlo Hatchery was collected from a salmon monitoring trap in Chaleur Bay during June, and held at the New Mills ponds.

With the closure of Kejimikujik Hatchery, it was necessary to move the LaHave salmon program to the Mersey Hatchery. By modifying and adapting the equipment at this station, it appears that 1-yr smolts can be successfully reared. Modification of the incubation facilities, by installing troughs for eggs and "Heath" incubators for sac fry, will overcome the smothering problem experienced in the circular tanks in 1975. A 2,000-liter/min pump and 610 m of 30-cm pipeline were installed to permit pumping of cool water from below the thermocline in the headpond. This permitted manipulation of rearing temperature and avoidance of the lethal levels which have been common at this station. At present, 80% of the salmon at this station are >17 cm in length. It is expected that 95% will be smolts (> 15 cm) by April, 1976.

In the ongoing search for methods to increase productivity and fully utilize the staff at the older stations, a proposal is being evaluated whereby



New 18.2-m³ tanker used to transport both juvenile and adult salmon from Mactaquac Hatchery.



Net enclosures for rearing salmonids in no. 3 headpond on the Mersey River.

production of speckled trout or Atlantic salmon at Mersey Hatchery could be increased by 100%. This proposal is to rear 100,000 salmonids overwinter in net enclosures in the #3 headpond on the Mersey River. This site is adjacent to the hatchery and, at present, there are 30,000 speckled trout fingerlings in three net cages on site. This method of rearing is not new. The site is being evaluated to ascertain the water flows, icing conditions and other factors associated with winter rearing.

Rearing of 2-yr Atlantic salmon smolts from the egg stage was initiated at Cardigan Hatchery in 1975. This is part of a management program to stock the Morell River with 20,000 smolts annually, beginning in 1977. Atlantic salmon underyearlings have been reared at Cardigan in the past, but this is the first attempt to rear them longer than to the first fall season. Although the average summer temperatures are relatively low (13.8°C) for salmon, no difficulties are anticipated at this time. Additional facilities to rear these 20,000 smolts are being planned and should be completed for overwintering the smolts in 1976. To initiate this stocking program, smolts were supplied from Charlo Hatchery in 1975. Also, under-yearling parr were provided from Miramichi Hatchery, to be reared to the smolt stage at Cardigan and released in 1976.

Evaluation of an earthen pond, of a new type proposed for salmon rearing, was carried out this summer at Antigonish Hatchery. This pond is 38.1 m long, 11.0 m wide and 1.7 m deep, with a side slope of 2:1.

A Branch program has been undertaken to produce a number of domestic/wild-crossed speckled trout, to see if their ability to survive in a competitive situation in nature is superior to that of a domestic trout (several generations in captivity). The rearing of the fish for this program will be carried out at Antigonish Hatchery.

To fulfil commitments to other agencies, 100,000 lake trout (*Salvelinus namaycush*) eggs were obtained from the Michigan State Hatchery in Marquette. These eggs were imported to be used in a

joint development program with the New Brunswick Department of Natural Resources, Fish and Wildlife Branch. In addition, 125,000 eyed, rainbow trout (*Salmo gairdneri*) eggs were imported from the U.S. Federal Hatchery at White Sulphur Springs, West Virginia, to carry out ongoing Branch programs such as supplying rainbow trout to the Environmental Protection Service for bioassay of industrial effluent, the continuation of aquaculture studies, and the provision of stocks for put-and-take fisheries in the Halifax-Dartmouth and Sydney areas.

Production Quality

The annual evaluation of Atlantic salmon smolt quality, which includes examination of length, weight, fin condition and physiological parameters, was again undertaken in 1975. The results of this year's assessment indicate that the quality of smolts released from Maritime hatcheries continues to improve (Table 33). Noticeable improvements were observed for all factors considered in the determination of good quality fish. Average fork length was 20.2 cm, with only 6.5% being smaller than 14.5 cm — the minimum size of a good quality smolt. Less than 2% had a condition factor < 0.9, also the minimum standard set for good quality smolts. Improvements were also observed in fin-condition, with more than 75% having good fins according to the arbitrary standard.

In 1975, 71.4% of the smolts released were of good quality. This high quality evaluation is the result of considerable effort on the part of all individuals in hatchery operations. Reduction in fish densities is one of the main reasons for improved smolt condition. This action now seems warranted in view of the improvement in adult return rates. This is particularly apparent on the Saint John River, New Brunswick, the release site of more than 50% of all hatchery-reared salmon smolts produced in the Maritimes. Since 1972, the number of smolts released into the Saint John River has been reduced by more than 50%, but the number of adults of hatchery origin returning to Mactaquac continues to increase. This increase in adult returns appears to be correlated with improved smolt quality (Table 34). The percentage of good quality smolts released in 1975 was approximately 25% greater than in 1974, while total releases remained approximately the same.

Production Cost

A review of operating costs of two stations rearing Atlantic salmon reveals that the larger station can produce a 2-yr smolt more economically. In this study it was found that the unit cost of rearing smolts was \$0.94 at Mactaquac Hatchery and \$2.69 at Charlo Hatchery (Table 35).

During 1975, Atlantic salmon were reared at Mersey Hatchery, which is one of the stations with a warm water supply and a longer growing season. It is anticipated that 85% of these fish will result in 1-yr smolts, with an average length >17cm. The projected unit cost of producing the 55,000 1-yr smolts will be \$0.43. This indicates it is more economical to rear 1-yr smolts, if this can be accomplished without

Table 35. Cost of hatchery production of Atlantic salmon smolts, 1975.

Hatchery	No. of smolts produced	Smolt age (yr)	Cost/smolt (\$)
Charlo	25,000	2	2.69
Mactaquac	222,000	2	0.94
Mersey ¹	55,000	1	0.43

¹Estimated production, spring of 1976.

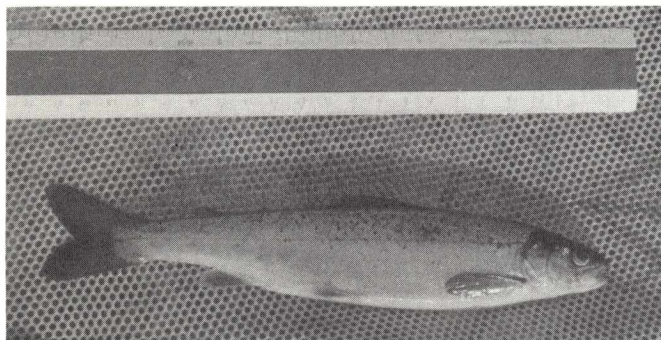
artificially heating water for long periods of time to initiate early fry feeding.

There have been significant achievements in recent years in reducing mortalities in Atlantic salmon broodstock by the use of artificial ponds supplied with well water. The high mortalities experienced in natural ponds, such as at New Mills and Miramichi, have been virtually eliminated in the artificial facilities presently in use at Coldbrook and Mactaquac hatcheries (Table 36). Mortalities were experienced at first in these artificial facilities but, through improved techniques of capture, handling, transportation and treatment, they have been greatly reduced. Poaching in broodstock facilities has always been a problem, but it is more easily detected in an artificial facility located on the station where surveillance is easily maintained.

Table 36. Comparison of mortalities in salmon broodstock holding facilities, 1972-75.

Hatchery	Water supply	% mortality			
		1972	1973	1974	1975
New Mills	Surface fresh water and salt water	4.1	64.0	—	12.0
Miramichi	Surface fresh water and salt water	14.9	14.1	3.1	5.2
Coldbrook	Ground water	—	11.7	2.5	2.0
Mactaquac	Ground water	12.0	3.0	0.5	1.0

The efficiency of the secondary sorting facilities at Mactaquac has been improved by the purchase of an 18.2- m³ tank truck late in 1975. This truck has the capacity to transport 1,360 kg of live adult salmon to upriver sites on the Saint John River system. It is anticipated that this unit will reduce these costs by 50%.



Juvenile salmon reared at Mersey Hatchery (36 weeks from hatch; 30 weeks feeding).

Fish Health

During 1975, the Branch fish disease laboratory was relocated from Mactaquac Hatchery to space in the Halifax Laboratory. In spite of this and a change in technical staff, more than 60 fish health cases involving five fin-fish species were investigated. Most cases originated from Branch hatcheries, with the remainder coming from other government operations, private operations and kills in the wild. Fish health problems diagnosed in Branch hatcheries included losses of Atlantic salmon and speckled trout fingerlings from infectious pancreatic necrosis virus (IPNV), nutritional causes, bacterial and parasitic infestations, and environmental pollution. Gas bubble disease was identified at Coldbrook Hatchery last spring and was temporarily controlled. Other fish health problems ranged from *Pseudomonas* sp. infections in commercial eel culture and vibriosis in experimental mariculture to losses in the wild, caused by environmental pollution, physiological disorder (nephrocalcinosis) and furunculosis (*Aeromonas salmonicida*).

Bacteriological culturing of tissues from under-yearling Atlantic salmon parr and salmon broodstocks for Charlo and Miramichi hatcheries yielded no isolation of *A. salmonicida*. However, serological studies now in progress indicate that at least one adult salmon trapped at Dalhousie on the Bay of Chaleur and spawned at the nearby New Mills Holding Pond had been infected at some time in the past with *A. salmonicida*. The eggs from the New Mills spawning are being incubated at Charlo Hatchery.

It is well known that IPNV annually causes sporadic losses among speckled trout fingerlings in one or more Maritime hatcheries. However, of special significance this year was the identification of an IPNV-caused mortality among Atlantic salmon fingerlings at Mersey Hatchery. Moreover, a high incidence of IPNV carriers was noted among Saint John Hatchery post-yearling salmon and, for the first time, salmon fingerlings and post-yearlings at Mactaquac Hatchery were identified as IPNV carriers.

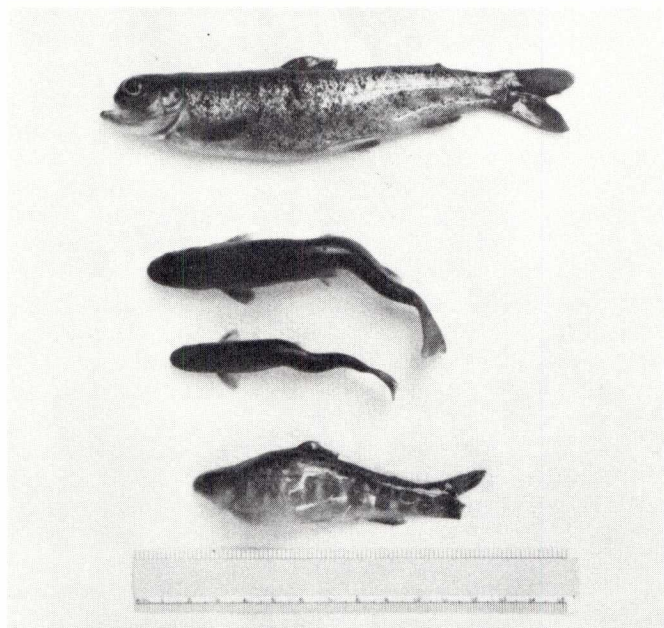
In 1974, Mactaquac Hatchery experienced losses of 33% of its Atlantic salmon underyearling parr. In 1975, this figure was reduced to 25%. A significant portion of this loss is considered to be related to water quality, although analysis by the Water Quality Laboratory of the Environmental Protection Service at Moncton found pesticides to be within acceptable limits. Hatchery staff are attempting to closely document circumstances surrounding significant losses which do not appear to have an infectious agent as the primary cause.

An attempt was made to determine if the Grafton Lake water supply for Kejimkujik Hatchery was the source of the organism which necessitated the destruction of salmon stocks in this facility in 1974. From July to October, LaHave stock post-yearling salmon parr were maintained at Kejimkujik Hatchery in disinfected 8-ft tanks at rearing densities which were eventually increased up to six times the normal for the station. The test utilized water drawn directly from Grafton Lake through a new water line. Neither *Pasteurella* sp. nor any other obligate fish pathogen

was isolated from mortalities or surviving fish. Investigations to date have not found Grafton Lake to be a source of serious bacterial pathogens for salmon.

During the summer, Dr. R. MacKelvie of the Halifax Laboratory undertook a requested disease survey of a lake and its watershed in southwestern Nova Scotia. The lake is currently under consideration as the water supply for the proposed new hatchery in the same area.

A program was initiated in conjunction with Dr. W. Paterson of the Halifax Laboratory to develop and assess the potential usefulness of vaccines and iodide-supplemented diets in controlling *Corynebacterial* kidney disease in Atlantic salmon reared at Margaree Hatchery. The maximum rearing density resulting in smolts free of gross kidney lesions is also being determined for Margaree Hatchery, since data from 1973 tagging experiments indicated a greatly improved rate of return by spring-released smolts having less than 1% gross kidney lesions.



Deformities such as these may have a genetic, nutritional, infectious or environmental cause.

This year, a spring and fall assessment of hatchery stocks was carried out. Together, these assessments evaluated 130 groups of Atlantic salmon, speckled trout and rainbow trout in 12 hatcheries. A group is determined by species, strain, age-class, diet, water supply, container, rearing history and hatchery. While the condition of most groups was generally good, a number of areas were identified as requiring corrective response or investigation. The deformities, scoliosis and kyphosis, occurred in some groups in sufficient numbers to warrant further investigation of its specific cause. Excessive fin erosion in one group of speckled trout and a high condition factor in others should be decreased by reducing stress conditions and feeding rates, respectively. Parasite infestations in a few groups were severe enough to warrant attention.

Fish Culture Investigations

Fish culture investigations in 1975 included the testing of different salmon and trout feeds, experimentation in different temperature regimes that could be adopted for rearing high quality one-year smolts and a study to determine the effects of starvation on hatchery-reared brook trout.

The most important of the diet trials was the comparison of Ewos and Silver Cup salmon feeds. This trial was conducted at Mactaquac, Antigonish and Miramichi hatcheries during the period from 1973 to 1975. Although final results of this trial will not be known until adult return rates for each of the groups are determined, it is significant to note that those reared on Silver Cup were on the average longer, heavier and better with respect to fin condition than those reared on Ewos. Mortalities were, however, slightly lower within the Ewos groups at two of the three hatcheries. Cost of food per unit weight of fish produced was higher at all three hatcheries for the Ewos smolts (Table 37). Based on these initial results, the Silver Cup feed appears to produce a better Atlantic salmon smolt at a lower cost than does the Ewos feed.

A second diet trial, designed to assess the Oregon Moist Pellet (OMP) as a food for Atlantic salmon, was carried out in the wet-laboratory

Table 37. Mean values of selected parameters used to compare Silver Cup and Ewos salmon feeds being tested at three hatcheries, 1973-75.

Parameters measured	Antigonish		Mactaquac		Miramichi	
	Ewos	Silver Cup	Ewos	Silver Cup	Ewos	Silver Cup
Fork length (cm)	16.0	18.3	21.5	22.9	14.5	15.6
Weight (g)	41.5	65.0	111.7	140.9	33.2	41.8
Condition factor	0.96	1.00	1.08	1.11	1.07	1.05
Hemoglobin (g%)	8.0	8.3	8.9	9.1	9.1	9.2
% good quality smolts	45.5	61.5	82.0	91.5	38.5	62.5
Cumulative mortality (%)	36.1	35.4	33.3	45.8	36.3	38.7
Food conversion	2.18	1.66	2.21	2.13	2.87	2.56
Food cost/kg of fish produced (\$)	1.92	1.10	1.95	1.36	2.47	1.62

Table 38. Mean values of selected parameters at end of 4-month Atlantic salmon diet trial, in which Oregon Moist Pellet and Silver Cup feeds were compared.

Diet	Fork length (cm)	Weight (g)	Food conversion	Food cost/kg of fish produced (\$)	Hemoglobin (g%)	Plasma protein (g%)
Oregon Moist Pellet	6.4	2.5	2.5	1.15	6.5	4.0
Silver Cup	9.5	9.7	1.2	0.83	8.3	4.6

facilities at Mactaquac Hatchery. Silver Cup feed was used as the control diet in this test. Both the OMP and Silver Cup groups were comprised of three lots of 200 fish each. Each lot was held in a 122-cm circular, fiberglass tank, with a water temperature of $15^{\circ} \pm 1^{\circ}\text{C}$. Fish were fed to satiation four times a day, six days a week for four months. At the beginning of the test, the average weight of fish in both groups was 1 g. At the end of the test, fish fed Silver Cup were in better condition than those fed OMP (Table 38). Weight gain was higher and food conversion was lower for Silver Cup Fish. Based on the results of this experiment, OMP is not recommended as a fish feed for Atlantic salmon.

A third feeding trial, designed to assess the floating-formula food produced by Martin Mills, was initiated at Yarmouth Hatchery. This test was terminated after 12 weeks, as it was observed during the early stages of the trial that the food did not float and was not readily accepted by the trout.

The subject of rearing a high percentage of 1-yr smolts at southern, warm-water stations, such as Yarmouth, Kejimikujik and Mersey, has been given increased attention in recent years. In 1975, a preliminary study was initiated at the Mactaquac laboratory facilities to determine the extent to which rate of development in Atlantic salmon can be accelerated by heating water. In the most accelerated group, salmon attained a size of 17.7 cm from full swim-up in eight months. This was not, however, achieved without a high loss (69%). Also, the cost of heating water to achieve this rate of growth prohibits the utilization of this regime on a large production scale. The program is still in progress and will be carried out until spring, 1976, at which time growth rates of several groups reared at lower temperatures will have been determined. Results of these accelerated rearing studies indicate that both incubation period and mortality vary according to water temperature (Table 39). A further interesting observation, although not totally unexpected, was that salmon fry

started feeding actively in water above 10°C and that feeding ceased in water below 7°C . A controlled incubation and rearing regime should therefore be adjusted so that fry reach the swim-up stage at a water temperature of approximately 10°C .

To determine the effect of starvation on hatchery-reared brook trout, an experiment was conducted in the wet-laboratory facilities at Mactaquac Hatchery. Yearling trout, with an average condition factor of 1.27, were starved from April to the end of October while being held at seasonal water temperatures ranging from 7° to 18°C . The fish survived the first three months of starvation with minimum apparent effects, as shown by a very slow decrease in condition factor, body fat and low mortality (3.3%). This was followed in the next three months by a rapid

Table 40. Mean values of selected parameters for yearling brook trout recorded monthly during starvation experiment.

Sampling dates	Cumulative mortality (%)	Condition factor	Hematocrit (%)	Hemoglobin (g%)	Plasma protein (g%)
April	0.0	1.27	41	8.6	3.5
June	3.3	1.20	38	7.8	3.1
August	49.9	0.96	— ¹	— ¹	— ¹
October	90.0	0.82	25	5.2	1.9

¹Not measured.

decrease in condition factor and a sharp increase in mortalities (78%). The results indicated that the general physiological condition of the fish deteriorated during starvation (Table 40) at an increasing rate, to the point where the fish died before utilizing the large amount of fat remaining in its body cavity. A yearling brook trout with a high condition factor (>1.3) has an inordinate amount of fat, in excess of that which the fish can utilize. This excess fat or weight adds to the cost of fish production, and should be avoided by controlling the feeding rate.

Table 39. Incubation period and mortalities for Atlantic salmon reared at different water temperature regimes¹.

Average water temperature ($^{\circ}\text{C}$)	Spawning to full hatch (days)	Mortality from spawning to full hatch (%)	Spawning to full swim-up (days)	Mortality from spawning to full swim-up (%)
4	130	7.7	155	10.1
7	85	12.9	120	18.9
10	60	12.9	95	29.9

¹The 7° and 10°C regimes were constant in temperature; the 4°C regime included variations between 1.5° and 8.5°C .

Hatchery Evaluation

Assessment of hatchery-reared Atlantic salmon stocking programs continued in 1975 with the release of 70,000 tagged smolts. As in recent years, virtually all salmon smolts distributed from Maritime hatcheries were adipose fin-clipped. These marking programs are providing feedback on the success of stocking programs, as well as information contributing to improved effectiveness of the hatcheries.

Tagging experiments are providing further evidence that heredity is important in determining age at first maturity in Atlantic salmon. Groups of 4,000, 2-yr smolts from pure grilse and pure salmon matings of Medway River stock produced significantly different proportions of grilse. Each group yielded more than 100 tag returns. Progeny of salmon matings produced proportionately more salmon than did smolts from grilse matings (27% vs 7%).

Aid to Other Agencies

Assistance to other government agencies, private ponds, commercial aquaculture operations and universities — which received eggs and fish ranging in size from fry to 2-yr smolt — utilized 29% (590,552) of all hatchery-produced fish in 1965 (Table 41).

The greatest numbers of fish were speckled trout sold to individuals for their private ponds. These fish are 2-4 cm in length and are surplus to the rearing capability of the stations.

The second greatest demand, again for speckled trout, was that of commercial aquaculture projects. This increased by 98% over that of 1974, and was the result of rearing problems causing high mortalities in the two larger aquaculture ventures in the Region.

Closely following is the assistance provided to provincial agencies. In Nova Scotia these fish are supplied as fall fingerlings (8-10 cm) and are held over winter for stocking in public waters. In New Brunswick they are used to support a winter fishery in

the Minto strip-mining ponds. In Prince Edward Island they are used for special stocking projects.

Researchers at universities and federal research laboratories rely exclusively on the Branch to supply their requirements for live salmonids. In 1975, 3.5% (73,259) of the salmonids distributed were supplied to these agencies.

The ongoing program of supplying Atlantic salmon eggs to the United States Government for restoration programs on the Connecticut and Merrimack rivers was adversely affected this year by an outbreak of furunculosis (*Aeromonas salmonicida*) in adults in the Restigouche River. As a result, the number of Atlantic salmon broodstock collected was reduced. This reduced the egg collection from 300,000 to 150,000, obtained from late-run Miramichi females crossed with early-run Saint John River males.

Assistance was extended to the Salmon Research Centre, Chamcook, New Brunswick, by providing the use of one of the broodstock ponds at Mactaquac Hatchery in 1975. This is the second year this service has been provided, as holding facilities have not been completed at Chamcook.

R. A. Eisner, A. Foda, F. M. MacMillan, J. A. Ritter, G. B. Robbins and J. M. Weber

Hatchery Engineering Services

The primary objective of this service is to provide support to artificial propagation operations through investigation of fish hatchery problems and design and construction supervision of new or improved facilities. Highlights of some of the more prominent projects undertaken during the year are given below.

Construction of a new trout-broodstock pond at Antigonish Hatchery, started in 1974, was completed in 1975. The gravel-lined pond, similar in construction to the existing salmon-broodstock pond, has a length of 38.1 m, a width of 11.0 m and a depth of 1.7 m, with

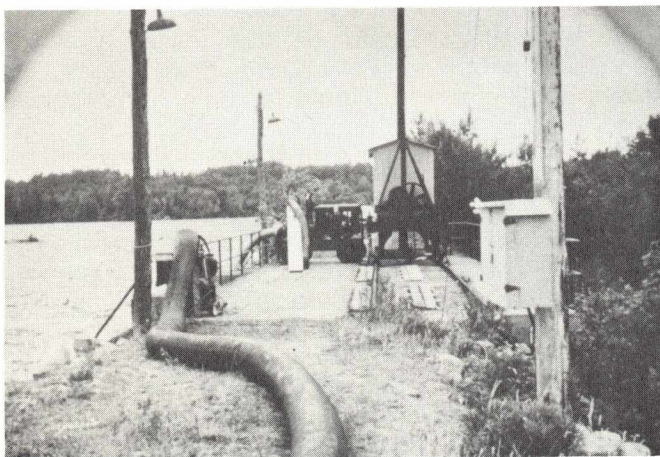
Table 41. Hatchery-reared stocks provided to other agencies and the public in 1975.

	Atlantic salmon		Speckled trout		Rainbow trout	
	Number	Wt (kg)	Number	Wt (kg)	Number	Wt (kg)
Commercial aquaculture	1,000	56.7	115,000	1,253.1	0	—
Research (government agencies)	39,399	2,467.5	14,697	904.3	15,002	250.8
Universities	2,130	38.3	2,031	98.8	0	—
National parks	0	—	31,500	1,313.8	0	—
Private fish ponds	0	—	225,737	722.6	0	—
Provincial agencies						
Nova Scotia	0	—	100,000	1,910.8	10,000	507.7
New Brunswick	0	—	23,056	429.3	0	—
Prince Edward Island	1,500	108.7	6,000	392.8	3,500	177.7
Totals	44,029	2,671.2	518,021	7,025.5	28,502	936.2

a 2:1 side slope. Water is supplied to the facility from either/or a combination of the following: a pumped well, capable of supplying 680 litres per min (150 gpm); a pipeline, 91.4 m long, supplying used water from the end of the hatchery long ponds at a rate of 9,550 litres per min (2,100 gpm).

A consultant was retained to prepare a report on the feasibility of obtaining 2,270 litres per min (500 gpm) from the artesian aquifer underlying Coldbrook Hatchery. Two observation wells and one 20.3 - cm (8 in.) test well were drilled and a pump test was performed. The consultant's findings indicated that 1,364 litres per min (300 gpm) could be withdrawn from the aquifer without affecting other wells in the area. Drilling of a 35.6-cm (14-in.) screened production well, and installation of a pump, pumping station and associated piping will be undertaken in 1976.

Because of the need for cool water during the hot summer months to prevent high mortalities at the Mersey Hatchery, a pumping station was installed to provide water from the deepest section of the headpond. A pumping capacity of 4,550 litres per min was provided through a 610-m length of flexible hose.



Auxiliary pumping system to draw cool water from below the thermocline in headpond no. 3, Mersey River.

The Mactaquac Hatchery received the major emphasis during the year, with the design and construction of an expansion to the aeration tower and secondary fish-sorting facilities, installation of replacement grating for the pond buildings and the design and construction supervision of a new fish-release site on the Tobique River.

Construction began early in 1975 on the modifications of the aeration tower. The modifications consisted of removing the existing wooden tower building and wooden baffles; construction of a new, larger, metal tower building; and rebuilding of the interior of the structure. Construction was carried out over a period of approximately a year, because only certain parts of the tower structure could be shut down at certain times of the year. The modifications were necessary to achieve better removal of nitrogen from the supersaturated river-water supply.

Modifications to the secondary fish-sorting facility were necessary to accommodate the anticipated increased salmon runs in future seasons. The modifications consisted of enlargement of the pres-



Newly modified aeration tower at Mactaquac Hatchery.

ent truck-loading area to accommodate the large, 18,184-litre tank truck; extension of the release channel from the concrete ponds to the tank truck; addition of 91.4 m of drain line from the enlarged truck-loading area; and construction of $4.6 \times 4.6 \times 3.0$ -m deep, reinforced-concrete holding pond and associated supply and drain lines. Due to delays in receipt of materials, strikes and inclement weather, the new addition was not operational until the end of August.

Complete renewal of grating for the station was necessary to replace the old aluminum grating that had warped and twisted, creating a toe-tripping hazard. The replacement grating is made of galvanized, riveted steel — much heavier and stronger than the original.

Because of the need for deeper receiving waters and a farther upstream release point, new fish-release facilities were constructed on the Tobique River, approximately 16 km upstream of the old site. The new facilities consist of a 17.4-m long, sheet-



Fish tank truck at newly constructed release site on the Tobique River.

steel-pile retaining wall, with associated anchor blocks, tie rods and truck bumper blocks.

Design work was completed on an expansion to the rearing ponds at Cardigan Hatchery. Three new 11-m Swedish ponds were designed. Water is to be supplied from the headpond through a new 236-m long pipeline. Construction of the new addition was not started in 1975 due to budgetary restraints and a redesign of the expansion.

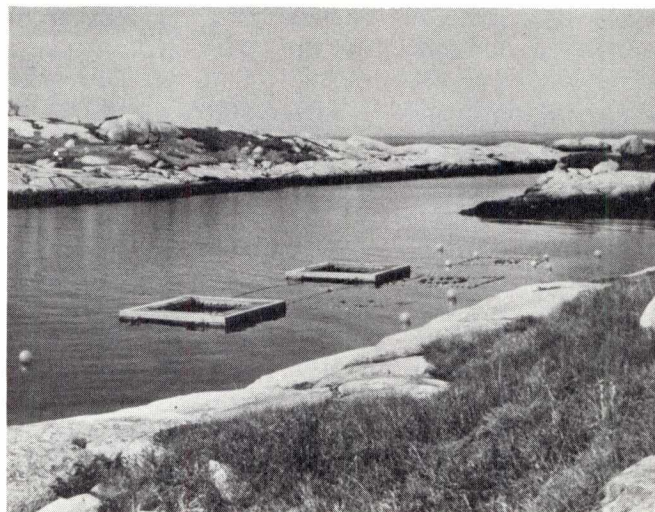
H. Jansen, A. K. Anderson, G. H. Jenkins and F. M. MacMillan

Commercial Fish Culture

Commercial fish culture continues to be of interest to many individuals in the Maritime Provinces. A large number of queries for both information and assistance was directed to the Fisheries and Marine Service during 1975. Fish farm establishments in the Maritimes continued to have a low level of production, due in part to the negligible rainfall this summer, resulting in unusually high freshwater temperatures. Five more individuals have made applications for permits to start fish culture operations in 1976, bringing the total number of operations in the Region to sixteen. Also, the potential of polyculture of salmonids with marine plants is being investigated by private developers in the area.

The Branch's pilot saltwater salmonid culture project at Polly Cove, near Halifax, Nova Scotia, continued for the third year. Four hundred and fifty Atlantic salmon from the 1974 program were carried overwinter in net cages in the sea. Superchilling water temperatures in late February and an algal bloom in April caused mortalities which reduced this stock to 200 by May 1.

In May, 500 speckled trout and 1,070 Atlantic salmon smolts were acclimated from fresh water to sea water. On May 1, speckled trout weight averaged 105 g (3.7 oz); on July 28, average weight was 231 g (8.1 oz). This would indicate that speckled trout suitable for marketing, 300 g or 10.5 oz, could be produced in 3.5 months. Total trout mortalities until July 27 were 10%. The Atlantic salmon smolts grew from an average of 107 g (3.8 oz) on May 1 to 240 g (8.4 oz) on July 28. Total salmon mortalities until July 27 amounted to 10%. The diet was processed on site, with an average ingredient cost of 35¢/kg (16¢/lb).



Saltwater rearing facilities at Polly Cove, Nova Scotia.

On July 28, a severe hurricane produced heavy seas and strong currents in the Polly Cove area. All the Atlantic salmon acclimated to the sea in May were lost due to tearing of the nets. Sixty-two percent of the salmon in their second sea-year and 70% of the speckled trout were also lost at this time.

As a result of overall lack of accessibility and a freshwater supply at Polly Cove, plus the loss of stocks and equipment during the July 28 hurricane, steps were initiated to move to a more suitable site. Previous investigations indicated that a site owned by the Marine Ecology Laboratory of the federal government at Boutilier's Point would be suitable. This site is completely accessible by road, contains a government wharf, a drilled well and has excellent sea-water net sites nearby. Relocation to this site was made in November.

A larger-scale production program is required to determine actual costs of operation and overall feasibility of salmonid culture in saltwater. Experimental programs in areas such as diet formulation, facility design and salmonid genetics would contribute needed information. Toward this end, an experimental genetic cross was made in the fall of 1975 with sea-run speckled trout males and hatchery brood-stock females.

J. C. Calder

PUBLICATIONS BY BRANCH STAFF — 1975

TECHNICAL REPORT SERIES

JESSOP, B.M. 1975. Investigation of the salmon (*Salmo salar*) smolt migration of the Big Salmon River, New Brunswick, 1966 - 72. Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-1, 57 p.

FODA, A. 1975. Effects of starvation on hatchery-reared Atlantic salmon (*Salmo salar*). Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-2, 12 p.

TURNER, G. E. 1975. Exploitation of Miramichi Atlantic salmon based on smolts tagged in 1968, 1969 and 1970. Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-3, 11 p.

MARSHALL, T. L. 1975. Movement of adult salmon of wild and hatchery origin placed in and above Mactaquac headpond. Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-4, 21 p.

RITTER, J. A. 1975. Relationships of smolt size and age with age at first maturity in Atlantic salmon. Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-5, 7 p.

JESSOP, B. M. 1975. A review of the American shad (*Alosa sapidissima*) stocks of the Saint John River, New Brunswick, with particular reference to the adverse effects of hydroelectric developments. Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-6, 23 p.

TURNER, G. E. 1975. Migration route and timing of Miramichi River salmon (*Salmo salar*) as indicated by recaptures of tagged smolts and adults. Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-7, 11 p.

ALEXANDER, D. R. 1975. Angler harvest of yearling brook trout (*Salvelinus fontinalis*) distributed from Antigonish and Yarmouth fish culture stations in 1973. Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-8, 21 p.

FRANTSI, C., T. C. FLEWELLING AND K. G. TIDSWELL. 1975. Investigations on Corynebacterial kidney disease and *Diplostomulum* sp. (eye-fluke) at Margaree Hatchery, 1972-73. Resource Develop-

ment Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-9, 30 p.

ALEXANDER, D. R. 1975. Sport fisheries potential on twenty lakes in the headwaters of the Shubenacadie River system, Nova Scotia. Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-10, 16 p.

MACPHAIL, D. K. 1975. Evidence of homing among transplanted Atlantic salmon (*Salmo salar* L.) kelts. Resource Development Branch, Fisheries and Marine Service, Maritimes Region, Halifax. MAR/T-75-11, 5 p.

STATISTICAL REPORT SERIES

DUNFIELD, R. W. 1975. 1974 Atlantic salmon sport catch statistics, Maritimes Region. Resource Development Branch, Fisheries and Marine Service, Halifax. MAR/D-75-1, 36 p.

DUNFIELD, R. W. 1975. 1974 Atlantic salmon commercial catch statistics, Maritimes Region. Resource Development Branch, Fisheries and Marine Service, Halifax. MAR/D-75-2, 72 p.

INFORMATION PUBLICATION SERIES

ENVIRONMENT CANADA. 1975. Oyster lease policy. Resource Development Branch, Fisheries and Marine Service, Halifax. 10 p.

ENVIRONMENT CANADA. 1975. Mactaquac and the Saint John River salmon. Resource Development Branch, Fisheries and Marine Service, Halifax. 12 p.

OUTSIDE PUBLICATIONS

(Including those published before 1975 but not listed previously)

ALEXANDER, D. R. AND H. R. MACCRIMMON. 1974. Production and movement of juvenile rainbow trout (*Salmo gairdneri*) in a headwater of Bothwell's Creek, Georgian Bay, Canada. J. Fish. Res. Bd. Canada, 31(1):117-121.

ALLAN, I. R. H. and J. A. RITTER. 1975. Salmonid terminology. PART I. A revised terminology list for Atlantic salmon (*Salmo salar* L.). International Council for the Exploration of the Sea, Anadromous and Catadromous Fish Committee, C.M.1975/M:7, 11 p.

BAKER, S. R. 1975. Cage rearing of salmonids in coastal areas of Nova Scotia. International Council for the Exploration of the Sea, Anadromous and Catadromous Fish Committee, C.M.1975/M:25, 6 p.

LAVOIE, R. E. 1975. Rétablissement d'une population naturelle d'huîtres après un désastre écologique. Annales de L'ACFAS, 42(1):147.

LAVOIE, R. E. 1975. Culture semi-naturelle de l'huître (*Crassostrea virginica*) dans le havre de Shemogue, au Nouveau-Brunswick. Annales de L'ACFAS,

42(2):33-35.

RITTER, J. A. 1975. Lower ocean survival rates for hatchery-reared Atlantic salmon (*Salmo salar*) stocks released in rivers other than their native streams. International Council for the Exploration of the Sea, Anadromous and Catadromous Fish Committee, C.M.1975/M:26, 10 p.

ROWELL, T. W. 1975. A strategy for the commercial utilization of the oyster (*Crassostrea virginica*) seed production of the Maritimes. International Council for the Exploration of the Sea, Shellfish and Benthos Committee, C.M.1975/K:49, 8 p.

ROWELL, T. W. 1975. Maritime oyster culture, development potentials and limitations. Proc. Bras d'Or Lakes Aquaculture Conf. College of Cape Breton Press, Sydney, Nova Scotia.

RUGGLES, C. P. 1975. The use of fish passes, traps and weirs in eastern Canada for assessing populations of anadromous fishes. EIFAC Tech. Paper No. 23, Supplement 1, Vol II:466-491.

RUGGLES, C.P. 1975. Atlantic salmon management.

New England Atlantic Salmon Restoration Conference. International Atlantic Salmon Foundation Special Publication Series, No. 6:157-158.

RUGGLES, C. P. and W. D. WATT. 1975. Ecological changes due to hydroelectric development on the Saint John River. J. Fish. Res. Bd. Canada, 31(1):161-170.

SEMPLE, J. R. AND C. L. MCLEOD. 1975. Experiments related to directing Atlantic salmon smolts (*Salmo salar*) around hydroelectric turbines. Pages 141-165 in S. B. Saila, ed. Fisheries and energy production. A symposium. D. C. Heath and Co., Toronto.

TURNER, G. E. 1975. Timing of migration of Atlantic salmon (*Salmo salar*) within the Miramichi River system, New Brunswick. International Council for the Exploration of the Sea, Anadromous and Catadromous Fish Committee, C.M.1975/M:24, 7 p.

WEBER, J. M. and R. B. STEWART. 1975. Cyclic AMP potentiation of interferon activity and effect of interferon on cellular cyclic AMP levels. J. Gen. Virol., 28:363-372.

STAFF SERVING IN FULL-TIME POSITIONS — 1975

BRANCH ADMINISTRATION

Campbell, G. E., *Secretary*
Childs, B. L., *Secretary*
Clattenburg, D. M., *Secretary*
Glass, D. L., *Secretary*
Jefferson, G. E., *Special Assistant*
Murphy, D., *Secretary*
Ruggles, C. P. (M.Sc.), *Biologist — Branch Chief*
Strangward, M., *Secretary*

SCIENTIFIC LIAISON AND SPECIAL PROJECTS

Cutting R. E. (M.Sc.), *Biologist — Section Head*
Smith, K. E. H. (B.Sc.), *Biologist*
Whynot, N. A., *Graphic Designer*

MARINE FISHERIES

Bryan, C. F., *Biol. Tech.*
Daigle, O. F., *Surveyor*
Daigle, R. S. A., *Biol. Tech.*
Dawson, J. E., *Clerk*
DeGrace, M., *Oyster Field Asst.*
England, L. A., *OIC Ellerslie Sta.*
England, W. A., *Biol. Tech.*
Hutchinson, H. A., *Oyster Field Asst.*
Jones, D., *Clerk*
Lavoie, R. E. (Ph.D.), *Biologist*
MacAusland, M. N., *Oyster Field Asst.*
MacEachern, N. E. (B.Sc.), *Biologist — Section Head*
MacKay, V. T., *Oyster Field Asst.*
McIver, A. R. (M.Sc.), *Biologist*
Oatway, W. E., *Biol. Tech.*
Pringle, J. D. (Ph.D.), *Biologist*
Robert, G. (Ph.D.), *Biologist*
Ross, A. A., *Oyster Field Asst.*
Ross, H. W., *Oyster Field Asst.*
Rowell, T. W. (M.Sc.), *Biologist*
Semple, R. E., *Biol. Tech.*
Williams, B. S., *Draftsman*
Woo, P. (B.Sc.), *Biol. Tech.*

FISH HABITAT PROTECTION AND ENGINEERING SERVICES

Anderson, A. K. (B.Sc.), *Engineer*
Ashfield, V. D. (M.Sc.), *Biologist*
Close, J. R., *Draftsman*
Conrad, V. (B.Sc.), *Engineer*
Cox, D. J., *Biol. Tech.*
Cullen, A. J. (M.Sc.), *Engineer*
Edwards, H. E. (B.Sc.), *Biologist*
Farmer, G. J. (Ph.D.), *Biologist*
Hall, J. A., *Eng. Tech.*

Humes, T. M. (M.Sc.), *Engineer*
Jansen, H. (B.Sc.), *Engineer*
Jenkins, G. H. (B.Sc.), *Engineer*
Kent, B. W., *Draftsman*
Leadbetter, J. C., *Eng. Tech.*
Leeman, J. W., *Biol. Tech.*
Lord, K. N., *Eng. Tech.*
MacDonald, E. V., *Eng. Tech.*
MacKinnon, L. P., *Eng. Tech.*
McLeod, C. L. (M.Sc.), *Biologist*
McMinn, A. M. (B.Sc.), *Biol. Tech.*
Pellerin, C. J. (B. Sc.), *Eng. Tech.*
Ray, S. (Ph.D.), *Chemist*
Riley, D. C. (B.Sc.) *Engineer — Section Head*
Rutherford, R. J., *Biol. Tech.*
Semple, J. R. (M.Sc.), *Biologist*
Sweeney, R. K. (B.Sc.), *Biol. Tech.*
Watt, W. D. (Ph.D.), *Biologist*
White, W. J. (M.Sc.), *Biologist*

FRESHWATER AND ANADROMOUS FISHERIES

Aitken, D. J., *Hatch. Tech.*
Aitken, J. L., *A/Hatch. Mgr. — Cardigan*
Alexander, D. R. (M.Sc.), *Biologist*
Amiro, P. G. (B.Sc.), *Biol. Tech.*
Arthurs, M. S., *Hatch. Tech.*
Austin, W. K., *Hatch. Tech.*
Baker, F. S., *Hatch. Tech.*
Black R.M., *Hatch. Mgr. — Saint John*
Brown, G. F., *A/Hatch. Mgr. — Yarmouth*
Calder, J. C. (M.Sc.), *Biologist*
Cameron, J. D., *Biol. Tech.*
Campbell, G. D., *Hatch. Maintenance*
Campbell, U. L. (B.A.), *Clerk*
Carey, T. G. (B.Sc.), *Biologist*
Cook, B. J., *Hatch. Asst.*
Cooling, A. L., *Hatch. Asst.*
Creighton, J. C., *Hatch. Asst.*
Ducharme, L. J. A. (B.Sc.), *Biologist*
Dunfield, R. W., *Biol. Tech.*
Eisner, R. A. (B.Sc.), *A/Hatch. Tech. Advisor*
Foda, A. (M.Sc.), *Biologist*
Forsyth, L. S., *Hatch. Tech.*
Fox, G. G. (B.Sc.), *Biol. Tech.*
Francis, A. A., *Biol. Tech.*
Fraser, O. E., *Hatch. Asst.*
Gallop, P. A., *Biol. Tech.*
Goff, T. R. (B.Sc.), *A/Hatch. Mgr. — Mersey*
Gray, R. W. (M.Sc.), *Biologist*
Gilks, J. A., *Hatch. Asst. (Ret.)*
Hanscom, B. E., *Hatch Tech.*
Hart, S. F., *Hatch. Asst.*
Hawkins, R. F., *Supervisor of Hatcheries (Ret.)*
Hill, M. G. (B.Sc.), *Hatch. Tech.*
Hitchcock, R. B., *Hatch. Tech.*
Ingraham, W. G., *Hatch Asst.*
Ingram, J. H., *Biol. Tech.*
Ives, B. H., *Hatch Tech.*
Jessop, B. M. (M.Sc.), *Biologist*
Kyte, C. E., *A/Hatch. Mgr. — Margaree*
Langille, E. G., *Hatch. Mgr. — Antigonish*
Lanteigne, O. J., *Hatch. Asst.*
Leaman, H. E., *Hatch. Asst.*
Lindsay, B. G., *Hatch. Asst.*
Lister, D. B. (B.Sc.), *Biologist — Section Head*

- Lloy, S. L., *Hatch. Asst.*
 Logan, E. A., *Hatch. Asst.*
 Lutzac, T. G. (M.Sc.), *Biologist*
 Lydon, T. K., *Hatch. Mgr. — Antigonish (Ret.)*
 MacDonald, D. J., *Hatch. Asst.*
 MacDonald, D. L., *Hatch. Asst.*
 MacIntosh, J. L. (B.A.), *Hatch. Mgr. — Cobequid*
 MacMillan, F. M., *Hatch. Tech. Advisor*
 MacNeil, S. L., *Hatch. Asst.*
 MacNeil, M. D., *Hatch. Asst.*
 MacPhail, D. K., *Biol. Tech.*
 McAskill, J. W., *Hatch. Mgr. — Mactaquac*
 McLean, D. L., *Hatch. Mgr. — Florenceville*
 Marshall, T. L. (Ph.D.), *Biologist*
 Merlin, P. P., *Hatch. Tech. (Ret.)*
 Miller, W. A., *Hatch. Asst.*
 Mullin, T. I., *Hatch. Asst. (Ret.)*
 Newbould, K. A. (S.C.A.), *Clerk*
 Nichols, E. M., *Hatch. Asst.*
 Nicholson, C. W., *Hatch. Tech.*
 O'Neill, J. J. (B. A.), *Biol. Tech.*
 Owen, B. W., *Secretary*
 Pace, M. J., *Clerk*
 Parish, A. A., *Hatch. Asst.*
 Patterson, J. A. (B.Sc.), *Hatch. Tech.*
 Penney, G. H. (B.Sc.), *Biologist*
 Penney, W. J., *Biol. Tech.*
 Peppar, J. L. (M.Sc.), *Biologist*
 Peverill, R. G., *Hatch. Mgr. — Margaree (Ret.)*
 Pickard, P. R. (B.Sc.), *Biol. Tech.*
 Rideout, A. W., *Hatch. Tech.*
 Ritcey, R. F., *Hatch. Asst.*
 Ritter, J. A. (M.Sc.), *Biologist*
 Robbins, G. B. (B.Sc.), *Supervisor of Hatcheries*
 Robertson, M. R. (M.Sc.), *Biologist*
 Robinson, E. L., *A/Hatch. Mgr. — Coldbrook*
 Ross, C. T., *A/Hatch. Mgr. — Charlo*
 Rushton, G. E., *Hatch. Tech.*
 Rushton, H. K., *Hatch. Asst. (Ret.)*
 Schofield, E. J., *Biol. Tech.*
 Shaw, W. G., *Hatch. Asst.*
 Shepard, R. T., *Hatch. Asst.*
 Silver, V. I., *Hatch. Asst.*
 Smeltzer, R. C., *Hatch. Asst.*
 Smith, R. C., *Hatch. Tech.*
 Stannix, A. J., *Hatch. Tech.*
 Swan, P. G., *Biol. Tech.*
 Sweet, L. J., *Hatch. Asst.*
 Swetnam, D. A., *Biol. Tech.*
 Taylor, A. S., *Hatch. Asst.*
 Tidswell, K. G. (B.Sc.), *Biol. Tech.*
 Turner, G. E. (M.Sc.), *Biologist*
 Webber, R. H., *Hatch. Mgr. — Charlo (Ret.)*
 Weber, J. M. (Ph.D.), *Biologist*
 Wynn, F. A., *Hatch. Mgr. — Miramichi*
 Zwicker, B. M., *Biol. Tech.*