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Comprehensive Development Strategy for the Anadromous and Inland Recreational Fisheries of New Brunswick

K. K. Loftus, L. A. Greig, T. A. Pinfold,
M. Kilfoil and J. D. Meisner

Department of Fisheries and Oceans
Gulf Fisheries Centre
Canada/New Brunswick Cooperation Agreement on
Recreational Fisheries Development
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6

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**Canadian Manuscript Report of
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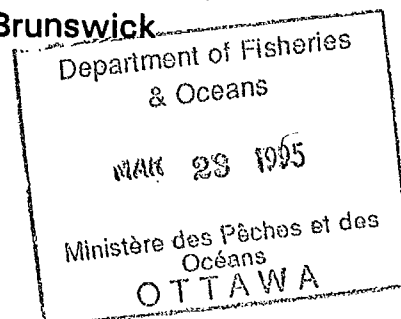
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**Comprehensive Development Strategy for the Anadromous
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by

**K. K. Loftus¹, L. A. Greig², T. A. Pinfold³,
M. Kilfoil¹ and J. D. Meisner²**



**Department of Fisheries and Oceans
Gulf Fisheries Centre
Canada/New Brunswick Cooperation Agreement on
Recreational Fisheries Development
P.O. Box 5030, Moncton, N.B., E1C 9B6**

¹LGL Limited environmental research associates, King City, Ontario, L0G 1K0

²ESSA Environmental and Social Systems Analysts Limited, Richmond Hill, Ontario, L4C 9M5

³Gardner Pinfold Consulting Economists Limited, Halifax, Nova Scotia, B3J 2K5

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In August, 1992, the Canada/New Brunswick COOPERATION Agreement on Recreational Fisheries Development was signed, recognizing the long-term strategic importance of the recreational fishing sector to the social and economic future of New Brunswick. Under the Resource Development Program of the Agreement, a Strategic Planning and Evaluation component was mandated to develop a strategic approach which would define program areas for all species. The Final Report, submitted by LGL environmental research associates, is the net result of this undertaking and represents many months of consultative effort. It forms a solid strategic foundation on which to structure future development initiatives in the province's recreational fishery sector.

RÉSUMÉ

Loftus, K. K., L. A. Greig, T. A. Pinfold, M. Kilfoil and J. D. Meisner. 1993. Comprehensive Development Strategy For the Anadromous and Inland Recreational Fisheries of New Brunswick. Can. Manuscr. Rep. Fish. Aquat. Sci. 2216: xxii + 235 p.

En août 1992, les gouvernements du Canada et du Nouveau-Brunswick ont conclu une Entente de coopération sur le développement des pêches récréatives, reconnaissant ainsi l'importance stratégique à long terme du secteur de la pêche récréative pour l'avenir socio-économique du Nouveau-Brunswick. En vertu du Programme de la mise en valeur des ressources, on a mis au point un projet intitulé Planification et évaluation stratégiques, dans le but d'élaborer un plan stratégique qui définira les secteurs du programme pour toutes les espèces visées. Le présent rapport final, soumis par LGL environmental research associates, est le fruit de ce projet et représente un travail de consultation échelonné sur plusieurs mois. Il constitue une base stratégique solide sur laquelle on pourra façonner les futurs projets de mise en valeur dans le secteur de la pêche récréative au Nouveau-Brunswick.

**COMPREHENSIVE DEVELOPMENT STRATEGY
FOR THE ANADROMOUS AND INLAND
RECREATIONAL FISHERIES OF NEW BRUNSWICK**

FINAL REPORT

by

**¹Kevin K. Loftus, ²Lorne A. Greig, ³Tom A. Pinfold,
³Mary Kilfoil and ²J. Don Meisner**

**¹LGL Limited environmental research associates
P.O. Box 280, 22 Fisher Street
King City, Ontario
L0G 1K0**

**²ESSA Environmental and Social Systems Analysts Limited
Suite 308, 9555 Yonge Street
Richmond Hill, Ontario
L4C 9M5**

**³Gardner Pinfold Consulting Economists Limited
1313 Breton Street, 3rd Floor
Halifax, Nova Scotia
B3J 2K5**

**Appendix M - Compendium of New Brunswick Sportfish
prepared by the Atlantic Reference Centre
St. Andrews, New Brunswick**

prepared for

**The Canada - New Brunswick
Cooperation Agreement on Recreational Fisheries**

LGL Project Number TA 2007

Executive Summary

This report has been prepared for Fisheries and Oceans Canada (DFO), Gulf Region Recreational Fisheries, and the New Brunswick Department of Natural Resources and Energy (DNRE), as part of a project to establish a strategy for further economic development of New Brunswick's anadromous and inland recreational fisheries.

The work of developing this strategy was supported by the Canada-New Brunswick Cooperation Agreement for Recreational Fisheries Development. The goal of this Federal-Provincial program is to promote economic development within New Brunswick. During the next four years, various components of the program will invest approximately fifteen million dollars in the development of the recreational fishery in New Brunswick, much of which will be spent in cooperative initiatives with private sector groups. A component of the strategy is the development of a sustainable resource through a potentially wide spectrum of resource enhancement and protection initiatives.

Goals

The following goals, as defined in the Canada - New Brunswick Agreement, are central to the development of the recreational fisheries strategy:

- To restore degraded fish stocks and manage the fisheries resources in New Brunswick to provide a diversity of sustainable fishing opportunities based upon a healthy environment and naturally sustaining fish populations.
- To establish cooperative management of the fisheries resource by all resource users.
- To provide the basis for sustainable social and economic benefits derived from the fisheries resource.

The Resource Base and Current Economic Value

New Brunswick's fisheries resources are based upon an extensive network of streams totalling 32,000 km, a relatively small number of lakes and a coastline approximately 2,200 km in length. These water resources once supported some of the richest recreational fisheries in North America, particularly for Atlantic salmon. At present, however, New Brunswick's brook trout and Atlantic salmon populations are depleted, and the populations of some other species are also showing signs of depletion. The depletion of stocks has resulted in a decline in the value and real economic growth of the recreational fisheries sector over the past several years. This decline can be attributed, in part, to habitat degradation, but more significantly, to over-exploitation. The situation is further intensified by other issues related to the recreational fishery that need to be resolved.

In 1985, there were close to 180,000 licensed adult anglers in New Brunswick, 95 % of whom were residents of the province. These anglers spent a total of \$81.6 million in 1985, \$51.3 million of which could be directly attributed to the sports fishing in the province.

By 1990, the total number of anglers, angler effort and total catch had declined relative to 1985 levels. Most of this decline appears to have been related to a reduction in effort associated with the continued depletion of brook trout stocks. Despite the decline in overall angling effort, the total sport fishing expenditure in 1990 ($\approx$ \$45-48 million - our estimate) was only slightly lower than the estimate reported in 1985, likely due to the increased angling effort directed in 1990 towards Atlantic salmon.

Process

Public consultations were held with First Nations bands and organized angler groups to provide the opportunity for a wide range of stakeholders to help define the strategy. During these consultations, participants were asked to describe 1) their aspirations for the future of recreational fishing in New Brunswick, 2) current issues related to resource status and management, and 3) specific actions needed to address the issues. The general public was also provided an opportunity to provide input into the strategy via a solicitation for input published in daily newspapers throughout the province. Discussions were then held with the DFO and the DNRE to obtain their input on the management of the recreational fishery and to further identify key management issues and potential actions.

For the most part, stakeholders, including resource managers, felt the need to develop initiatives with a broad strategic focus (such as the need for planning, public education, improved regulations and management approaches), more so than identifying specific actions for stream rehabilitation or stocking programs. This was consistent with the goal of the Canada - New Brunswick Recreational Fisheries Agreement, *"to provide a strategic approach for restoration of the recreational fisheries resource and to sustain the economic benefits from this development by strengthening the recreational fishery sector"*.

The results of the first round of public consultations were combined with the results of discussions with the DFO, the DNRE and other input to provide a starting point for discussion at a strategy design workshop. Workshop participants were asked to consider the issues identified in the first round of consultation. They were encouraged to define site-specific and/or strategic actions needed for resolving the issues; to identify the resource, social and economic implications of the identified actions; and to identify resource and information needs and constraints. As before, most of the actions identified by subgroups were strategic, rather than site-specific, in nature. It was concluded that site-specific restoration measures and actions would best be identified through local planning initiatives. It was also noted that much of the information on which such decisions should be based was simply not available.

Following this process, a strategy review and implementation workshop was held to examine the strategy's assumptions, to identify priorities for implementing the strategy, and to refine the evaluation criteria used to guide the development and selection of projects for implementing the strategy.

Issues

Resource users identified a significant number of issues related to the recreational fishery. The issues identified 1) during the initial round of public consultations held with organized angler groups and native organizations, 2) during discussions with agency personnel, and 3) in the letters received in response to a solicitation for input published in newspapers, served as a starting point for workshop discussions. Interestingly, there were marked similarities in the perceptions of issues amongst the different groups contacted.

The list of issues was briefly reviewed at the workshop and was expanded by workshop participants to include: 1) depleted fish stocks; 2) over-harvesting of fish stocks; 3) physical habitat destruction and/or degradation; 4) chemical degradation of habitats; 5) inadequate management of the fishery resource due to a variety of reasons including, but not limited to, insufficient financial and staff resources, an inadequate level of inter-agency coordination, confusion about agency jurisdiction, lack of regional fisheries management planning, and a lack of reliable assessment data on which to base management decisions; 6) insufficient public and First Nation involvement in management decisions and in hands-on management; 7) insufficiently stringent regulations; 7) inadequate enforcement and penalties for fishing infractions; 8) allocation conflicts between natives and non-natives, between anglers and commercial fisherman, and amongst anglers; 9) insufficient public access to angling opportunities (an issue related to the land tenure system in the province, including the crown reserve system); 10) concerns regarding over-crowding and other factors affecting the quality of the angling experience; 11) the under-utilization of alternative species; 12) a desire for self-sustaining fisheries versus put and take fisheries; 13) concern with the introduction of exotic species; 14) concern with the issue of fishing rights versus privileges, particularly as related to native fishing rights; 15) social versus economic values (some persons felt that priority should be given to the development of the recreational fishery for the benefit of New Brunswick residents); 16) cost versus quality of fishing; and 17) concern over an inadequate sense of stewardship of the resource amongst some resource users. Several issues clearly relate to the problem of over-exploitation of fish stocks. At the same time, many anglers expressed a strong desire for increased access to recreational fishing opportunities. The challenge for managers is to find ways of balancing these seemingly conflicting issues while increasing the social and economic benefits derived from New Brunswick's fish resources.

Aspirations

Aspirations for the management of New Brunswick's inland and anadromous recreational fisheries identified by stakeholders involved in the public consultation were generally consistent among the angler groups contacted. Essentially, all groups identified a need for the rehabilitation of native stocks and for increased opportunity for involvement in resource management. All groups indicated a willingness to work with other resource users. The list of key aspirations include:

- Rehabilitation of native fish stocks;
- Development of new fisheries to increase opportunities;
- Formal management of species other than Atlantic salmon and brook trout;
- Increased sustainable fishing opportunities;
- Cooperative management of fisheries;
- Employment;
- Increased understanding of management responsibilities;
- Maintenance of biodiversity of aquatic resources;
- Maintenance of a quality environment; and
- Maintenance of a quality fishing experience.

Native groups indicated similar aspirations for rehabilitation of depleted stocks, development of new fisheries and long term sustainable resource use. In addition, native leaders emphasized the need for employment for native people and for identifying economically viable resource-based initiatives to provide increased employment opportunities. Native people contacted during the initial consultations and who took part in either the strategy design and/or the strategy review and implementation workshops indicated a willingness to work in cooperation with other resource users in developing sound approaches to resource management. In doing so, they seek a shared commitment to wise resource use and protection, mutual respect and an open and honest cooperative process. An important aspiration for native people in any cooperative management initiative, is for a greater degree of integrity and respect in the interaction with others than they have been historically afforded.

While several First Nations participants indicated a willingness to work with other resource stakeholders in developing sound watershed management plans, it will be important for others to recognize that not all native aspirations are likely to be met through a recreational fisheries strategy. Other aspirations of the native community will be aided by a parallel program, the Aboriginal Fisheries Strategy, which focuses specifically on providing assistance to native people to improve their condition through development of fisheries based initiatives.

Potential Value of New Brunswick's Recreational Fishery

Angling surveys in New Brunswick and the results of the public consultation process conducted in association with this project indicate that most anglers value the sport fishery in

New Brunswick higher than the price paid for angler licences. These surveys also indicate a substantial willingness to pay above the expenditures associated with the fishing trip. This implies that a consumer surplus (potential additional economic benefit) associated with the New Brunswick recreational fishery is not being captured. An estimate of consumer surplus is essential to the prediction of potential economic benefits.

Prediction of the potential economic value of New Brunswick's anadromous and inland recreational fishery was, for most species, constrained by a lack of reliable and up-to-date assessment data on habitats (including carrying capacities), stocks, habitats and angling effort. However, using the best available information (including expert opinion), it is clear that large gains in species populations and, in turn, socio-economic benefits are possible with appropriate management. Further, it is clear that the development of new fisheries focused on currently under-utilized species offers considerable socio-economic potential.

Analyses of the current and potential economic value of the recreational fishery were conducted for the following species groups: 1) Atlantic salmon; 2) brook trout; 3) "other salmonids"; 4) warm water species; 5) striped bass; 6) coastal and "other anadromous" species; and all species combined. The analyses indicate considerable potential for growth in most fisheries. The estimate of potential total economic value for all species combined, assuming that the proportion of non-resident anglers does not change relative to current conditions ($\approx 5\%$), was \$102 million. This represents a 2.25 fold increase in the economic benefit relative to 1990 conditions. As expected, further gains in economic benefit were predicted to occur as the proportion of non-resident anglers increased.

A Strategy for New Brunswick's Recreational Fisheries

The goals of the strategy are supported by the following seven guiding principles which were defined in consultation with the stakeholders.

- primacy of conservation,
- sustainable development,
- an ecological basis for management,
- reliance upon natural production,
- equitable allocation of societal benefits,
- cooperative management, and
- the quality of the angling experience.

The recommended strategy for New Brunswick's recreational fisheries includes six major strategic components

- Establishing a new management framework that directly involves resource stakeholders in management decision making,

- Increasing communication between all resource stakeholders with regard to the status and potential of the resource,
- Increasing the knowledge needed to successfully manage the fisheries resource and its use,
- Developing specific allocation agreements between users,
- Increasing opportunities for sustainable resource use, and
- Managing resource harvests to ensure the sustainability of the fishery and of the benefits accruing from its use.

Strategic Initiatives and Recommendations

A variety of strategic initiatives and recommendations were developed to facilitate the achievement of the identified goals, including the potential socio-economic benefits described above. A long term commitment - not limited to the Federal-Provincial agreement - will be key to successful implementation of the strategic plan and the derivation of sustainable resource and socio-economic benefits.

1. Establish a new management framework

A formalized co-management framework which coordinates the activities of the DFO and the DNRE and which provides a mechanism for meaningful public/user group participation in resource management needs to be established. Resource users indicated a desire to be more directly involved in management. Involving users in management could increase the effective level of management effort and could provide important additional benefits.

The creation of a sport fish advisory committee, the Sport Fish Advisory Board, whose structure would encourage input from a wide variety of user groups and stakeholders, is recommended.

An agreement needs to be developed between the DNRE and the DFO to define their joint approach to fisheries management in New Brunswick, and to clarify each agency's responsibility for the management of recreational species.

Clearly define in a Memorandum of Understanding (MOU), agency responsibilities for management of all recreational species.

Joint management objectives and watershed-specific resource management plans have not been developed.

Specific management objectives for fish communities within watersheds and sub-watersheds should be developed in consultation with resource stakeholders within the co-management framework.

2. Increase Communication

There does not appear to be a strong sense of commitment to resource stewardship. Increasing the awareness of all parties of the value placed on the resource by other stakeholders, and of the fundamental principals of fisheries management, is important to achieving the long term objectives for the New Brunswick recreational fishery.

Formal communications/education programs are required. These should be peer reviewed prior to implementation.

Communications within and between agencies, and between agencies and the public need to be improved.

3. Increase the Availability of Knowledge Needed to Manage Effectively

With the exception of Atlantic salmon, the fundamental information required to effectively manage the recreational fishery to provide sustainable social and economic benefits is not available. In particular, the basic information and tools needed to predict the effects of management actions on fish stocks and, in turn, the effects of changes in stock status on socio-economic benefits, are not available. For example, much of the available information on habitat, stock status, harvest rates and angler expectations is either anecdotal, out-of-date, or of questionable accuracy.

Information needs and appropriate strategies for data gathering should be defined.

Existing information should be collated, analyzed and reviewed.

A joint federal-provincial policy on monitoring and assessment is required.

Standardized assessment methods, sampling protocols, etc., to guide the collection and analysis of habitat, stock and harvest data need to be developed.

Standardized but flexible information management systems should be developed.

Recognizing that better assessment information is essential to sound resource management, and that baseline data requirements could likely be met within a few years of intensive effort, a high priority should be assigned to initiatives which seek to use Strategic Plan funds to acquire these data. A coordinated, province-wide program is essential.

The DNRE's regional fisheries biologists, who play a lead role in the management of the inland fishery, have neither a clear mandate, nor the time to collect or the tools to analyze, management information.

Acquire the staff and funding resources needed to collect and analyze the required assessment information.

For some species, the scientific basis for management is not well understood. This is particularly true of species such as striped bass, but is also true for inland species such as brook trout and smallmouth bass for which resource carrying capacities and sustainable harvest rates are not well-established.

Science needs must be identified and prioritized. The Sports Fish Advisory Board should have significant input into this process. Research proposals should be subjected to peer review prior to their implementation. Studies addressing priority science needs should be funded.

4. Resolve Allocation/Access Issues

The rising demands for sport fishing and back country recreation are placing increasing pressures on the fisheries resource. Consequently, there is a need to develop an allocation mechanism capable of maintaining harvests within sustainable levels. Perhaps the most contentious allocation issue revolves around the rights of native people to fish, and to the allocation of harvest between Natives and non-Natives.

Resolving the allocation issue is a high priority. Doing so in a fair and just manner is fundamental to the successful implementation of the Strategic Plan.

Negotiate equitable allocation agreements among user groups.

By-catches and/or directed catches of important or potentially important sports fish species are affecting population levels of those species.

Strategies to reduce or eliminate the by-catch and/or directed catch of species such as striped bass and Atlantic salmon need to be adopted and monitored. This will require 1) changes to regulations, 2) the (re-) negotiation of allocation agreements, and/or 3) buy-out of some fishing licences.

In some areas, anglers hold conflicting views about management priorities. This is reflected by differences in species preference, and by disagreements over the appropriateness of certain management actions, such as those that affect the availability of fish species.

Conflicts amongst anglers should be addressed through the Regional Watershed Planning process in which aspirations for the local resources will be identified, and appropriate objectives and programs will be established.

5. Increase Fishing Opportunities

Since the main goal of the program is to provide increased economic benefit to New Brunswick, increasing fishing opportunities is an important component of the strategy.

Access to angling opportunities in the Province is limited due to private ownership of large tracts of land, riparian rights which restrict fishing along some water bodies, and the Province's crown reserve and crown lease systems. While some resource users feel that the current land tenure system is unfair, it has played an important role in protecting the fisheries resource.

Consideration should be given to renegotiating or developing new access agreements, providing that adequate harvest control/enforcement control mechanisms can be established.

The experimental application of an alternative management system, such as Quebec's ZEC system, intended to increase angling opportunities through access control, while improving management of some stocks, should be considered.

A watershed or regional review of the current mix of access options could identify opportunities for increased access to fishing.

Some opportunities may exist for increasing fishing opportunities through season extensions or by opening some waters which are presently closed to certain types of fishing.

Opportunities for increasing fishing opportunities through the above-described or similar mechanisms should be explored.

Privately and/or publicly operated put (grow) and take fisheries are growing in importance, particularly near urban centres.

In recognition of the public's strong preference for fisheries based upon natural production, as identified during the public consultation process, put (grow) and take fisheries should, as a first priority, be established in self contained ponds or reservoirs where the risks to natural fish communities are minimal.

Put (grow) and take fisheries could be allowed in natural waters if the conditions described elsewhere in this report are met.

Based upon an assessment of historical stock conditions and stock potential, it is clear that there is considerable potential for increasing the social and economic benefits that are derived from the resource.

Rehabilitate degraded stocks and critical habitats. Protect remaining habitats.

Manage for sustainable productivity and benefits.

There are a number of previously unexploited species which appear to be capable of supporting a considerable amount of angler effort.

Alternative species should be promoted to increase fishing opportunities and relieve fishing pressure on over-harvested species.

6. Reduce Harvest to Sustainable Levels

With few exceptions, the principal cause of fish stock depletion in New Brunswick is over-exploitation, either in the recreational fishery (e.g., brook trout, sea-trout) and/or in the commercial fisheries (e.g., Atlantic salmon, striped bass).

More stringent regulations are required.

Compliance with fishing regulations must be increased.

A greater emphasis also needs to be placed on managing the demand side of fisheries rather than simply being concerned with supplying more fish. Conservation fishing is one tool that can be effectively used in some situations to reduce the effect of angling on fish stocks.

Consider increasing licence fees to make them more in line with resource value.

Emphasis should be placed on hook and release fishing in some water bodies.

Consideration should be given to the development of a "conservation licence" for those anglers who agree to release their catches.

Upon completion of the regional watershed planning process, regulations should be revised as necessary.

In the absence of good data on the status of stocks, harvest rates, and sustainable harvest levels, regulations must be conservative.

Monitoring of stocks and harvests is essential so that the effectiveness of regulations can be assessed.

The DFO appears to have made, and continues to make, judicious use of stocking as a management tool. The DNRE appears to have placed a heavier reliance upon stocking than has the DFO. While selective stocking programs will accelerate the recovery of depleted stocks, there is a need to develop a joint federal-provincial policy on the use of hatchery fish.

The judicious use of stocking as a management tool should continue provided that the criteria described elsewhere in this report are met.

The intent, expected duration and expected benefits, both resource and socio-economic, of all stocking programs should be explicitly identified.

The effectiveness of stocking programs needs to be evaluated. Public assistance should be sought.

Strategy Implementation

Several of the initiatives and recommendations explored above are fundamental to the success of the strategy and the achievement of long term sustainable economic benefits. They are: 1) establishing a multi-user framework for cooperative resource management; and 2) increasing public and management agency understanding of the state of the resource and the needed actions for its rehabilitation.

The essential minimum set of steps needed to implement the strategy includes:

1. Forming and enabling the proposed co-management framework.
2. Within the co-management framework, begin the development of watershed-based fisheries management plans. This in turn requires
 - identifying critical information needs for managing the fisheries at the watershed level (also at the Provincial scale), and
 - identifying and ranking critical actions for the restoration of targeted fisheries in each area.
3. Using the best information currently available, modify regulations in each area, as required, to ensure a high level of resource conservation.
4. Initiating education/training programs aimed at anglers, natives, the judicial system, school children, and industry (e.g, farmers, loggers).

Initiatives supported under the program should comply with the strategy. To facilitate this, eight criteria for proposal evaluation were developed to guide proposal development and to determine how best to allocate funds. Projects should:

1. consistent with the strategic planning principles;
2. involve a multi-user planning group;

3. be based on an understanding of the state of the resource, i.e., the need for a project within the watershed or sub-watershed is clearly understood;
4. have a predicted benefit-cost ratio for the project which is positive;
5. increase the capacity of the proponents to contribute to resource management;
6. lead to increased public awareness;
7. include some outside funding; and
8. include a commitment to monitoring.

Criteria #1, #2, #4 and #7 are mandatory. By inference, criteria #3 then becomes mandatory.

Procedures and templates for predicting the effects of management actions on the resource (i.e., fish stocks, harvestable fish), and the economic benefits that might accrue from the predicted resource effects are provided in Section 5.0 of this report.

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Sincere thanks are extended to DFO and DNRE personnel, most of whom are listed in the Appendices to this report, for their cooperation, enthusiasm and openness, particularly in light of the nature of this project in which they opened themselves to potential criticism. Their knowledge of the resource, their experiences with the issues and their ideas contributed enormously to this project. We sincerely hope that this strategy meets with their approval. Many of the ideas and philosophies expressed herein are theirs.

Thanks are also extended to those anglers, First Nation representatives and other interested persons who took the time to attend the consultation meetings hosted by the Public Consultation Team, or to write letters expressing their views about the recreational fishery and its future. Your collective input has been fundamental to the development of this document. In this sense, we hope that this strategic plan reflects, to the greatest extent possible, the aspirations of the people of the province. In preparing this document, we have done our best to help you reach those goals. We feel strongly that many of your goals are both attainable and sustainable. Reaching them will take time and your cooperation.

Throughout the project we have been impressed with the dedication and ability shown in members of the public groups who were assigned the task of consulting with the public and in the scientists and biologists who are engaged in resource management. Both groups richly deserve the mutual benefits to be derived from an improved fishery.

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1.0 Introduction

1.1 BACKGROUND

This report has been prepared for Fisheries and Oceans Canada (DFO), Gulf Region Recreational Fisheries, and for the New Brunswick Department of Natural Resources and Energy (DNRE), as part of a project to establish a strategy for further economic development of New Brunswick's anadromous and inland recreational fisheries. These fisheries resources are based upon an extensive network of streams totalling 32,000 km, a relatively small number of lakes and a coastline approximately 2,200 km in length (Figure 1). The work of developing this strategy has been supported by the Canada-New Brunswick Cooperation Agreement for Recreational Fisheries Development (CNBCARFD).

The goal of this Federal-Provincial program is to promote economic development within New Brunswick. During the next four years, the various components of the CNBCARFD program will invest approximately fifteen million dollars in the development of the recreational fishery in New Brunswick, much of which will be spent in cooperative initiatives with private sector groups. The Federal-Provincial program has four program elements as described below.

A Resource Development

- i) Strategic Planning and Evaluation
- ii) Sustainable Resource Development
- iii) Pilot Projects

B Economic Development

- i) Native Enterprises
- ii) Commercial Fishing Compensation
- iii) Marketing, Development, Promotion

C Communications

D Administration

The sub-component of the overall CNBCARFD program for which this strategy has been developed falls under the Strategic Planning and Evaluation component of the Resource Development element. It is focused on the development of a strategy to guide the development of a sustainable resource through a potentially wide spectrum of resource enhancement and protection initiatives. Some of these initiatives may be funded under the Sustainable Resource Development element of the program. Other key sub-components of the Strategic Planning and Evaluation component include (1) the harmonization of the consultative process among existing advisory groups through the creation of a Sports Fish Advisory Board, (2) the development of an evaluation framework for identifying priorities and for evaluating the resource and socio-economic benefits of alternative management actions, and (3) the establish-

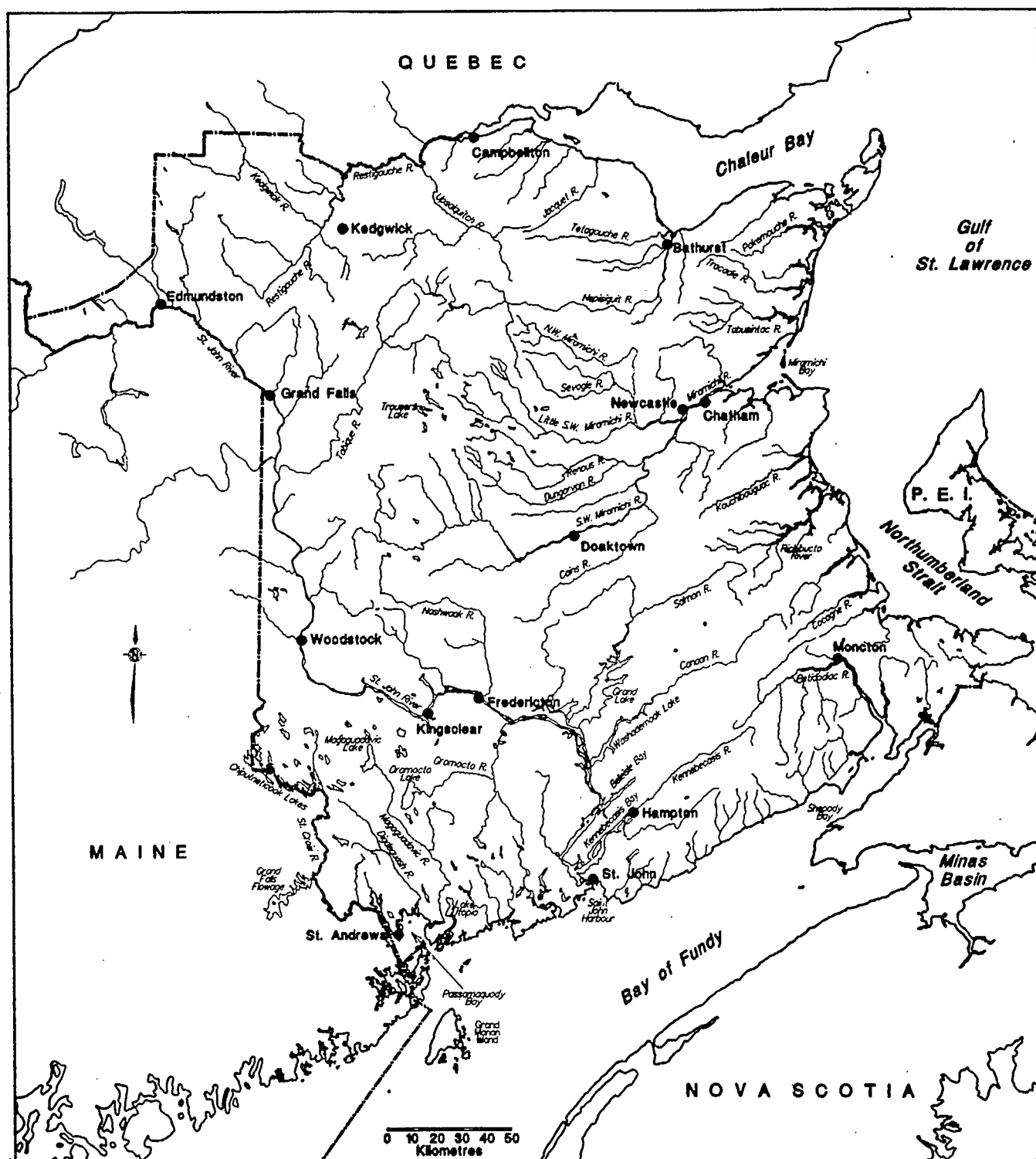


Figure 1. Map showing the major lake and river systems of New Brunswick.

ment of a memorandum of understanding between the DFO and the DNRE to improve cooperation and coordination in the planning and delivery of programs for recreational fisheries. Consequently, the strategic planning initiative documented in this report is an early component of the New Brunswick Recreational Fisheries Program (NBRFP) and has been undertaken to develop an overall approach for guiding development of recreational fisheries in the Province that will be consistent with the long term need for the sustainable use of the fisheries resource.

The remaining parts of this section describe objectives of the strategy development and the process employed in strategy development. Section 2 provides a brief overview of the current context for fisheries planning in New Brunswick. A discussion of potential futures for the recreational fishery and its management may be found in Section 3. The proposed strategy and considerations important to its implementation are presented in Sections 4 and 5, respectively.

1.2 PROJECT OBJECTIVES

The project to develop a strategy for New Brunswick's recreational fisheries has been directed by two key objectives,

1. To provide *the basis for a comprehensive strategy* for the restoration and development of recreational fisheries resources and supporting habitat in New Brunswick, and
2. To define the strategy in *partnership with the public and private sectors*, and meet public sector regional development objectives.

These objectives do not specifically identify economic development as an end-point of the strategy. However, the strategy is to be consistent with the overall aims of the Canada - New Brunswick Cooperation Agreement; that is, economic development *through restoration of the fishery resources*. Thus it is implicit in these objectives that economic development must be predicated upon a healthy resource and a sustainable pattern of resource use. One implication of these objectives is that the current state of the resource is sufficiently well known to provide a rational starting point for the prediction of the effects of management actions on future resource state which, in turn, is required to predict the social and economic benefits that result from management actions. This provides a rational basis for selecting between different management initiatives.

1.3 STRATEGIC PLANNING PROCESS

The strategy for developing and managing New Brunswick's anadromous and inland recreational fisheries is being developed in partnership among Fisheries & Oceans Canada, the New Brunswick Department of Natural Resources and Energy, the New Brunswick Salmon Council, the New Brunswick Wildlife Federation and the Mawiw Council of First Nations. The overall project has been directed by a project Core Team composed of

Mr. D. Dunn, Chief of Recreational Fisheries - Fisheries and Oceans Canada, Gulf Region
Dr. A. Boer, Executive Director, Fish and Wildlife Branch - Department of Natural Resources and Energy
Mr. R. Carroll, Director - New Brunswick Wildlife Federation,
Mr. W. Hooper, Fisheries Scientist - Department of Natural Resources and Energy
Mr. W. Myles, President - New Brunswick Salmon Council
Ms. S. Paul, Mawiw Council of First Nations on behalf of the Union of New Brunswick Indians, and
Mr. F. Wheaton, J. Heber Brown Ltd.

The steps being taken to develop the strategy are illustrated in Figure 2. Core Team members from the New Brunswick Salmon Council, the New Brunswick Wildlife Federation, and the Mawiw Council led the Public Consultation Team in soliciting input from anglers and First Nations bands. In addition, Mr. D. Fowler, a member of the New Brunswick Wildlife Federation and tourist outfitter, and Mr. D. Bird of the Atlantic Salmon Federation also worked as a member of the Public Consultation Team throughout the process. Mr. Wheaton undertook an in-depth review and analysis of the potential role for a Sport Fish Advisory Board as a part of the overall strategy. The Consulting Team for the strategy development project was assigned to lead tasks which did not directly involve public consultation and also to provide advice to the Core Team on the approach to public consultation.

1.3.1 Technical Data Review

Following the initial scoping session, a review and analysis of background materials was initiated. This task included two principal components as described below.

1.3.1.1 Review of Resource-Related Issues and Information

The intent of this review and analysis was to develop a description of the characteristics of the fisheries, the fish stocks, habitat information, management regimes and information gaps, that would be useful in the formulation and evaluation of watershed-level, fisheries management development scenarios. The following steps were undertaken.

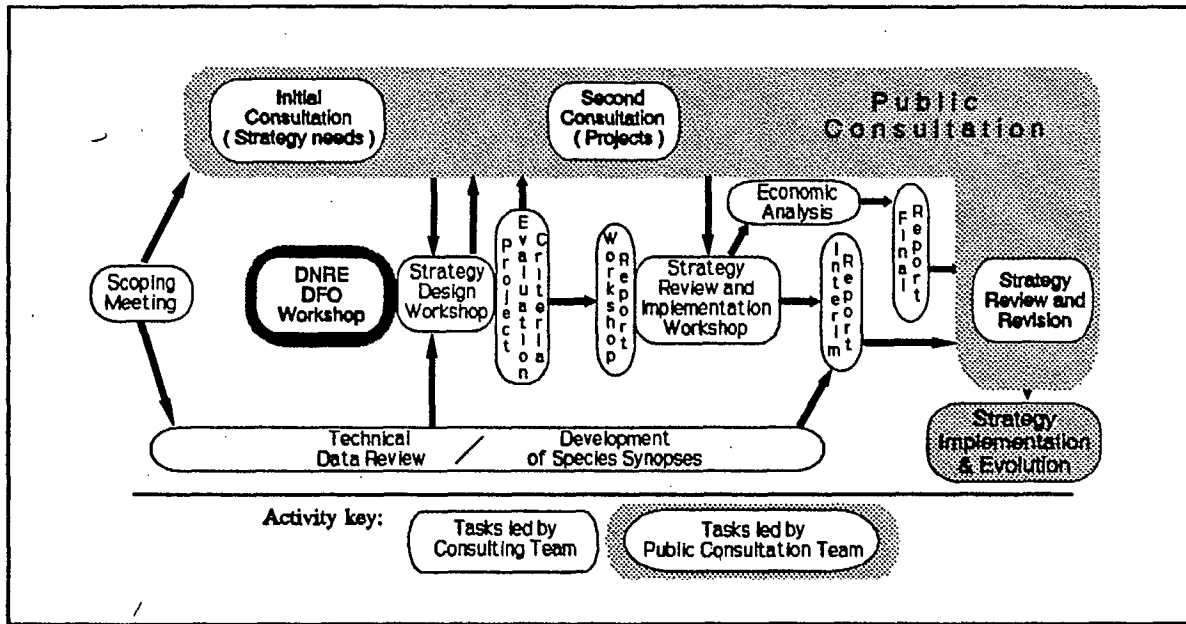


Figure 2: Overview of the strategy development process

- Background materials were obtained from agency personnel, including planning documents and stock status reports.
- Interviews were conducted with personnel from the DFO and the DNRE.
- Project advisors (Beamish and Scott) were consulted, as were members of the Public Consultation Team.
- Relevant scientific literature dealing with fisheries management issues and strategic planning documents were reviewed.
- Personnel from the Huntsman Marine Science Centre were assigned the task of producing species synopses and distribution maps for all of the inland and anadromous recreational species in the Province.

Some aspects of this background review were delayed until such time as the nature and scope of the analyses that were required became evident. Other aspects were reduced in scope once it became apparent that the detailed information required to support some analyses was not available.

1.3.1.2 Review of Socio-Economic Issues and Information

The initial intent of the technical review of socio-economic issues was to develop a sufficiently detailed understanding of the economics of recreational fishing in New Brunswick

and in other relevant jurisdictions to enable the economic evaluation of watershed-level, fisheries development scenarios. However, once it was recognized that much of the resource data upon which the economic analyses were to be based was not available, the focus of the review changed. The following tasks were undertaken.

- Existing studies and reports describing the economics of anadromous and inland recreational fishing in New Brunswick were collected and reviewed.
- Discussions were held with persons knowledgeable about the economics, management and status of stocks of selected species in the recreational fishery.
- Literature related to the economics of recreational fishing for key species was collected from other jurisdictions including selected provinces in Canada and some U.S. states.
- Information concerning the economics of selected activities which generate income from the recreational fishery (e.g. tournaments and outfitter operations), and information on alternative approaches to resource management such as Quebec's "Zones d'exploitation contrôlée" (ZEC) system, Controlled Exploitation zones, was collected and analyzed.

1.3.2 Public Consultation

1.3.2.1 Strategy Needs

The initial round of public consultations was held with First Nations bands and with organized anglers groups in December 1992 through January 1993. The scope of this consultation, as determined by the Core Team, was intended to provide an opportunity for the following stakeholders to help define the strategy:

- members of organized angler groups,
- members of each First Nations band,
- tourist outfitters/non-residents,
- anglers not included in the membership of organized angler groups,
- concerned staff from the two principal management agencies, and
- the general public.

Contributions to the strategy definition by organized angler groups (listed in Appendix A₁) were made through structured meetings conducted by members of the Public Consultation Team from the NB Salmon Council and the NB Wildlife Federation. Consultation with each First Nations band (listed in Appendix A₂) was done through individual meetings by the representative from the Mawiw Council with band Chiefs and subsequently with any band members or representatives identified by the Chief.

A separate meeting with the membership of the New Brunswick Outfitters Association (NBOA) could not be arranged, due largely to the time of year when the consultation was undertaken. Meetings were held, however, with both the NBOA executive and the smallmouth bass committee of the NBOA. The views of the NBOA have been further represented in part by consultation with the New Brunswick Salmon Council which also represents the NBOA, private camp operators and associations with both residents and non-residents among their membership. In addition, one of the members of the Public Consultation Team is engaged in the outfitting business.

Views of non-residents were represented in part by the direct involvement of both the New Brunswick Salmon Council and the Atlantic Salmon Federation whose members include non-residents. The international membership of the Atlantic Salmon Federation was informed of the strategy development initiative through the ASF newsletter. Due to the timing of the consultation, however, non-resident input to the strategy has been limited. This can likely be substantially improved during the next round of consultations which are intended to provide an opportunity for a broad public review and where necessary, a revision of the strategy.

To provide an opportunity for anglers not involved with organized groups, and for members of the general public including non-consumptive users of the resource to provide input to the strategy, a general solicitation was made by a request for information published in major daily and weekly newspapers (Appendix B). The placement of the request was designed to achieve province-wide coverage. Contributions from management agency staff were obtained through a one-day DFO/DNRE workshop. Agency personnel also participated in both workshops led by the Consulting Team.

The initial public consultations sought guidance from the participants regarding their aspirations for the future of recreational fishing in New Brunswick, current issues related to resource status and management, and specific actions needed to address the issues. The following seven step process and sample questions were used to provide a consistent structure to the meeting process for the solicitation of views from angler groups:

1. *Wants / needs* - What do you want from of the fishery? In the best of all worlds what would the fishery be like?
2. *Issues / Problems* - What do you feel are the major problems/issues facing NB's fisheries?
3. *Clarify Issues* - As necessary, clarify each of the issues identified. For example, someone might define an issue as being "not enough stocking". Is it because the catch has declined? If so, over what period? Where? Alternately, does that person want to develop another species? Or, is it that the stocking program attracts too much attention, bringing too many other anglers into the area and destroying the quiet enjoyment of the fishery?

4. *Actions* - For each issue identified, try to determine possible course of action. What actions should we take to resolve this?
5. *Opportunities* - Are there fishing opportunities in this area that you think are being missed now? If you wanted to raise funds to improve the fishing in this area, who would you approach?

If all of the discussion in the previous steps focuses on only one or two species then ask, What about other species of fish (e.g. striped bass, shad)?

6. *Public Involvement* - If there is a management problem on which you want to influence decision making, how do you go about providing your input now? Or, how do you influence fisheries management now? Do you do it just through the Salmon Council, or the Wildlife Federation? Are there other ways? Are there problems with how this works? What would improve it?

Have you thought about River Management Committee's or other mechanisms of co-operative management? How do you think they might work here?

7. *Other concerns* - Is there anything else you are concerned about regarding the recreational fishery? What do you think we missed?

This general outline was also used in soliciting input from the other stakeholder groups contacted during the initial consultations.

1.3.2.2 DNRE / DFO Workshop

Discussions held with DFO and DNRE field personnel during a workshop held in Fredericton on January 28, 1993, were intended to provide those persons directly engaged in day-to-day fisheries management with an opportunity to express their views on the management of the recreational fishery and to further identify key management issues and potential management actions. Together with the results of the initial public consultation, the results of this workshop provided the initial starting point for the strategy design workshop facilitated by the Consulting Team.

1.3.2.3 Project Proposals

The expectation of the strategy development team was that the Initial Public Consultation, DFO/DNRE Workshop and the Strategy Design Workshop (described below) would all serve to identify specific actions and/or projects needed to *develop* the New Brunswick Recreational Fishery. The surprising aspect of each of these consultations was the broad and general nature of the actions identified. Although a few angler groups and native bands did identify specific

stream rehabilitation and/or stocking projects, for the most part the necessary actions identified by stakeholders in resource management dealt with initiatives with a more strategic focus such as the need for planning and public education and for improved regulations and management approaches. Similarly, most agency personnel, including those who entered the first workshop with specific project ideas in mind, ultimately concluded that strategic initiatives should be given a higher priority than project-specific initiatives if the goal of the Canada - New Brunswick Recreational Fisheries Agreement, *"to provide a strategic approach for restoration of the recreational fisheries resource and to sustain the economic benefits from this development by strengthening the recreational fishery sector"*, is to be achieved.

Since an important component of the Canada - New Brunswick Recreational Fisheries Agreement will be the conduct of specific resource enhancement projects (some of which are to be initiated in 1993), a second round of public consultation was undertaken to identify specific initiatives. This consultation used the overall principles and strategic direction that evolved from the results of the initial round of public consultations and the Strategy Design Workshop (see below) together with specific project evaluation guidelines developed immediately following the Strategy Design Workshop, to guide the identification and development of appropriate project proposals.

1.3.3 Strategy Development Workshops

1.3.3.1 Strategy Design

The objectives of the Strategy Design Workshop, which was held in Moncton from 31 January to 2 February, 1993, were four-fold:

- 1) Review and clarify the issues to be addressed by the strategy;
- 2) Begin the development of an evaluation framework to guide the selection of actions to be included in the strategy;
- 3) Review and screen actions suggested for addressing issues; and
- 4) Develop a preliminary outline of the strategy and define initial "scenarios" for evaluation.

Participants at the strategy design workshop (Appendix C) included all members of the project team (Core Team, additional members of the Public Consultation Team and Consulting Team), key staff from DNRE and DFO, and a small number of representatives from First Nations communities. The lists of aspirations, issues and suggested actions arising from the initial public consultations were reviewed and slightly expanded as a starting point for discussion during an initial plenary session of the workshop. Three subgroups then convened to consider the issues from the perspective of managing resident fish populations, managing anadromous fish populations and the institutions involved in fisheries management. Each subgroup was asked to:

- clarify issues with respect to the group's focus;
- define site-specific and/or strategic actions needed for resolving the issues;
- identify and consider the resource, social and economic implications of the actions identified; and
- identify resource and information needs and constraints.

Where appropriate, each group first considered each of the appropriate actions in a broad context and subsequently considered what specific actions might be appropriate in different lakes and/or river systems across the province. Interestingly, as previously indicated, most of the actions that were identified to restore the recreational fishery were strategic in nature. Furthermore, recognizing that the public has expressed a strong desire to become actively involved in the management of the recreational fishery through the formation of genuine partnerships, many participants concluded that, with a few exceptions, site-specific restoration measures/actions would best be identified through local planning initiatives.

1.3.3.2 Strategy Review & Implementation

Participants who attended the strategy review and implementation workshop, held in Moncton, included most of those present at the strategy design workshop plus additional representatives from First Nations communities throughout the province. The objectives of the workshop were three-fold:

- 1) to critically examine and challenge the components and underlying assumptions of the strategy defined during the previous workshop to assess whether any critical elements were missing and/or whether any components of the strategy were based upon erroneous assumptions;
- 2) to identify priorities for implementation of the strategy; and
- 3) to further refine the evaluation criteria that will be employed to guide development and select projects for implementation under the strategy.

The workshop took place in two phases. During the initial two day phase, from March 23-24, 1993, participants (Appendix D) focused on all three of the workshop objectives. The workshop began with a plenary review of the workshop objectives and the draft strategy. Three sub-groups then critically reviewed the strategy and assumptions, considered implementation priorities and sequencing, and evaluated the merits of the draft evaluation criteria. As at the first workshop, participants were asked to identify site-specific management actions/initiatives. A final plenary session provided the opportunity for participants to review and comment on the results of the sub-group discussions.

In the second phase of the workshop, a smaller group of participants (Appendix E) met for one day (March 25, 1993) to revise the project evaluation criteria (section 5.2, pg. 97).

To facilitate this analysis, a brief series of hypothetical project proposals was used to test the utility of the proposed criteria.

1.4 THE ECONOMICS OF RECREATIONAL FISHING

This section briefly reviews some of the terminology and basic concepts that are essential to an understanding of the economics of a recreational fishery. The section begins by noting the difference between market and non-market goods, and then discusses direct vs. indirect, and incremental vs. distributional benefits. In subsequent sections of the report, some of the methodology necessary to value the non-market part of the economic benefits is discussed (Section 1.4.5, pg. 14). An application of the valuation methodology to recreational fishing activities in Maryland is given in Appendix F. A discussion of the current economic value of the New Brunswick recreational fishery is found in Section 2.3, pg. 20. The current and potential future economic benefits (direct and indirect) of several important fisheries are discussed on a species by species basis in Section 3.2, pg. 30. The economic benefits are further analyzed in terms of their incremental and distributional nature in Section 3.3, pg. 54. Finally, strategies for achieving the potential economic benefits are outlined in Section 3.5, pg. 56.

1.4.1 Market vs. Non-Market Goods

Recreational fishing activities generate economic benefits. To put these in perspective, we must note the difference between market goods and non-market goods. This distinction is important because recreational fishing has important non-market characteristics. To obtain market goods, a consumer must be willing to pay the going market price asked by the supplier. For most consumers, food, clothing, housing and so on are market goods. Non-market goods, on the other hand, are goods for which no market price exists. Consumption of these goods is possible without paying a market price usually because the goods are freely available to anyone who wants them¹. Recreational fishing is a good example of a non-market good where there is unrestricted access to fishing sites. An angler can fish and enjoy all the satisfactions this brings and pay nothing (other than the cost of a license), even if he or she is willing to pay for the fishing experience. However, if access is restricted through riparian rights², the private owner/lease holder may be able to charge a (market) price which captures part or all of what the angler is willing to pay. Fishing then becomes a market good. Where access is restricted by some form of licensing or a lottery system (e.g., New Brunswick's Crown

¹ The important condition is no private ownership of the good, or the resources required to produce it. Without private ownership, there is no mechanism to restrict consumption of the good only to those willing to pay a price.

² In parts of New Brunswick, some landowners whose land borders waters have riparian rights attached to those waters, i.e., they have exclusive rights to fish in those waters and may regulate and/or enforce the use of such waters for angling purposes. Similar riparian rights can also be purchased through the Crown Lease system.

Reserve system), recreational fishing may still be mainly a non-market good. For example, a nominal value license fee, such as the \$16 fee for a resident New Brunswick fishing license, excludes few if any anglers from taking part in fishing activities. Furthermore, as the willingness to pay data for New Brunswick (including the results of the public consultation) show, the license fee does not capture all of the willingness to pay for many anglers.

1.4.2 Direct Benefits

Directs benefits refer to the enjoyment or satisfaction anglers receive directly from participating in recreational fishing activities. Because of the dual non-market and market character of recreational fishing, economic benefits also have both a non-market part and a market part. The non-market part comes into play because the fishing experience is something for which anglers are willing to pay but do not actually pay for, other than the cost of a licence. Anglers value the fishing experience directly even if they do not pay a market price for it. This value is generally thought to be captured in measures of willingness to pay.

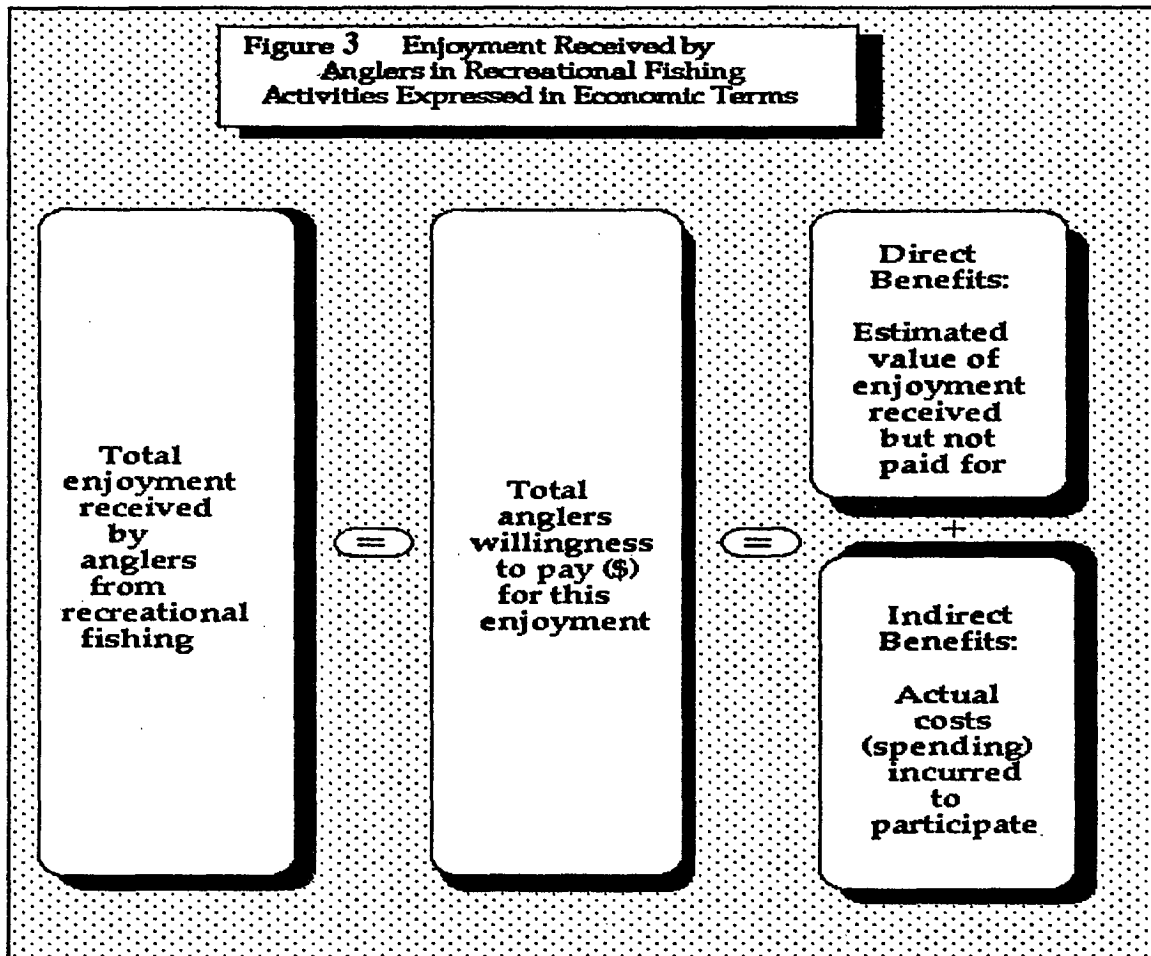
1.4.3 Indirect Benefits

Indirect benefits are the impacts on the economy that arise from the spending on goods and services required to take part in recreational fishing activities. Anglers must buy bait, tackle, fishing equipment, special clothing and so on. Spending on travel, accommodation, food and other specialized equipment such as canoes or boats may also be necessary. While all of this spending is for inputs necessary to produce the fishing experience, it does not represent the value of the fishing experience itself. Thus, we can distinguish between direct and indirect benefits.

Indirect benefits are usually measured in terms of income or gross domestic product. The employment associated with the income may also be reported. It is not really a separate benefit, just a different way of expressing the same benefit. The income (and employment) result from the spending on goods and services required to take part in recreational fishing activities. Sometimes the taxation revenue accruing from the spending and income is also reported - simply another way of reporting part of the same indirect benefit.

Figure 3 summarizes conceptually the relationship of direct and indirect benefits as parts of the total benefit. The column on the left shows the total enjoyment or satisfaction received by anglers participating in the recreational fishery. The central column shows the anglers' total willingness to pay for this enjoyment. One part of this willingness to pay is the actual costs the anglers incur to enjoy recreational fishing activities. Hence, as shown on the right of the figure, the actual costs of participating underestimate the total enjoyment received. The net benefit received, or direct benefit, is equal to the total willingness to pay less the actual costs incurred. In other words, the direct benefit is the economic value of the anglers' enjoyment in excess of actual costs incurred. Other terms used for this are *consumer surplus*

and *net willingness to pay*. The net or direct benefit is shown as the box in the upper right corner of the figure.



1.4.4 Incremental vs. Distributional Economic Benefits

Incremental benefits refer to a net gain in economic benefits accruing in New Brunswick as the result of expanded recreational fishing activities. These benefits accrue with the expanded activities but not without them. That is, they are a net gain in provincial economic activity.

Distributional benefits are gains in economic activity in one area of the province that result because something does not take place in another part of the province. For example, if resident anglers expand their fishing activity in the northwestern part of the province, that area will enjoy an increase in economic benefits. To the extent that the anglers reallocate their spending away from other recreational and non-recreational goods in favour of fishing related goods, the province as a whole will experience no net gain in economic activity. In other words, the benefits noted in the northwestern area are a redistribution of economic activity, hence the term redistribution benefits.

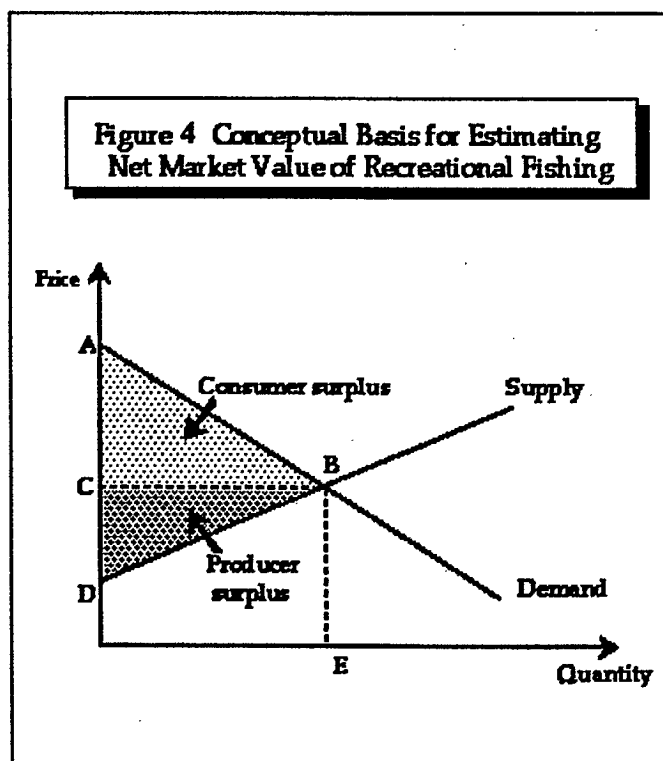
Where resident anglers are concerned, the indirect benefits referred to previously will be largely redistribution benefits. This is because the anglers consume other goods and services in New Brunswick if they do not fish. Assuming the goods consumed are mainly market goods and services (where the market price is taken as a measure of the value of satisfaction), the direct benefits from angling for resident anglers will be incremental benefits.

For non-resident anglers, the main economic benefits for New Brunswick comes from their spending on goods and services in the province. Thus, in this case, the indirect benefit is an incremental benefit for the province. On the other hand, the direct benefit cannot be attributed to the province since the recipient is a non-resident.

1.4.5 Estimating the Economic Benefits of Recreational Fishing

The economic value of recreational fishing has received considerable recognition and study over the years. A variety of methods and techniques has been used to define and estimate what constitutes this value. The usual procedure for measuring the "value" of a good is to use competitive market prices and quantities. If a sport fishing market existed, one could obtain market data on price, number of customers and amount of fish landed per customer. With information from this private activity, a demand curve and supply curve for the New Brunswick sport fishery could be estimated. The demand and supply curves would show the market revenue, the consumer surplus (net economic benefit) and the producer surplus (net producer benefit) at equilibrium as shown below in Figure 4.

However, with the exception of private and Crown Lease waters, sport fishing in New Brunswick does not take place in a completely limited access, private market situation. In Crown Open waters, anglers are allowed access to the recreational fishery resources with the payment of an annual license fee, and there is no additional provincial direct access price associated with either the fishing trip or the fish. In Crown Reserve waters, however, an additional fee of \$20 per day is charged. The Crown Reserve system is discussed in more detail in Sections 2.4.2, pg. 27, and in Section 3.5.7, pg. 64. Angling surveys in New Brunswick show that anglers value the New Brunswick sport fishery much higher than the price paid for angler licences, indicating a



substantial willingness to pay above the expenditures associated with the fishing trip. This implies that a consumer surplus associated with the New Brunswick recreational fishery is not being captured.

Therefore, to determine the demand function for a relatively free-access sport fishery, implicit or derived prices must be used. These implicit prices are derived through the use of trip costs or with the Contingent Value Method. In this report, the Contingent Value Method, as discussed below, is used; however, the basic theoretical concept of the trip cost approach to valuating a recreational fishery is explained in Appendix G. Both approaches offer a method for the researcher to determine the economic value of the fishery as it is, and to determine how changes in creel limits or changes in the available fish stocks will change anglers' net economic benefits from fishing.

1.4.5.1 Contingent Value Methodology

Net willingness to pay is a direct measure of consumer surplus and is the standard measure of value in cost/benefit analysis. Angler expenditure, on the other hand, is useful only to measure the impact or effect of resource management action on local economies, not for valuing resources. One of the most commonly used methods for measuring the economic value of a natural resource is the Contingent Value Method (CVM). This is a "direct method" for determining what anglers would be willing to pay above the actual trip costs to fish at a particular site. The objective of this approach is to measure anglers' net willingness to pay for current fishing conditions or for improved fishing conditions.

The CVM is a useful tool because it is straight forward. It allows the estimation of willingness to pay for current conditions and hypothetical changes in fisheries resources (e.g., doubling the stock rates of a particular species) or changes in harvest regulations (e.g., allowing "catch and release" fishing only). While these measures may not increase the number of anglers, they will increase the value of the fishery, which is important management information.

2.0 The Current Context for Planning

2.1 ISSUES

Resource users identified a significant number of issues related to the recreational fishery. The issues identified 1) during the initial round of public consultations held with organized angler groups and native organizations, 2) during discussions with agency personnel, and 3) in the roughly 50 letters received in response to a solicitation for input published in local newspapers, served as a starting point for workshop discussions. Interestingly, there were remarkable similarities in the perceptions of issues amongst the different groups contacted. The list of issues was briefly reviewed at the workshop and was expanded by workshop participants to include:

- **Depleted fish stocks** including native trout (especially brook trout), Atlantic salmon, smallmouth bass, and other species such as striped bass and shad.
- **Over-harvesting of fish stocks** through the combined effects of anglers, poachers, commercial harvest (both directed catch and by-catch), native catch and, in a few cases, the effects of concentrated egg harvesting for stocking programs.
- **Physical habitat destruction and/or degradation** due to forestry and other industrial practices, agriculture, road construction, and shoreline development. Habitats have also been physically altered due to the effects of dams which include changes in flow regimes and water levels, the creation of barriers to migration, and changes in upstream and downstream habitats.
- **Chemical degradation of habitats** through the effects of acidification, agricultural pollution, municipal and industrial (e.g. mines, mills) effluents, inadequate septic systems and perhaps forest pest spraying practices.
- **Inadequate management of the fishery resource** due to insufficient financial and staff resources, an inadequate level of inter-agency coordination, confusion about agency jurisdiction, lack of regional fisheries/resource management plans including river and/or lake specific plans, and a lack of reliable assessment data (habitat, stocks, harvests) on which to base management decisions.
- **Insufficient public and First Nation involvement in management decisions** and in hands-on management. Other related issues include a limited understanding of stocking strategies particularly as related to the distribution of stocking programs across the Province, a perception that hatchery capacity is inadequate, and the view that the DFO's management presence is insufficient at the local level.

- **Insufficiently stringent regulations.** Many anglers and managers expressed the view that catch limits for some recreational species (e.g., brook trout) are too high and are contributing to the over-exploitation of stocks.
- **Inadequate enforcement and penalties for fishing infractions.** It was felt that fisheries regulations should be enforced more strictly. Many anglers were of the opinion that many infractions, some quite serious, were not being addressed. Concern was expressed that the legislation and regulations dealing with environmental quality, such as controlling the discharge of effluents, were not being adequately enforced.
- **Allocation conflicts** were a major issue. The principal conflicts were related to the allocation of recreationally-desirable fish species between natives and non-natives, and between recreational fisherman and commercial fisherman. To a lesser degree, allocation conflicts were also identified regarding differences of opinion regarding the management focus within specific areas (e.g., Atlantic salmon vs. brook trout).
- **Insufficient public access** to angling opportunities and over-crowding in some areas were important issues. A large proportion of the anglers who responded to the newspaper solicitation for input identified, as a high priority, the need for increased access.
 - This issue stems, in part, from the fact that large parts of the Province are privately owned, either in large blocks or in smaller parcels, and that the rights to fish in adjacent waters are controlled by the landowner(s). Some of these blocks of land are foreign-owned.
 - A second aspect deals with the DNRE's Crown Reserve system in general, and the Crown Lease system in particular. Under the Crown Lease system, the rights to fish in parts of the Province are leased for a period of up to 10 years to the highest bidder. This system, which clearly favours the wealthy, is considered by many to be inequitable.
- **Under-utilized species.** Recreational fishing in the Province focuses on two species, Atlantic salmon and brook trout. Many felt that presently under-utilized (or previously over-exploited) species such as smallmouth bass, chain pickerel, striped bass, shad and others would, if well-managed, provide a sustainable means of reducing angling pressure on the principal recreational species, and also provide an opportunity for considerable expansion of the recreational fishery and associated socio-economic benefits.
- **A desire for self-sustaining fisheries** versus put and take fisheries. The majority of persons contacted were strongly in favour of the maintenance of natural stocks.
- **The introduction of exotic species** is an issue of concern.

- **Fishing rights versus privileges.** Some anglers expressed frustration with and/or confusion over the issue of native fishing rights.
- **Social versus economic values of the fish resource.** Some persons felt that first priority should be given to the development of the recreational fishery for the benefit of resident anglers.
- **Cost versus quality of fishing.** Many anglers expressed a willingness to pay more for the angling experience provided that the additional funds would be dedicated to the management of the fishery and that they would lead to improved angling opportunities. A large proportion of the anglers who responded to the newspaper article indicated a willingness to pay more for the angling experience. Of those who were willing to pay more, most indicated that their willingness to pay more was contingent upon 1) re-investment of the additional revenues back into the fishery, and 2) evidence, in the relatively near future, of an improved fishery.
- **Inadequate sense of stewardship of the resource amongst some resource users.** Many anglers were frustrated with the apparent lack of a conservation ethic among some anglers and/or other resource users. The excessive harvest practices of some of these individuals suggests 1) a lack of commitment to the resource, and 2) a perception that individual actions have little effect on the resource.

Several of the issues described above clearly relate to the problem of over-exploitation of fish stocks. At the same time, many anglers expressed a strong desire for increased access to recreational fishing opportunities. The challenge for managers is to find ways of balancing these seemingly conflicting issues while increasing the social and economic benefits derived from New Brunswick's fish resources. Achieving this over the long term means developing mechanisms to ensure that the combined annual harvest of fish by all resource users remains within the annual productive capacity of the resource (referred to as sustainable yield). One method of doing this is by encouraging a shift in the motivation for fishing toward enjoyment of the experience with less emphasis on relatively large individual harvests.

Since it is the cumulative effect of individual impacts, which when taken alone are often considered unimportant, that often determine the fate of a fishery, it can be difficult to assure that harvest remains within sustainable levels if the number of anglers is not limited. As a society, we place a high value on open access to fishing and although limiting the number of anglers or angling opportunities can benefit the resource, it also limits the potential for economic development. The key to meeting both objectives clearly rests with seeking ways to maximize access while keeping the cumulative impact on the resource within sustainable levels. The best way to do this may well be through voluntary reduction in harvest, such as catch and release. Whether it will actually work depends entirely on gaining the cooperation of a significant majority of anglers, especially those who are most effective.

2.2 STATE OF THE RESOURCE

2.2.1 Water Resources of New Brunswick

New Brunswick has an area of approximately 72,800 sq. km. (28,000 sq. mi.). It supports an extensive network of streams totalling more than 32,000 km. (20,000 mi.) in length, but contains only 2,800 lakes, most of which are located in the southern part of the province. The Province has approximately 2,200 km (1,360 mi.) of coastline (Canada 1988), and can be divided into five major drainage basins or watersheds (Figure 5). These water resources once supported some of the richest recreational fisheries in North America, particularly for Atlantic salmon.

Over the past few decades, however, land use practices such as forestry, road construction, agriculture, urban development, industrial development, dam construction and pollution, have resulted in the modification, degradation and/or destruction of fish habitats in many parts of the Province. While these habitat changes and/or losses are serious, and are thought to have contributed to the decline of stocks, the overall productive capacity of fish habitats in the Province are still thought to be high. Unfortunately, an accurate assessment of the impacts of habitat changes on fish populations cannot be made because the magnitude, aerial extent and impacts of habitat changes have not been quantified. Trend-through-time data on habitat changes are not available.

2.2.2 The Recreational Fisheries Resources of New Brunswick

New Brunswick's inland waters contain 51 species of fish, 17 of which are of interest to anglers. Ten of these are coldwater species (brook trout, Atlantic salmon, land-locked salmon, lake trout, brown trout, Arctic char, smelt, burbot, round whitefish, lake whitefish and rainbow trout) and the remaining seven are warmwater species (smallmouth bass, white perch, yellow perch, chain pickerel, bullhead, pumpkinseed sunfish and redbreast sunfish). About 80 % of all angling effort in the Province takes place in streams, 15 % on lakes, and the remaining 5 % takes place on coastal shoreline waters (Canada 1988). The brook trout is the most sought after coldwater species (Beamish et al. 1986; Canada 1988), followed by the Atlantic salmon, which has and continues to be the focus of considerable management attention (Carter 1985; Hooper and Ayer 1985). Smallmouth bass is the most popular warmwater fish species in the Province, largely due to its promotion by management (Canada 1988). Smelt, striped bass and flounder are among the more important species caught in coastal/estuarine waters.

New Brunswick's brook trout and Atlantic salmon populations are depleted. The depletion of stocks has resulted in a decline in the value and real economic growth of the recreational fisheries sector over the past several years. As indicated above, habitat degradation has likely played a role in stock depletion. However, a review of the history of the recreational fishery in the province, including past regulations and angler use patterns, provides strong anecdotal

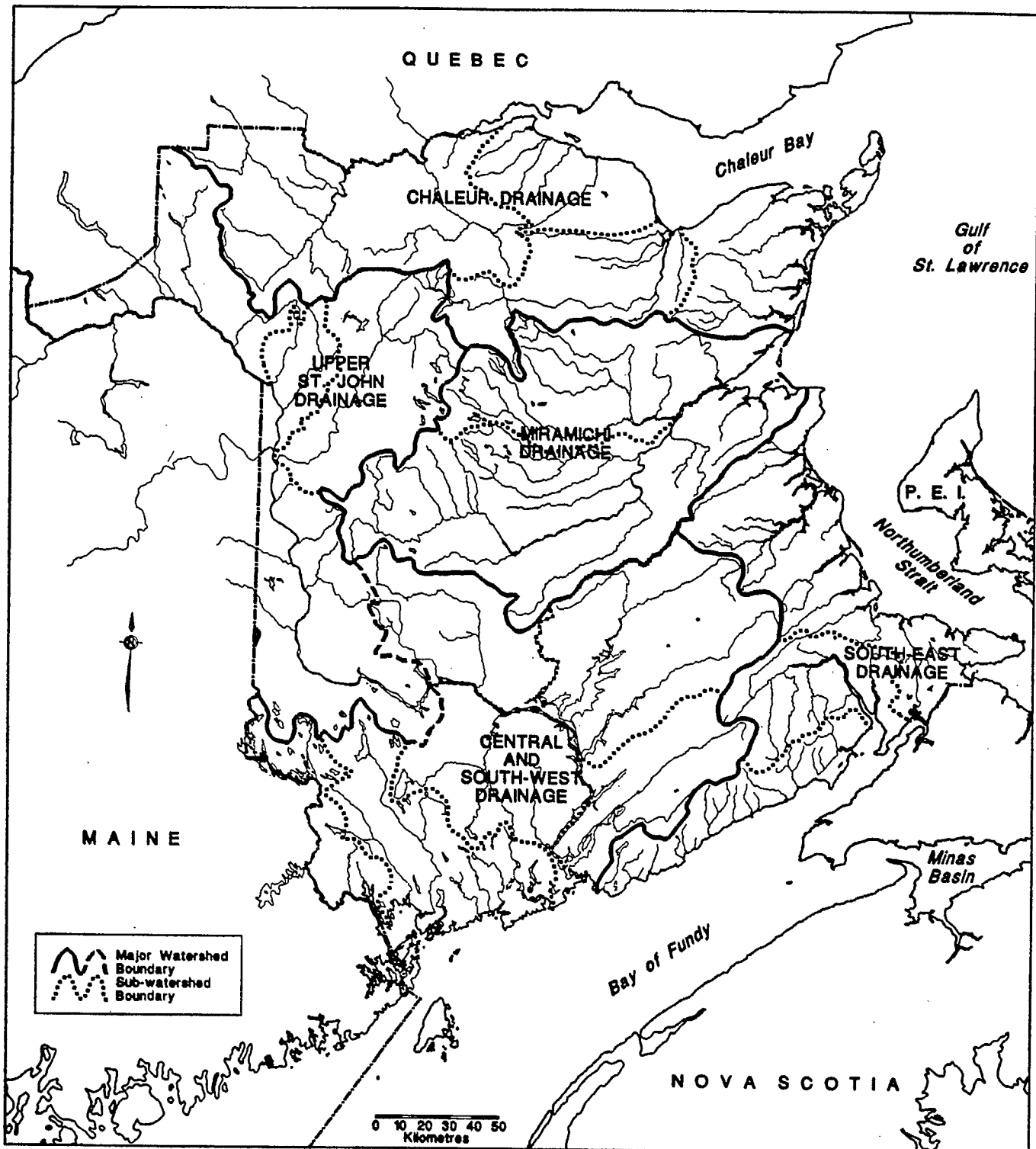


Figure 5. Map showing the principal watersheds in New Brunswick.

evidence that the principal cause of stock decline is overexploitation, a view shared by most DFO and DNRE professional staff and also by many anglers and natives. The Atlantic salmon resource is presently showing some signs of recovery, although no such recovery is evident in brook trout stocks. Management efforts directed to the restoration of the brook trout fishery are seriously constrained by the absence of basic assessment information concerning stocks, habitat use, harvest rates, and resource carrying capacities.

2.3 THE CURRENT VALUE OF RECREATIONAL FISHING IN NEW BRUNSWICK

2.3.1 Overview

In 1985, there were close to 180,000 licensed adult anglers in New Brunswick, 95 % of whom were residents of the province. These anglers spent approximately \$24.7 million on activities and supplies directly related to angling that year (Pearse 1988). Anglers also spent \$56.9 million on major durables and property, \$26.5 million of which was used for sport fishing. In all, anglers spent a total of \$81.6 million in 1985, \$51.3 million of which could be directly attributed to the sports fishing in the province (Canada 1988).

In 1985, anglers captured an estimated 6.8 million fish of all species and retained 4.9 million. Resident anglers spent an average of \$182 each and non-resident anglers spent an average of \$611 per person. Brook trout, smelt and mackerel were the most widely taken species, accounting for 89 % of the harvest. Brook trout alone accounted for over 66 % of the harvest. In order of preference, trout, salmon and bass were the most sought after species (Canada 1988).

By 1990, based upon preliminary data, the total number of anglers, angler effort and total catch declined relative to 1985 levels. Most of this decline appears to have been related to a reduction in effort associated with the continued depletion of brook trout stocks to the point that catch rates and the average size of fish captured had decreased. Despite the decline in overall angling effort, the total sport fishing expenditures in 1990 were similar to those in 1985, likely due to the increased angling effort directed in 1990 towards Atlantic salmon.

Recognizing that the social and economic benefits described above were derived from a recreational fishery characterized by depleted stocks and dominated by only two species, it is reasonable to expect substantial increases in social and economic benefits once stocks have been restored and under-utilized species are developed.

2.3.2 Valuation of the New Brunswick Recreational Fishery

Applying the methodology described in Section 1.4.5, pg.14, to the New Brunswick sport fishery, estimates of average daily trip expenditures and marginal willingness to pay value for resident and non-resident anglers were calculated. These estimates can be used to measure the

direct and indirect economic benefits of the New Brunswick sport fishery as a whole. In Section 3.2., pg.30, similar estimates, calculated on a species basis, are presented for the New Brunswick sport fishery for both "present day" and "potential" conditions.

2.3.2.1 Indirect Benefits of the New Brunswick Sport Fishery

The average New Brunswick fishing trip expenditures for all species are presented in Table 1, based on 1990 trip expenditure data from the 1990 angler survey. Dividing total trip expenditures by the average number of days fished for resident, non-resident Canadian and non-resident non-Canadian anglers respectively, yields daily fishing expenditure data for each of these three groups. As would be expected, average daily trip expenditures for resident anglers are significantly less than for non-resident anglers. (One may also expect trip expenditures for freshwater fishing to be considerably less than for saltwater angling for species other than salmon. This is due mainly to the relative distance anglers have to travel in order to fish various saltwater areas.).

Table 1: Direct Expenditures Made for Recreational Fishing by Jurisdiction, 1990				
Expenses (\$1990)	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Food & Lodging	\$ 7,531,365	\$322,917	\$1,404,677	\$ 9,258,959
Travel Costs	6,876,020	143,159	380,751	7,399,930
Fishing services	184,844	165,946	816,066	1,166,856
Fishing supplies	3,227,133	159,227	466,613	3,852,973
Hhld.owned boat costs	1,641,032	4,331	79,298	1,724,661
Other	116,427	32,754	13,370	162,551
Total	\$19,576,821	\$828,334	\$3,160,793	\$23,565,930
Total Active Anglers	86,792	1,871	4,644	93,307
Trip Expenses per angler	\$226	\$443	\$681	\$253
Average days fished/angler	14	4	6	11
Daily trip expenses	\$16.11	\$110.68	\$113.44	\$22.96

Total expenditures per day fished for resident New Brunswick anglers are noticeably lower at \$16.11 per day versus their non-resident counterparts, which averaged between \$110.68 and \$113.44. Intuitively, this makes sense, considering a substantially larger number of residential

fishers, and average days fished per fisherman. This results in smaller total expenditures on food, lodging and travel costs per resident angler than per non-resident angler.

Total fishing expenditures for resident, non-resident Canadian and non-resident non-Canadian anglers amounted to active anglers spending \$23.6 million on sport fishing in New Brunswick during 1990. This figure represents the total direct economic impact of the New Brunswick sport fishery in 1990.

The economic impact of residential recreational fishing of New Brunswick waters was \$19.6 million. Non-residential Canadian recreational angling had an economic impact of \$828 thousand and non-residential, non-Canadian recreational angling had an economic impact of \$3.2 million in 1990.

2.3.2.2 Direct Benefits of the New Brunswick Sports Fishery

Measuring Marginal Willingness to Pay

A measure of net willingness to pay is needed to measure the net economic value of the New Brunswick sport fishery. In the 1990 angler survey, fishermen were asked how much additional cost they would be willing to pay for fishing in New Brunswick waters.

The question posed in the New Brunswick survey was very similar to that of the Maryland survey: "What is the maximum additional amount you would have paid per fishing day before deciding it was too expensive to fish the same number of days in New Brunswick in 1990?" This cost represents the additional amount anglers would be willing to pay, per day, to fish in New Brunswick, given current fishing conditions, above the current cost of their fishing trip. The values (marginal willingness to pay) of additional costs anglers were willing to pay are presented in Table 2.

As in the Maryland survey, anglers were asked to choose one of thirteen values ranging from 0 to more than \$100 at the upper end of the range. A weighted value was calculated for resident and non-resident anglers. The upper end of the range was closed off at \$110, making the choices even increments of \$10. This means the weighted value is more conservative than if we had chosen a value of \$150, for example. (The values in the Maryland questionnaire ranged from \$0 to \$500).

The overall net economic valuation of the New Brunswick sport fishery in 1990 was \$21.08 per day. This means the average angler would be willing to pay an additional \$21 above his/her current daily fishing expenditures to fish in New Brunswick waters. The average net economic value (consumer surplus) of a New Brunswick fishing day to the resident angler

was \$18.35³. This amount is considerably lower than the net economic valuation per day of non-resident anglers. Non-resident Canadian anglers were willing to pay an additional \$45.69 per day above their trip expenditures and non-resident, non-Canadian anglers were willing to pay an additional \$48.76 per day.

Table 2:				
Additional Costs Active Anglers are Willing to Pay for Fishing in New Brunswick, 1990 (%)				
	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Unknown	0.3	0	0	0.3
Less than \$10.00	25.9	9.3	5.1	24.1
\$10	29.2	9.9	11.1	27.6
\$20	23.9	20.5	20.6	23.6
\$30	8.7	13.8	11.6	9
\$40	3.1	2.3	4.3	3.1
\$50	6.3	19.7	18.3	7.4
\$60	0.3	0.6	1.4	0.4
\$70	0.2	0	2.5	0.4
\$80	0.2	1.6	0.9	0.3
\$90	0	0	0	0
\$100	1.1	9.5	10.1	1.9
More than \$100	0.7	12.8	14.1	1.9
Weighted Value	18.35	45.69	48.76	21.08

Unfortunately, anglers in New Brunswick were not asked how much additional costs they would be willing to pay if stocks doubled, as in the Maryland survey. We can, however, infer from the Maryland survey that the number of anglers who would be willing to pay for increased stock in New Brunswick would also increase.

Current Direct Economic Benefits

The net economic value (direct economic benefits) of sport fishing in New Brunswick can be calculated by multiplying the net willingness to pay per day valuations indicated for residential and non-residential anglers by the total angling days fished in each category. This gives an estimated total net economic value of the New Brunswick sport fishery of roughly

³ The relatively low value for the weighted average of the marginal willingness to pay value for resident anglers is due, in large part, to the large numbers of resident trout fishermen pulling this average down.

\$18.8 million by resident anglers, \$362 thousand by non-resident Canadian anglers and \$1.4 million by non-resident non-Canadian anglers. Multiplying the total weighted average of the net economic valuation of the New Brunswick sport fishery in 1990 of \$21.08 by the total number of days fished for all recreational fisheries (1,061,259 days) gives a total net economic value of the New Brunswick sport fishery of \$22.7 million in 1990. This total varies slightly with the total obtained by summing the net economic value of residential and non-residential fisheries which gives a value of \$20.5 million in 1990 due to rounding in the weighted averages.

Current Indirect Economic Benefits

The total expenditures on fishing trips in New Brunswick, or, in other words, the total indirect economic benefits, amounted to roughly \$23.6 million in 1990. Non-residential Canadian recreational angling had an indirect economic value of roughly \$800 thousand, and non-residential, non-Canadian anglers had an indirect economic impact of roughly \$3 million.

Current Gross Economic Value

The total gross economic value of the New Brunswick sport fishery for 1990 is derived by combining total net economic value (direct benefits) and total fishing expenditures (indirect benefits). Combining the economic impact value of \$23.6 million and the more conservative value of the total net economic value of \$20.6 million gives an estimated total gross economic value of approximately \$44.2 million for the New Brunswick sport fishery in 1990.

Total gross economic value of the non-residential Canadian sport fishery in New Brunswick was roughly \$1.2 million and the non-residential, non-Canadian recreational angling had a total gross economic value of roughly \$4.4 million in 1990.

2.3.3 Stakeholder Valuation of the Resource

There is a perception that neither government nor the general public places sufficient value on the sustainability of the fisheries resource.

Resource users feel that the Province has dedicated insufficient resources to fisheries management, and feel that additional resources should be allocated to the fisheries. This could be achieved by dedicating provincial fishing license revenues to fisheries management.

From the perspective of resource managers, the difficulty in obtaining sufficient funds for management activities reflects a lack of public value for the resource relative to the demand for other government services. The likelihood of additional funding is seen as remote, given the current economic climate and other government obligations, unless the public makes it clear that increased management of the fisheries resource is a priority. In addition, continued

over-harvesting of the resource in the face of declining stocks is seen as a symptom of a general lack of public value for the future of the resource.

There is little to be gained by pursuing a debate about who, if anyone, is at fault in undervaluing the resource. The real need is to increase management activity and effectiveness.

2.4 RESOURCE MANAGEMENT

2.4.1 Inter-agency Coordination

In the past, the two levels of government represented by DFO and DNRE have, for the most part, worked independently with only limited interaction and cooperation. Although both agencies are concerned with fisheries resource management, the two agencies are mandated by laws which affect fisheries management in different ways. Federal laws and regulations, under which DFO operates, deal with issues of resource conservation and the protection of fish habitat. On the other hand, provincial law deals with issues of resource allocation and property rights. Although both of these legal systems affect resource use, they differ in their basic tenets. Both resource users and agency staff are not always aware of these fundamental differences. Consequently, there is confusion about the responsibility and accountability for fisheries management. To complicate matters further, the Province does not have a clear mandate to manage the inland fisheries. In the absence of strong coordination and cooperation, the provincial agency can not deal effectively with issues of resource conservation.

2.4.2 Resource Allocation and Access

In New Brunswick, since private land ownership can include riparian rights to fish, resource allocation and access are closely related issues. Approximately 50 % of the land in the Province is privately owned (Figure 6). While there is a lack of current information on the state of the resource, there is general agreement that where there has been open access, excessive rates of harvest have led to declines in fish abundance. In areas where relatively high catch limits are still in force, there has been essentially no mechanism to limit harvest. The limited access to fishing created by private land ownership is in itself a form of allocation.

The general consensus is that fish stocks are in greater abundance where extensive private landholdings exist and/or in Crown Reserve areas. The proportion of publicly accessible fishing opportunities differs substantially throughout the province. In the south, a significant portion of waters is publicly accessible. In other areas, such as the Restigouche and Miramichi watersheds, public access is limited. In some areas, it is felt that lands have been falsely posted as private, unduly restricting public access to fishing opportunities.

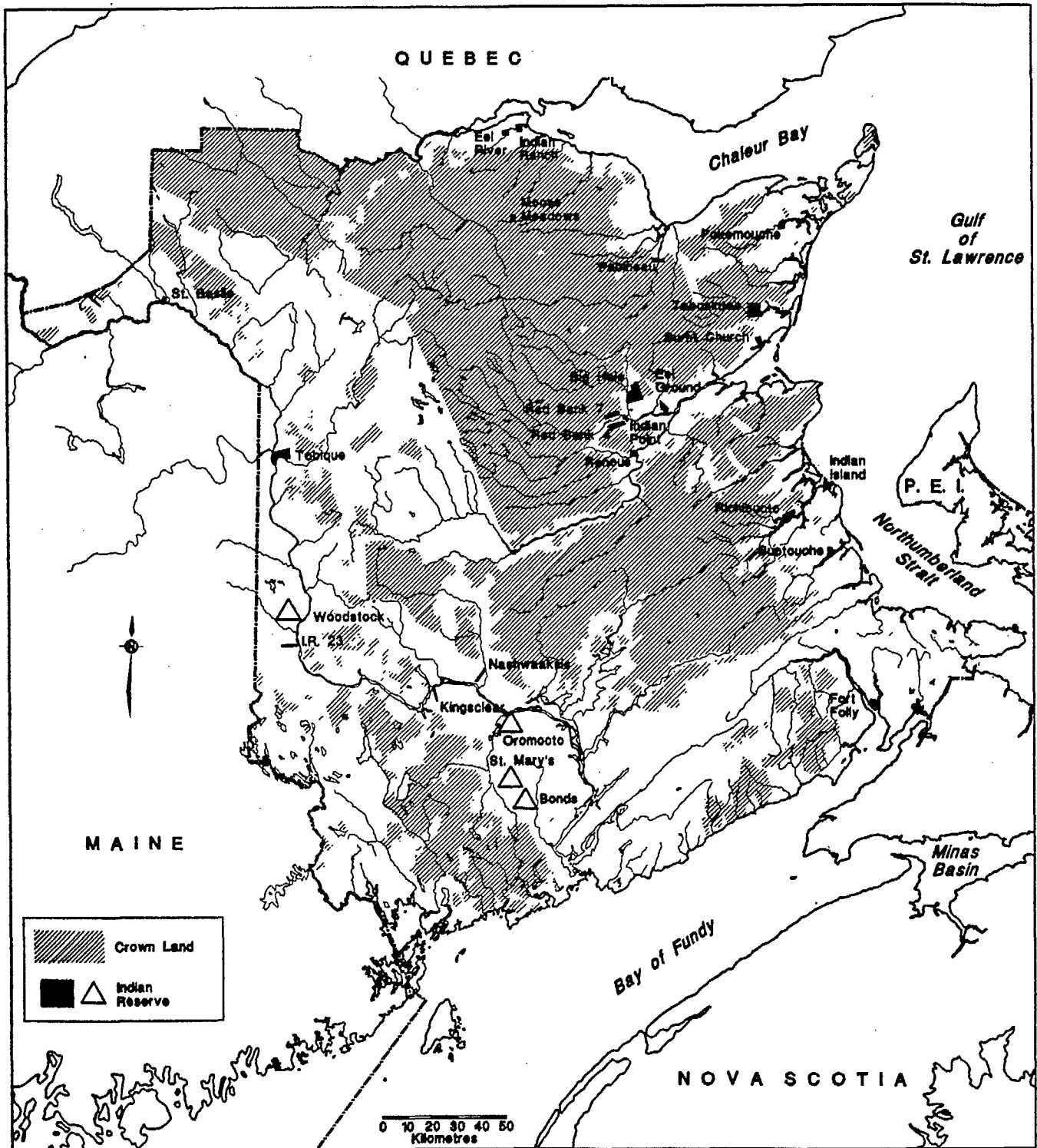


Figure 6. Map showing the distribution of private lands, Crown lands and native reserves in New Brunswick.

The accessibility of an area depends upon the amount of private and crown land, as well as the access designation of the land. Extensive privately owned tracts comprising in aggregate roughly 20 % of the land base are held by forest management companies. Some of these lands are publicly accessible for fishing through agreements with the province. Other significant areas are closed to public access. Crown lands and, hence, waters fall in one of four categories: Crown Open (publicly accessible, unrestricted access to anglers), crown closed (e.g. headwaters and sanctuaries, no angling allowed), Crown Lease (leased to private groups and/or commercial ventures, controlled access), and Crown Reserves (limited access, anglers selected by random draw). The Crown Reserve system is discussed in greater detail in Section 3.5.7, pg. 62.

At the heart of the allocation issue is the need to maintain harvests within the sustainable capacity of the resource. Even where private land ownership limits access, riverine fish populations may range between private and publicly accessible areas. This is especially true of anadromous species which migrate over large distances. This issue is further complicated by the fact that some species migrate across either provincial and/or international boundaries during their life cycles. Thus, while limited access can assist in limiting harvest, it is not sufficient in itself to guarantee sustainable harvests. Some form of allocation mechanism is needed. In the case of lakes, private controlled access may be sufficient. However, any lakes where access is available to more than one stewardship group will require some form of access agreement.

Perhaps the most contentious allocation issue revolves around the rights of Native people to fish and, in particular, to the allocation of harvest between Natives and non-natives. Aboriginal peoples engaged in subsistence fishing base their allocation claims on culture and tradition, prior and unextinguished rights, and the absence of alternative sources of food and income (Beamish et al. 1986). The rights of Natives to fish are now recognized by the courts.

The law dictates that Native people have an aboriginal right to fish, a right that is protected by the Constitution. According to Pearse (1992), this right can only be restricted when it is necessary to conserve stocks. For fisheries managers, this ranking of priorities - conservation requirements, Native fisheries, sport and commercial fisheries - presents significant management challenges, particularly for anadromous species such as Atlantic salmon. Nevertheless, prompt resolution of allocation issues surrounding Natives is imperative. Fair and equitable agreements must be reached through negotiations conducted in good faith. A change in attitude amongst non-natives may be required to achieve negotiated agreements -- Native people should not be viewed as simply a competing user group. Failure to resolve the allocation issue in a fair and equitable manner poses considerable risks to the long-term sustainable use of the resource.

2.4.3 Involvement of Resource Users in Management

Throughout the public consultations, resource users indicated their desire to be more directly involved in management. At the same time, government resources for management are limited. Local groups may be able to access additional sources of funding beyond those available to the management agencies. Involving users in management could increase the effective level of management effort and would provide a specific local or regional focus through their specific local knowledge.

Current interaction and debate between resource users tends to focus on allocation disputes and often overlooks the need for resource conservation (wise use). Providing a mechanism for direct user co-operation in management and management planning including identification of needs, information collection, participation in selecting management actions and in hands-on management activities, could help to shift discussions toward increased stewardship of the resource. Native peoples, fish and game clubs, commercial fishermen, industry and municipalities as well as the two lead management agencies could participate in this process. Native representatives contacted during the consultation and in attendance at the workshop expressed a willingness to work with others. Some First Nations bands in New Brunswick have already started or completed work on fisheries management plans and many are weighing the benefits of promoting recreational use of the resource. Technical assistance is needed to help advance these efforts.

3.0 Potential Futures

3.1 ASPIRATIONS

Aspirations for the management of New Brunswick's recreational fisheries by stakeholders involved in the public consultation were remarkably consistent among the angler groups contacted. Essentially, all groups identified a need for the rehabilitation of native stocks and for increased opportunity for involvement in resource management. All groups indicated a willingness to work with other resource users. The list of aspirations for the recreational fishery established during the public consultations and supported by participants at the strategy design workshop include the following:

- Rehabilitation of native fish stocks;
- Development of new fisheries to increase opportunities;
- Formal management of species other than Atlantic salmon and brook trout;
- Increased sustainable fishing opportunities;
- Cooperative management of fisheries;
- Employment;
- Increased understanding of management responsibilities;
- Maintenance of biodiversity of aquatic resources;
- Maintenance of a quality environment; and
- Maintenance of a quality fishing experience.

Native groups contacted indicated essentially the same aspirations for rehabilitation of depleted stocks, development of new fisheries and long term sustainable resource use. In addition, native leaders frequently emphasized the need for employment for native people and for identifying economically viable resource-based initiatives to provide increased employment opportunities. Some leaders and band members indicated an interest in developing recreational fisheries on band lands as either an alternative or adjunct to commercial fishing and which could provide greater employment and financial return. In addition, native people contacted during the initial consultations and who took part in either the strategy design and/or the strategy review and implementation workshops indicated a general willingness to work in cooperation with other resource users in developing sound approaches to resource management. In doing so, they seek a shared commitment to wise resource use and protection, mutual respect and an open and honest cooperative process. An important aspiration for native people in any cooperative management initiative, is for a greater degree of integrity and respect in the interaction with others than they have been historically afforded.

While several First Nations participants indicated a willingness to work with other resource stakeholders in developing sound watershed management plans, it will be important for others to recognize that not all native aspirations are likely to be met through a recreational fisheries strategy. Native aspirations for fishing include the provision of food for people residing on band lands: commercial fishing continues to be seen as a valuable source of both

employment and food. As new ventures based on recreational resource use provide increased employment, these aspirations may change, but it would be unreasonable to expect that such a change will happen quickly. While some aspirations of the native community may be met through the recreational fisheries strategy others (perhaps many) will be aided by a parallel program, the Aboriginal Fisheries Strategy, which focuses specifically on providing assistance to native people to improve their condition through development of fisheries based initiatives.

A striking feature of the aspirations (and also the necessary actions) identified during the public consultations is their strong consistency with those identified by staff from the two key resource management agencies. This occurred during the DNRE/DFO workshop held as a part of this strategy development process and also at an earlier workshop held in Ludlow, N.B., in March of 1992 (DFO-Gulf Region, 1993).

3.2 CURRENT AND POTENTIAL VALUE OF THE N.B. RECREATIONAL FISHERY

This section uses the methodology from Section 2.3.2, pg. 20, to provide an economic assessment of the current value and the potential value of New Brunswick's recreational fisheries on a species by species basis. No attempt was made to analyze the current or potential value of privately-operated, put-and-take fishing operations in ponds near urban centres, since the required data were not available. Nevertheless, it seems probable that such operations could provide considerable economic benefits to the operators while helping to meet the demand for angling opportunities near urban centres.

A detailed application of the methodology employed in these analyses, using data on the State of Maryland's striped bass fishery, is illustrated in Appendix F. The assessment covers each of the major recreational fisheries in the province as well as some species, such as striped bass, which appear to offer significant growth potential. Realizing the projected economic benefits from most species depends upon (1) the recovery of depleted stocks, (2) the sustainable management of stocks following their recovery, and (3) encouraging more non-residents to participate in the recreational fishery (this may require directed marketing programs, especially for some species, e.g., striped bass). The species and/or species groups analyzed are:

- Atlantic salmon;
- brook trout (both resident and sea-run populations);
- other salmonids (including land-locked salmon, lake trout, brown trout, rainbow trout, Arctic char, trout hybrids and whitefish);
- warm water species (including smallmouth bass, chain pickerel, perch, sunfish, muskellunge, etc.);
- striped bass; and
- coastal/other anadromous species (including smelt, mackerel, flounder, shad, pollock, tomcod, etc.).

Finally, to provide an overall perspective all species are analysed as a group under the heading:

- Species Composite.

An estimate of the net economic value (direct benefits) of individual species in the New Brunswick recreational fishery can be derived, based on estimates of anglers' willingness to pay to fish the species above current trip costs for the respective species. Angler willingness to pay by species will be calculated using appropriate proportions of resident and non-resident fishing effort for each species.

The direct economic impact (indirect benefits) of the species' fisheries can be estimated using fishing expenditure data to calculate total expenditures in each fishery respectively, based on the proportion of resident and non-resident angling effort for each of the major species considered. Finally, the gross economic value of each fishery will be calculated by combining the net value and the economic impact value of each respective species. In this way, the total economic value of selected species can be compared to the economic value of the overall recreational fishery in New Brunswick, as well as with other species of sports fish in New Brunswick. This assessment will be broken into two sections:

- Current Economic Value of each of the major recreational fisheries in New Brunswick; and,
- Potential Economic Value of a Restored Fishery on a species basis.

Each of these sections provides an economic valuation of the major species and/or species groups based on current catches, stock levels, effort, expenditures, and willingness to pay conditions. Descriptions of the status of each of these species or species groups are provided in Section 2.2.2, pg. 18. The current economic valuation will be based primarily on the 1990 New Brunswick Angler Survey. The potential economic value of a restored fishery will be based on increased stock estimates as a result of restoration.

For each of the major species and/or species groups examined, where possible, data from the 1990 New Brunswick angler survey is used. In cases where actual direct data are not available from the 1990 survey, estimates from industry and government experts were used. The Contingent Valuation Method was used to calculate the net economic value of each of the major fisheries. Each section for each species and/or species group examined includes the following format:

- Discussion of Current Fishery (stocks, catches, effort, etc.).
- Estimation of Current Net Economic Value, Direct Economic Impact and Gross Economic Value.
- Discussion of the Potential for a Restored Fishery for Each Species.
- Estimation of Potential Net Economic Value, Direct economic Impact and Gross Economic Value.

All assumptions are clearly stated and, where appropriate, a range of scenarios is presented if the data is not directly defined by the 1990 survey. Weaknesses in 1990 New Brunswick sport fishing survey data are also discussed. Catch data are available from the 1990 survey for all species, and are used to calculate the proportion of resident and non-resident anglers. Estimated efforts on a species basis⁴ are shown below in Table 3. These estimates will be used to calculate both direct and indirect economic benefits by species and species groups.

Table 3:	
Estimated Angling Effort by Species, New Brunswick, 1990	
Species	Estimated Angling Effort (Angler Days, 1990)
Atlantic Salmon	224,000
Brook Trout	539,000
Land Locked Salmon	30,000
Lake Trout	5,000
Brown Trout	7,000
Rainbow Trout	41,500
Trout Hybrids	7,000
Smallmouth Bass	100,000
Other Warmwater Species	70,000
Arctic Char	1,500
Striped Bass	2,500
Coastal/Other Anadromous Species	52,500
Totals	1,080,000

The economic values reported below are conservative values. The values obtained depend on the choice of methodology, the per angler day coefficients for the direct benefits (willingness to pay (WTP)) and for the indirect benefits (expenditures for fishing inputs), and the estimates of potential angler days by species which, in turn, are dependent upon estimates of potential stock size and/or sustainable harvests. The methodology used is widely accepted in the literature as producing acceptable economic values for recreational fishing activities. The angler day coefficients for WTP⁵ and expenditure on inputs used for fishing activities are based on the 1990 Sportsfishing Survey for New Brunswick. The expenditure values include

⁴ The estimates of the number of angler days expended for each species and/or species group were provided by Mr. Bill Hooper, N.B. Department of Natural Resources and Energy, Fredericton.

⁵ A willingness to pay (WTP) figure of \$18.35 per day for resident anglers was applied to all species because species-specific WTP estimates were not available. This approach may underestimate the current and potential economic benefits for species such as Atlantic salmon which are highly prized, and may overestimate the benefits for some warmwater species.

only the direct expenditures for directly used fishing related inputs. The estimated potential angler days by species used were selected after a careful review of the current status of the stocks and the relevant biological and habitat information. All things considered, we believe the values generated are credible and defensible.

3.2.1 New Brunswick Atlantic Salmon Fishery

3.2.1.1 Current Economic Value of the N.B. Atlantic Salmon Fishery

Current Direct Economic Benefits

This section develops an estimate of the net economic value of the New Brunswick Atlantic salmon fishery, based on average angler willingness to pay for Atlantic salmon above current trip costs. Total Atlantic salmon angler days in 1990 were estimated to be 224,000 days (Table 4).

Multiplying the total number of angler days for Atlantic salmon by the marginal willingness to pay per day to fish in New Brunswick waters results in an estimate of the net economic value of the Atlantic salmon fishery in New Brunswick. Using the proportion of resident to non-resident salmon catches, total Atlantic salmon angler days can be broken out into resident and non-resident angler days. The resulting estimates of angler days for New Brunswick Atlantic salmon is 174,720 days by resident fishermen, 8,960 days for non-resident Canadian fishermen, and 40,320 days for non-resident non-Canadian anglers. The current net economic value (direct economic benefit) of the New Brunswick Atlantic salmon can be estimated by multiplying these estimates of angler days by the corresponding marginal willingness to pay per day values from the 1990 New Brunswick angling survey.

Table 4:				
Current Economic Value of New Brunswick Atlantic Salmon Fishery				
Atlantic Salmon	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Allocation of Angling Days, 1990	174,720	8,960	40,320	224,000
Average % salmon angling days	78%	4%	18%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$3,206,112	\$409,382	\$1,966,003	\$5,581,498
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$2,814,739	\$991,693	\$4,573,901	\$8,380,333
Total gross economic value	\$6,020,851	\$1,401,075	\$6,539,904	\$13,961,830

The resulting net economic value of Atlantic salmon for resident fishermen is estimated to be roughly \$3.2 million for resident Canadian anglers, \$409 thousand for non-resident Canadian anglers and \$2 million for non-resident non-Canadian anglers. The total estimated current net economic value (direct economic benefit) for the New Brunswick Atlantic salmon fishery is roughly \$5.6 million. The estimate for resident net economic value could be considered a conservative estimate, based on the low estimate of the weighted average marginal willingness to pay per fishing day for resident anglers. It would be reasonable to assume this estimate is pulled down by the large number of resident trout fishermen in New Brunswick.

Current Indirect Economic Benefits

Total indirect economic benefits of the New Brunswick Atlantic salmon fishery can be estimated from trip expenditure data from the 1990 New Brunswick angler survey. Multiplying average daily trip expenditures by the estimated angler days for New Brunswick Atlantic salmon gives an estimate of fishing expenditures (indirect impacts) for New Brunswick Atlantic salmon.

Estimated indirect benefits for resident Atlantic salmon anglers is \$2.8 million for non-resident Canadian anglers, \$1 million for non-resident Canadian anglers, and \$4.5 million for non-resident, non-Canadian anglers. Summing, the total indirect impact of the Atlantic salmon fishery in New Brunswick is estimated to be \$8.4 million in 1990.

Current Gross Economic Value

The total current gross economic impact of the Atlantic salmon fishery in New Brunswick is calculated by totalling the total net economic value and the total indirect impacts to give a value of \$14.0 million in gross economic value.

3.2.1.2 The Potential for a Restored Atlantic Salmon Fishery

Based on an analysis of information obtained from a number of sources (CAFSAC 1992; Hooper 1991; Chadwick, pers. comm) on the New Brunswick Atlantic salmon fishery, the potential production of sea-run Atlantic salmon appears to be about 600,000 adults, of which 500,000 may potentially be available for harvest. This could translate into an equal number of angler days assuming a one fish retained per day limit and that all anglers are successful. The challenge for managers will be maintaining the availability of high quality angling opportunities, an important component of which is the avoidance of excessive crowding. Some of the increase in angler days may result from anglers gaining increased access to presently inaccessible waters on large private landholdings. Another part of the increase could potentially be accommodated by extending the autumn fishery in some waters, by extending the season of the spring kelt fishery, or by allowing kelt fisheries in waters such as the

Restigouche and Nepisiquit rivers where such fisheries are currently not allowed. Clearly such changes must be made cautiously.

The stage has already been set for the recovery of Atlantic salmon stocks; the regulations that are currently in place are reasonable. Realization of this 500,000 figure depends on continued wise management and regulation and upon further reductions in harvests by the offshore commercial fishery.

3.2.1.3 Potential Economic Value of the N.B. Salmon Fishery

Potential Direct Economic Benefits

Atlantic salmon are potentially attractive to non-resident anglers. After New Brunswick anglers' needs are met, the surplus could be marketed to non-residents. Assuming that the same proportion of resident to non-resident fishery is maintained, the potential net economic value (direct economic benefits) of the New Brunswick Atlantic salmon fishery can be calculated by using the corresponding marginal willingness to pay figures for resident and non-resident anglers (Table 5). This will be a conservative estimate of potential benefits considering the much higher marginal willingness to pay and expenditures per day for non-residents.

Table 5: Potential Economic Value of New Brunswick Atlantic Salmon Fishery (assuming no change in the resident:non-resident angler ratio)				
Atlantic Salmon	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Potential Angling Days	390,000	20,000	90,000	500,000
Average % salmon angling days	78%	4%	18%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$7,156,500	\$913,800	\$4,388,400	\$12,458,700
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$6,282,900	\$2,213,600	\$10,209,600	\$18,706,100
Total gross economic impact	\$13,439,400	\$3,127,400	\$14,598,000	\$31,164,800

Given the estimated potential total number of angler days of 500,000, and assuming the current proportion of resident to non-resident anglers with a restored fishery, the estimated angler days for Atlantic salmon for resident anglers would be 390,000 days, for non-resident Canadians 20,000 days and a potential 90,000 angler days for non-resident non-Canadian anglers.

Multiplying the estimated angler days by the corresponding marginal willingness to pay values, the estimated potential net economic value of a restored New Brunswick Atlantic salmon fishery was estimated to be roughly \$7 million for resident anglers, \$0.9 million for non-resident Canadian anglers, and \$4.3 million for non-resident non-Canadian anglers. This gives a total potential net economic value of approximately \$12.5 million.

Potential Indirect Economic Benefits

The potential indirect economic benefits of the Atlantic salmon fishery were calculated using average expenditures per day fished for the resident and non-resident anglers and the estimated potential angler fishing days under a restored fishery, and are shown in Table 5. Total potential indirect impacts for resident anglers were estimated to be roughly \$6.3 million, for non-resident Canadian anglers \$2.2 million and \$10.2 million for non-resident non-Canadian anglers. This gives an estimated total indirect impact value of the Atlantic salmon fishery in New Brunswick of \$18.7 million under a restored fishery. It is interesting to note that 2/3 of this total, or \$12.4 million, is expected to be attributable to the 22% of the anglers who are non-residents, a clear indication of the economic impact of non-resident anglers.

Potential Gross Economic Benefits

The total potential gross economic value of a restored Atlantic salmon fishery is the sum of the net economic value and the direct economic benefits or expenditures. The gross economic value of a restored Atlantic salmon fishery in New Brunswick was estimated to be approximately \$31 million, a \$17 million increase over the estimated valuation of the current Atlantic salmon fishery in New Brunswick. Shifting a greater proportion of the increase in angler days to non-residents would increase this value. Marketing initiatives could be undertaken to encourage greater non-resident participation in the fishery.

3.2.2 New Brunswick Brook Trout Fishery

3.2.2.1 Current Economic Value of the N.B. Brook Trout Fishery

Current Net Economic Benefits

An estimate of the net economic value of the brook trout fishery was derived, using the same methodology as above, based on angler willingness to pay above current trip costs for trout fishing. Total angler days for brook trout for 1990 are estimated to be 539,000 days. Using the proportion of resident/non-resident brook trout catches for 1990, total brook trout angler days can be allocated to resident and non-resident fishers. The resulting net economic value (direct economic benefits) of the brook trout fishery in New Brunswick was estimated to be approximately \$10 million, 97% of which is accounted for by resident anglers (Table 6).

Current Indirect Benefits of the N.B. Brook Trout Fishery

The indirect economic benefits of trout fishing were calculated by multiplying the total number of trout angling days by an estimate of the average expenditures per day for the resident and non-resident anglers. Expenditures per day were calculated by using the proportion of resident to non-resident trout anglers in New Brunswick in 1990. The total indirect impact of the New Brunswick brook trout fishery is estimated to be \$9.2 million. Significant gains in the indirect benefits of the brook trout fishery, relative to 1990 levels, could be achieved by encouraging greater non-resident participation.

Table 6: Current Economic Value of New Brunswick Brook Trout Fishery				
Brook Trout:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
% Brook Trout angling days	99%	0%	1%	100%
Brook Trout angling days, 1990	533,610	0	5,390	539,000
Marginal willingness to pay for fishing per day in NB.	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$9,791,744	\$0	\$262,816	\$10,054,560
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$8,596,457	\$0	\$611,442	\$9,207,899
Total gross economic impact	\$18,388,201	\$0	\$874,258	\$19,262,459

Current Gross Economic Value of the N.B. Brook Trout Fishery

The total gross economic value of the brook trout fishery in New Brunswick is estimated at around \$19.3 million, given current effort levels, marginal willingness to pay values, and ratio of resident to non-resident anglers.

3.2.2.2 The Potential for a Restored Brook Trout Fishery

Population estimates for brook trout in New Brunswick are limited, as are the estimates of production potential. Some estimates are provided in DNRE reports (e.g., Hooper 1985). Because of these limitations, it is extremely difficult to estimate sustainable harvests. Most biologists believe brook trout populations are depressed and that current populations are roughly 30-50% of potential. Using these percentages, the numbers of potentially harvestable brook trout could be expected to increase by a factor ranging from 2.0 to 3.3 under a well-managed scenario, which may include some catch and release fishing.

Applying a best estimate to these figures and assuming that crowding can be controlled through a variety of mechanisms⁶, and that bag limits can be changed, it seems reasonable to assume the number of sustainable angler days could be increased by at least a factor of two over the levels achieved in 1990. This translates into a potential 1,078,000 angler days for brook trout.

3.2.2.3 Potential Economic Value of the N.B. Brook Trout Fishery

Assuming that an increase in harvestable stocks results in a modest increase in non-resident anglers, it might be expected that the fishery would be 85% resident and 15% non-resident. Allocation of potential angler days to the resident/non-resident fishery is calculated in Table 7 below.

Table 7: Potential Economic Value of New Brunswick Brook Trout Fishery (assuming an 85% resident and 15% non-resident fishery)				
Brook Trout:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Potential Angling Days	916,300	107,800	53,900	1,078,000
Average % Trout angling days	85%	10%	5%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$16,814,105	\$4,925,382	\$2,628,164	\$24,367,651
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$14,761,593	\$11,931,304	\$6,114,416	\$32,807,313
Total gross economic value	\$31,575,698	\$16,856,686	\$8,742,580	\$57,174,964

Potential Direct Economic Benefits

The resulting potential direct economic benefit of the brook trout fishery in New Brunswick was estimated to be approximately \$17 million for resident anglers, \$5 million for non-resident Canadian anglers and \$3 million for non-resident non-Canadian anglers.

⁶ The maintenance and/or attainment of a high quality angling experience was an important goal identified during the public consultations. Some anglers reported that crowding at some locations is reducing the quality of their angling experience. It is expected that some of the increase in angler density that occurs with a restored fishery might be offset by access to presently closed areas.

Potential Indirect Economic Benefits

The potential indirect economic impact was calculated using average expenditures per day fished for the resident and non-resident anglers, based on estimated potential angler fishing days under a restored fishery (Table 7). Total indirect impact of the brook trout fishery in New Brunswick is estimated to be approximately \$32.8 million in 1990 dollars.

Potential Gross Economic Value

The gross economic value of a restored brook trout fishery in New Brunswick was estimated to be \$57.2 million, an increase of \$38 million from the current gross economic value.

3.2.3 Other Salmonids

3.2.3.1 Current Economic Value of Other Inland Salmonid Species

The species included under this "other salmonid" group include land-locked Atlantic salmon, lake trout, brown trout, rainbow trout, trout hybrids, whitefish and Arctic char. According to the results of the 1990 Recreational Fishing Survey, with the exception of whitefish, at least some angler effort was directed to each of these species in 1990.

Current Net Economic Benefits

An estimate of the net economic value of "other inland salmonid" species was derived using the same methodology as before, based on anglers' willingness to pay above current trip costs for "other" salmonid fishing. The results are presented in Table 8. Total angler days for "other salmonid" species in 1990 are estimated to be 92,000, and are restricted entirely to resident fishermen.

The resulting net economic value (direct economic benefits) of the "other salmonid" fishery in New Brunswick was estimated to be approximately \$1.7 million in 1990, 100% of which was accounted for by resident anglers.

Current Indirect Benefits of Other Inland Salmonid Species

The indirect economic benefits of the "other salmonid" fishery were calculated by multiplying the total number of "other salmonid" angling days by an estimate of the average expenditure per day for resident anglers. The total indirect impact of the New Brunswick "other salmonid" fishery is estimated to be \$1.5 million.

Current Gross Economic Value of Other Inland Salmonid Species

The total gross economic value of the "other salmonid" fishery in New Brunswick is estimated to be \$3.2 million, given current effort levels, marginal willingness to pay values, and resident:non-resident mix of anglers.

Table 8:				
Current Economic Value of Other Inland Salmonid Recreational Species, New Brunswick				
Other Salmonids:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Angling Days, 1990	92,000	0	0	92,000
Average % current angling days	100%	0%	0%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$1,688,200	\$0	\$0	\$1,688,200
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$1,482,120	\$0	\$0	\$1,482,120
Total gross economic value	\$3,170,320	\$0	\$0	\$3,170,320

3.2.3.2 The Potential for a Restored Other Salmonid Species Fishery

Estimating the number of angler days that the "other salmonid" fishery could support was made difficult by the absence of fish population or resource capacity data. In the analyses that follow, we used an estimate of 200,000 days of angler effort, slightly more than twice the number of days of angler effort expended in 1990. This estimate, which we believe is conservative, was based in part upon estimates provided in internal DNRE reports (e.g., Hooper 1985), modified by a number of factors such as the current level of angler interest in the species, and the potential for increased access by anglers to some private waters. As more information becomes available, the potential for growth in the "other salmonid" fisheries should be assessed on a species by species basis to ensure that management efforts are directed to where they are most needed and where the greatest benefits can be attained.

3.2.3.3 Potential Economic Value of the N.B. Other Salmonid Species Fishery

Assuming an increase in harvestable stocks and an increase in non-resident anglers, it might be expected that the fishery would be 90% resident and 10% non-resident. Allocation of potential angler days to the resident/non-resident fishery is calculated in Table 9, below.

Potential Direct Economic Benefits

The resulting potential direct economic benefit of a restored other salmonid species fishery is approximately \$3.3 million for resident anglers, \$457 thousand for non-resident Canadian anglers, and \$488 for non-Canadian non-resident anglers.

Potential Indirect Economic Benefits

The potential indirect economic impacts were calculated using average expenditures per day fished for the resident and non-resident anglers, based on estimated potential angler fishing days under a restored fishery, and are presented in Table 9. Total indirect impact of the "other salmonid" fishery in New Brunswick is estimated to be approximately \$5.1 million in 1990 dollars.

Potential Gross Economic Value

The gross economic value of an well-developed fishery focusing on New Brunswick's "other salmonid" species was estimated to be \$9.4 million dollars, an increase of \$6.2 million from the current gross economic value. Achieving this increase in economic value is dependent upon an increase in the proportion of non-resident anglers in the fishery.

Table 9:				
Potential Economic Value of Other Inland Salmonid Recreational Species, New Brunswick (assuming a 90% resident fishery and a 10% non-resident fishery)				
Other Salmonids:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Potential Angling Days	180,000	10,000	10,000	200,000
Average % current angling days	90%	5%	5%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$3,303,000	\$456,900	\$487,600	\$4,247,500
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$2,899,800	\$1,106,800	\$1,134,400	\$5,141,000
Total gross economic value	\$6,202,800	\$1,563,700	\$1,622,000	\$9,388,500

3.2.4 New Brunswick Warm Water Fishery

3.2.4.1 Current Economic Value of the N.B. Warm Water Fishery

Current Direct Economic Benefits

The principal warm water species include smallmouth bass, chain pickerel and perch. Other species of recreational interest include muskellunge, sunfish and perhaps bullhead. An estimate of the net economic value of these warm water species can be derived using the previous methodology. Total warm water angler days in 1990 were estimated at 170,000, 100,000 of which were focused on smallmouth bass. Using the average proportion of resident/non-resident catches for these species in 1990, total angler days can be allocated to resident and non-resident fishers. This calculation is shown in Table 10, below.

The total current net economic value of New Brunswick's warm water fishery was estimated to be roughly \$3.1 million in 1990 dollars. Approximately 60% of this can be attributed to smallmouth bass.

Table 10:				
Current Economic Value of New Brunswick Warm Water Fishery				
Warm Water species:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Angling Days, 1990	170,000	0	0	170,000
Average % warm water angling days	100%	0%	0%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$3,119,500			\$3,119,500
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$2,738,700			\$2,738,700
Total gross economic value	\$5,858,200			\$5,858,200

Current Indirect Benefits

Total current indirect economic impact of the warm water fishery is estimated to be \$2.7 million which, according to Table 10, can be attributed entirely to resident anglers. This is an over-simplification since some non-residents are known to fish for warm water species. For example, about 20% of the participants in the province's smallmouth bass tournaments are known to be non-residents (see Section 3.5.1, pg. 57, see also Appendix I). Possibly as much

as one-half of the roughly \$200,000 in direct expenditures resulting from these tournaments can be attributed to non-residents.

Current Gross Economic Value

The total current economic value of the New Brunswick warm water fishery is estimated at \$5.8 million given current effort levels.

3.2.4.2 The Potential for a Restored Warm Water Fishery

Based upon a comparison of industry expert (e.g., Hooper 1985) predictions of the number of angler days that can be sustained (200,000) against the effort expended in 1990 (170,000 angler days), and other factors⁷, it appears that the warm water fishery should be able to sustain approximately 300,000 angler days. Most of the regional biologists believe the populations of warm water species are under exploited and that more angler effort could be sustained. This may imply catch limits would have to change to ensure sustainability.

3.2.4.3 Potential Economic Value of the New Brunswick Warm Water Fishery

Recognizing the popularity of warmwater fisheries in parts of the U.S.A, and assuming that carefully directed marketing initiatives are successful in attracting more nonresident anglers, it is reasonable to target for a warmwater angler population consisting of 90% residents and 10% non-residents. The resulting total potential direct economic benefit of such a fishery in New Brunswick is estimated to be approximately \$6.4 million using this methodology (Table 11).

Potential Indirect Economic Benefits

The potential indirect economic impact was calculated using average expenditures per day fished for the resident and non-resident anglers, based on estimated potential angler fishing days under a restored fishery. These values are given in Table 11. The total indirect impact of the warm water fishery in New Brunswick was estimated to be \$7.7 million in 1990 dollars.

Potential Gross Economic Value

The potential gross economic value of a restored warm water fishery in New Brunswick was estimated to be approximately \$14.0 million, an increase of \$8.2 million over the current gross economic value of the warm water fishery.

⁷ According to DNRE biologists, very little fishing effort is currently being directed to species such as white and yellow perch, sunfish and chain pickerel, yet these species offer excellent potential.

Table 11:				
Potential Economic Value of New Brunswick Warm Water Fishery (assuming a 90% resident fishery and a 10% non-resident fishery)				
Warm Water Species:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Potential Angling Days	270,000	15,000	15,000	300,000
% Warm Water angling days	90%	5%	5%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$4,954,500	\$685,350	\$731,400	\$6,371,250
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic impacts	\$4,349,700	\$1,660,200	\$1,701,600	\$7,711,500
Total gross economic impact	\$9,304,200	\$2,345,550	\$2,433,000	\$14,082,750

3.2.5 New Brunswick Striped Bass Fishery

3.2.5.1 Current Economic Value of the N.B. Striped Bass Fishery

Current Direct Economic Benefits (using N.B. willingness to pay estimates)

Using the Contingent Value Method, an estimate of the net economic value of striped bass can be derived, based on angler willingness to pay above current trip costs for striped bass fishing. Total estimated striped bass angler days in 1990 were 2,500. These estimates were obtained from industry experts and are based on current depleted stocks of striped bass and a sharp decrease in the number of sport anglers seeking solely striped bass.

Multiplying the total number of angler days for striped bass by the marginal willingness to pay per day to fish in New Brunswick waters would result in an estimate of net value of the striped bass fishery in New Brunswick. Given the fact that virtually all (99%) striped bass caught in New Brunswick in 1990 was by resident anglers, using the marginal willingness to pay per day value by resident recreational anglers (\$18.35) for all species in the New Brunswick sport fishery gives an estimate of the willingness to pay per day for striped bass. Multiplying the number of striped bass angling days by \$18.35 per day results in a net economic value of \$45,875 (Table 12).

This estimate could be considered conservative, based on the conservative estimate of the number of striped bass angler days. It could be argued that the weighted average marginal willingness to pay value for resident anglers of \$18.35 is also a conservative value for striped bass fishing. The willingness to pay for striped bass fishing is likely to be higher than the

weighted average value because the striped bass fish is an excellent sport fish, with very good fighting characteristics.

Table 12:
Current Economic Value of the New Brunswick Striped Bass Recreational Fishery

Striped Bass:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Angling Days, 1990	2,500	0	0	2,500
Average % current angling days	100%	0%	0%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$45,875	\$0	\$0	\$45,875
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$40,275	\$0	\$0	\$40,275
Total gross economic value	\$86,150	\$0	\$0	\$86,150

Current Direct Economic Benefits (using Maryland willingness to pay estimates)

An alternative approach to measuring the net value of the striped bass fishery in New Brunswick was used since the required data were available. The methodology in this approach is to multiply the average consumer surplus of an additional striped bass by the number of striped bass caught. This approach is outlined in detail in the Appendix H. The value of marginal willingness to pay for an additional striped bass used was from the Mid-Atlantic striped bass fishery along the eastern seaboard in the United States. This fishery most resembles the New Brunswick striped bass fishery. The resulting net economic value of the New Brunswick striped bass fishery from this approach is \$351 thousand. This value is substantially higher than the value obtained by using the weighted average marginal willingness to pay from the 1990 New Brunswick angler survey of \$46 thousand. Also it is interesting to note that the marginal willingness to pay for an additional striped bass in the Mid-Atlantic is valued at \$14.61, which is slightly lower than the marginal willingness to pay per day value of \$18.35 from the 1990 New Brunswick angler survey.

The discrepancy between the resulting two values of direct economic benefit of the New Brunswick striped bass fishery lies not so much in the differences in the marginal willingness to pay values, but in the discrepancy between the estimated days fished and the catch data for striped bass in New Brunswick in 1990.

Current Indirect Economic Benefits

The indirect impact of the striped bass fishery in New Brunswick is calculated by multiplying the average fishing expenditures per day by the number of angler days. Again, since the striped bass is currently a predominantly resident fishery, the average resident daily trip expenditure of \$16.11 is used. Total estimated current indirect impacts of the striped bass fishery in New Brunswick is \$40,275, in 1990 dollars.

Current Gross Economic Value

Total current gross economic value of the striped bass fishery in New Brunswick is the sum of the net economic value and the indirect impacts. This gives a total current gross economic value of \$86,150 if the marginal willingness to pay from the New Brunswick survey is used and \$392,528 if the marginal willingness to pay from the 1980 Maryland study is used.

3.2.5.2 The Potential for a Restored Striped Bass Fishery

Data on striped bass populations in New Brunswick are extremely limited. Based on data from a study of the striped bass fishery in the Kouchibouguac system and other sources (e.g., Chadwick et al. 1985; Hogans and Stokesbury 1991; Dadswell, pers. comm.), the exploitation rate for adult striped bass is approximately 33% of available stock. According to Hogans (pers. comm.), current estimates are that the Miramichi River could produce approximately 10-20% of the total striped bass in the Gulf Region, (roughly 330,000) and the Scotia Fundy region, namely the Saint John River, could produce 50,000 striped bass under a restored fishery. This gives a total potential annual production of striped bass of approximately 380,000 adults/sub-adults. Although this figure appears to be the best estimate available, Hogans (pers. comm.) suggests that it be applied cautiously. Assuming a 60% harvest rate, 228,000 fish would be available for harvest. This could translate into an equivalent number of angler days if one assumes that a one fish per day catch limit is in place and that all anglers are successful. Because it is unlikely that all anglers would be successful, the number of angler days may actually be higher.

This 228,000 estimate of the potential number of angler days that might be directed towards a healthy striped bass fishery might also be considered conservative because it does not include migrant fish from the east coast of the U.S.A. Some of these migrants are angled in the Bay of Fundy region. Although the number of migrants is not accurately known, numbers are likely substantial. Furthermore, the number of migrants can be expected to increase in the years ahead as a result of recently implemented strict harvest control programs in some northeastern states.

3.2.5.3 Potential Economic Value of the N.B. Striped Bass Fishery

Potential Direct Economic Benefits

As the most economically important anadromous fish in North America, striped bass are potentially attractive to tourists. After the needs of New Brunswick anglers are met, the surplus could be allocated to non-residents. This may require an intensive marketing initiative. Assuming that a shift from a 99% resident striped bass fishery to 60% resident/40% non-resident striped bass fishery is achieved, and that the estimate of potentially harvestable fish is reasonable, the potential net economic value of the striped bass fishery can be calculated by using the corresponding marginal willingness to pay figures for resident and non-resident anglers. If it is also assumed that the 40% non-resident angler component is comprised equally of non-resident Canadian and non-resident, non-Canadian anglers, then the total potential striped bass angler days can be allocated between resident and non-resident anglers. These values are given below in Table 13a. Estimates based upon an 80% resident and 20% non-resident angler fishery are shown in Table 13b.

Table 13a:				
Potential Economic Value of New Brunswick Striped Bass Fishery (assuming a 60% resident and 40% non-resident fishery)				
Striped Bass:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Potential Angling Days	136,800	45,600	45,600	228,000
Average % striped bass catches	60%	20%	20%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$2,510,280	\$2,083,464	\$2,223,456	\$6,817,200
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic impacts	\$2,203,848	\$5,047,008	\$5,172,864	\$12,423,720
Total gross economic impact	\$4,714,128	\$7,130,472	\$7,396,320	\$19,240,920

Potential Indirect Economic Benefits

The potential indirect economic impact or expenditure data is calculated using average expenditures per day fished for the resident and non-resident anglers, based on estimated potential angler fishing days under a restored fishery (Tables 13a and 13b). Total potential indirect benefits could be expected to increase from about \$8.0 million in a fishery with an angler population consisting of 20% non-residents, to more than \$12.4 million for a fishery based upon an angler population composed of 40% non-residents.

Potential Gross Economic Value

The total potential gross economic value of a restored striped bass fishery is the sum of the net economic value and the direct economic benefits or expenditures. The gross economic value of a restored striped bass fishery in New Brunswick is \$14.2 million. The total potential gross economic value of a restored and well-marketed striped bass fishery is expected to range from \$13.5 million for a fishery based with a 20% non-resident angler component to \$19.2 million for a fishery with an angler population characterized by 40% non-residents.

Table 13b: Potential Economic Value of the New Brunswick Striped Bass Recreational Fishery (assuming an 80% resident and 20% non-resident fishery)				
Striped Bass:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Potential Angling Days	184,400	22,800	22,800	228,000
Average % current angling days	80%	10%	10%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$3,347,040	\$1,041,732	\$1,111,728	\$5,500,500
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$2,938,464	\$2,523,504	2,586,4320	\$8,048,400
Total gross economic value	\$6,285,504	\$3,565,236	\$3,698,160	\$13,548,900

3.2.6 Coastal and Other Anadromous Species

The principal coastal species in this group include mackerel, flounder, cod and pollock. Based upon the results of the 1985 Recreational Fishing Survey, catches of mackerel and flounder were the third and fifth highest of all species in 1985. The high catches reflect the fact that individual angler catches were large; only a small amount of angler effort was directed towards these species.

The "other" anadromous species in this group include rainbow smelt, shad and tomcod. Catches of rainbow smelt in 1985 were the second highest of all species due to ease of capture and the absence of catch limits. The shad is one of the most economically important inshore fishes on the east coast of North America; however it is does not presently support an important recreational fishery in New Brunswick. The most important anadromous species, including Atlantic salmon, sea-run trout and striped bass, are covered in previous sections of this report.

3.2.6.1 Current Economic Value of Coastal & Other Anadromous Species

Current Net Economic Benefits

An estimate of the net economic value of coastal and other anadromous species was derived using the same methodology as before, based on anglers' willingness to pay above current trip costs for other anadromous species fishing (Table 14). Total angler days dedicated to coastal and other anadromous species in 1990 was estimated to be 52,500, slightly less than half the roughly 111,000 angler days focused on the same species in 1985 (Canada 1985). All of the anglers who targeted coastal and other anadromous species in 1990 were New Brunswick resident.

Table 14: Current Economic Value of Coastal/Other Anadromous Recreational Species, New Brunswick				
Coastal/Other Anadromous species:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Angling Days, 1990	52,500	0	0	52,500
Average % current angling days	100%	0%	0%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$963,375	\$0	\$0	\$963,375
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$845,775	\$0	\$0	\$845,775
Total gross economic value	\$1,809,150	\$0	\$0	\$1,809,150

The resulting net economic value (direct economic benefits) of the other anadromous species fishery in New Brunswick was estimated to be approximately \$963 thousand, 100% of which is accounted for by resident anglers.

Current Indirect Benefits of Coastal & Other Anadromous Species

The indirect economic benefits of other anadromous species fishing were calculated by multiplying the total number of angling days by an estimate of the average expenditure per day for resident anglers. The total indirect impact of the New Brunswick other anadromous fishery is estimated to be \$846 thousand.

Current Gross Economic Value of Coastal & Other Anadromous Species

The total gross economic value of the other anadromous fishery in New Brunswick is estimated to be \$1.8 million, given current effort levels and marginal willingness to pay values.

3.2.6.2 The Potential for a Fishery for Coastal & Other Anadromous Species

Although, with the possible exception of shad, there are few if any population estimates for most of the species within the "coastal and other species" group, most stocks are thought to be relatively healthy and capable of supporting a substantial increase in angling pressure. However, in the absence of better population data, or of estimates of production potential, estimates of the recreational potential of a fishery based upon these species should be set conservatively. Based upon a number of factors including expert opinion (e.g., Hooper 1985), it appears likely that the fishery could support at least 200,000 days of angler effort, particularly if reasonable catch limits are adopted. The challenge for managers will be to market the fishery.

3.2.6.3 Potential Economic Value of the N.B. Fishery for Coastal & Other Anadromous Fisheries

Assuming an increase in harvestable stocks and an increase in non-resident anglers, it might be expected that the fishery would be 90% resident and 10% non-resident. Allocations of potential angler days to the resident/non-resident fishery are shown in Table 15, below.

Table 15:				
Potential Economic Value of Coastal/Other Anadromous Recreational Species, New Brunswick (assuming a 90% resident fishery and a 10% non-resident fishery)				
Coastal/Other Anadromous species:	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Potential Angling Days	180,000	10,000	10,000	200,000
Average % current angling days	90%	5%	5%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$3,303,000	\$456,900	\$487,600	\$4,247,500
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic benefits	\$2,899,800	\$1,106,800	\$1,134,400	\$5,141,000
Total gross economic value	\$6,202,800	\$1,563,700	\$1,622,000	\$9,388,500

Potential Direct Economic Benefits

The resulting potential direct economic benefit of a restored other anadromous species fishery is approximately \$3.3 million for resident anglers, \$457 thousand for non-resident Canadian anglers, and \$488 for non-Canadian non-resident anglers.

Potential Indirect Economic Benefits

The potential indirect economic impact was calculated using average expenditures per day fished for the resident and non-resident anglers, based on estimated potential angler fishing days under a restored fishery. These values are presented in Table 15. Total indirect impact of the "coastal and other anadromous" fishery in New Brunswick is estimated to be approximately \$5.1 million in 1990 dollars.

Potential Gross Economic Value

The potential gross economic value of a well-developed recreational fishery in New Brunswick based upon "coastal and other anadromous" species was estimated to be \$9.4 million dollars, an increase of \$7.6 million from the current gross economic value.

3.2.7 Composite Species

3.2.7.1 Current and Potential Economic Value of the Total N.B. Recreational Fishery

This section examines the current and potential economic value of all species of the recreational fishery in New Brunswick. The current valuation of the total New Brunswick sport fishery was outlined in greater detail in Section 2.3.2, pg. 20, and is summarized in the first part of Table 16, below.

Potential Total Economic Value of a Restored Recreational Fishery in N.B.

Three estimates of the potential economic value of a restored and/or optimal recreational fishery are also provided in Table 16. The analyses are based upon two premises: (1) that New Brunswick's anadromous and inland recreational fishery is potentially capable of supporting 2.5 million days of angler effort, not including urban put-and-take fisheries, and (2) that, in the most likely scenario, the proportion of non-residents participating in the fishery would increase from its current level of roughly 5% to 10% at some point in the future, divided equally between non-resident Canadians and non-resident, non-Canadians.

With respect to the first point, our 2.5 million angler day is higher than the estimate provided by DNRE biologists by about 200,000 angler days. The small difference can likely be attributed to our view that the warmwater fishery and the "coastal and other anadromous species" fisheries are capable of supporting more days of angler effort than indicated by DNRE. Overall however, the similarity in the estimates, despite the fact that they were calculated independently, suggests that they are reasonable.

With respect to the second point, because it is difficult to predict how successful New Brunswick will be in attracting more non-resident anglers to the province, we used sensitivity analysis to compare the potential value of New Brunswick's recreational fishery under different levels of non-resident angler participation. Three levels were chosen, 5%, 10% and 15%. In each sensitivity analysis, these percentages were applied uniformly to each species

Table 16:				
Current Economic Value of New Brunswick's Recreational Fishery, All Species				
ALL SPECIES	Resident	Non-resident Canadian	Non-resident Non-Canadian	Total
Alloc'n of Angling Days, 1990	1,025,330	8,960	45,710	1,080,000
% resident/non-res. angling days	94.94%	0.83%	4.23%	100%
Marginal willingness to pay for fishing per day in NB	\$18.35	\$45.69	\$48.76	\$21.08
Estimated net economic value	\$18,814,806	\$409,382	\$2,228,820	\$21,453,008
Average expenditures per day	\$16.11	\$110.68	\$113.44	\$22.96
Total indirect economic impacts	\$19,576,821	\$828,334	\$3,160,793	\$23,565,930
Total gross economic impact	\$38,391,627	\$1,237,716	\$5,389,613	\$45,018,938
Potential Valuation of the New Brunswick Recreational Fishery Using Sensitivity Analysis				
Assuming 95% resident fishery:				
Resident/non-res. angling days	95%	2.50%	2.50%	100%
Allocation of Potential Angling Days	2,380,700	62,650	62,650	2,506,000
Estimated net economic benefits	\$43,685,845	\$2,862,479	\$3,054,814	\$49,603,138
Estimated indirect benefits	\$38,353,077	\$9,796,581	\$10,161,830	\$52,394,195
Total Gross Economic Impact	\$82,038,922	\$9,796,581	\$10,161,830	\$101,997,333
Assuming 90% resident fishery:				
Resident/non-res. angling days	90%	5%	5%	100%
Allocation of Potential Angling Days	2,255,400	125,300	125,300	2,506,000
Estimated net economics benefits	\$41,386,590	\$5,724,957	\$6,109,628	\$53,221,175
Estimated indirect benefits	\$36,334,494	\$13,868,204	\$14,214,032	\$64,416,730
Total gross economic impact	\$77,721,084	\$19,593,161	\$20,323,660	\$117,637,905
Assuming 85% resident fishery:				
Resident/non-res. angling days	85%	7.50%	7.50%	100%
Allocation of Potential Angling Days	2,130,100	187,950	187,950	2,506,000
Estimated net economic benefits	\$39,087,335	\$8,587,436	\$9,164,442	\$56,839,213
Estimated indirect benefits	\$34,315,911	\$20,802,306	\$21,321,048	\$76,439,265
Total gross economic impact	\$73,403,246	\$29,389,742	\$30,485,490	\$133,278,478

or species group. This differs from the previous analyses where the ratio of resident to non-resident anglers was selected on a case by case basis.

As expected, the estimates of the potential economic value of a restored fishery (all species combined), differed considerably depending upon the estimated level of non-resident angler participation chosen. The potential economic value ranged from a low of \$102 million, representing a 2.25-fold increase over existing conditions, at a non-resident angler participation rate of 5%, to a high of \$133 million, representing an almost 3-fold increase over existing conditions, based upon a 15% non-resident angler participation rate. Under the most likely scenario, based upon a 10% non-resident angler participation rate, the total economic value of the recreational fishery is estimated at \$117 million. Clearly the actual benefits achieved will depend not only upon the ability of the resource to sustain the project numbers of angler days, but also upon the anglers' level of satisfaction with the fishing experience. This could be strongly influenced by factors such as crowding, catch limits (i.e., regulations), and catch per unit of effort.

3.2.7.2 Summary of Economic Valuation of Each Species

This section summarizes the estimated total economic valuation of the New Brunswick recreational fishery, all species combined (Table 17). While Table 17 is the summation of values worked out on a species by species basis for tables 4 through 15, its values are slightly different because it uses the average resident to non-resident split for angling days (derived from Table 16) as a basis for its calculations. This difference leads to slight variations in the Gross Economic Impact values reported in Tables 16 and 17.

Table 17: Summary of Current and Potential Economic Valuation of New Brunswick Sport Fishery by Species (\$ thousands)						
Species	Current Benefits			Potential Benefits		
	Direct Benefits	Indirect Benefits	Gross Value	Direct Benefits	Indirect Benefits	Gross Value
Atlantic Salmon	\$5,581.5	\$8,380.3	\$13,961.8	\$12,458.7	\$18,706.1	\$31,164.8
Brook Trout	\$10,054.6	\$9,207.9	\$19,262.5	\$24,367.7	\$32,807.3	\$57,175.0
Other Salmonids	\$1,688.2	\$1,482.1	\$3,170.3	\$4,247.5	\$5,141.0	\$9,388.5
Warm Water	\$3,119.5	\$2,738.7	\$5,858.2	\$6,371.3	\$7,711.5	\$14,082.8
Striped Bass	\$45.9	\$40.2	\$86.1	\$5,500.5	\$8,048.4	\$13,548.9
Coastal &/or Other Anadromous Sp.	\$963.4	\$845.8	\$1,809.2	\$4,247.5	\$5,141.0	\$9,388.5
All Species	\$21,453.1	\$22,695.0	\$44,148.1	\$57,193.2	\$77,555.3	\$134,748.5

From the results of Table 17, it is clear that Gross Value of the N.B. recreational fishery could increase from approximately \$45 million under 1990 conditions to roughly \$135 million when the potential of the resource is being realized (i.e., when an optimal pattern of use is achieved and when presently depleted stocks have recovered). This translates into a 2.45-fold increase in the value of the recreational fishery. This estimate assumes an increase in the percentage of non-resident anglers from roughly 5% in 1990 to 10% at the time when the resource is being used at optimal levels. As shown in Table 16, above, the relative gain in benefits is closely linked to the percentage of non-resident anglers.

3.3 INCREMENTAL VERSUS DISTRIBUTIONAL ECONOMIC BENEFITS

As discussed in the introduction, when valuating the recreational fishery in this manner, it is important to make the distinction between incremental and distributional economic benefits. Incremental benefits refers to those benefits accruing in New Brunswick as the result of increased recreational fishing activities. These benefits represent benefits accrued as a result of economic gains from outside the province. In the case of the above valuation of the New Brunswick sports fishery, these benefits are represented by increases in non-resident expenditures in the Province, or the indirect economic benefits. That is, they are a net gain in provincial economic activity.

Distributional benefits are gains in economic activity in one area of the province that result because something does not take place in another part of the province. For example, if resident anglers expand their fishing activity in the northwestern part of the province, that area will enjoy an increase in economic benefits. To the extent that the anglers reallocate their spending away from other recreational and non-recreational goods in favour of fishing-related goods, the province as a whole will experience no net gain in economic activity. In other words, the benefits noted in the northwestern area are a redistribution of economic activity, hence the term redistribution benefits.

Where resident anglers are concerned, the indirect benefits referred to previously will be largely redistribution benefits. This is because these anglers would consume other goods and services in New Brunswick if they did not fish. Assuming the goods consumed are mainly market goods and services (where the market price is taken as a measure of the value of satisfaction), the direct benefits from angling for resident anglers will be incremental benefits.

For non-resident anglers, the main economic benefits for New Brunswick comes from their spending on goods and services in the province. Thus, in this case, the indirect benefit is an incremental benefit for the province. On the other hand, the direct benefit cannot be attributed to the province since the recipient is a non-resident.

Table 18, below, provides a breakdown of the difference between incremental and distributional impacts as a result of the potential increased economic value of a restored recreational fishery in New Brunswick. For each species examined, the estimated increase in economic impact, as measured on the basis of the potential increase in harvestable stocks, is

broken down on an incremental and distributional basis. An increase in resident expenditures is measured as a redistribution of economic impact within the province, whereas an increase in non-resident expenditures is represented as an incremental economic impact.

Brook trout represents the largest gain in incremental benefits. This is due largely to the fact that any increase in non-residential brook trout fishing, even the 10% increase assumed under a restored fishery, would represent an incremental benefit since there is virtually no non-residential brook trout fishery at present. This figure would be small under an assumption of a smaller resulting non-residential segment under a restored fishery.

Table 18:
**Incremental Versus Distributional Impacts of a Restored
Recreational Fishery in New Brunswick**

(\$ million)			
Species	Distributional	Incremental	Total
Atlantic Salmon	\$3.5	\$6.9	\$10.4
Brook Trout	\$6.2	\$17.4	\$23.6
Other Salmonids	\$1.4	\$2.2	\$3.6
Warm Water	\$1.6	\$3.4	\$5.0
Striped Bass	\$2.2	\$10.2	\$12.4
Other Coastal &/or Anadromous Sp.	\$2.1	\$2.2	\$4.3
All Species	\$17.0	\$42.3	\$59.3

3.4 RESOURCE MANAGEMENT

Substantial changes are required in the way in which the recreational fishery resources of New Brunswick are managed if the social and economic potential of the resource is to be realized. These changes can be summarized as follows:

- Establish a new management framework that involves co-management with resource users, and increases agency cooperation in such areas as objective setting, policy development, the development of management plans, and on-the-ground management.
- Increase the knowledge available for management.
- Increase communication between and among managers of the resource and resource users. Foster an increased sense of resource stewardship among resource users.
- Resolve existing allocation conflicts through negotiated agreements.

- Identify and/or create new angling opportunities.
- Manage sustainably. At present, with the exception of Atlantic salmon, most species are not being managed sustainably. More stringent regulations are required. Increased compliance with regulations is required. Habitats must be protected. Critical degraded habitats must be restored.

A detailed analysis of these changes and/or strategic initiatives, including recommendations, is provided in Section 4.0.

Using examples and case studies, the following section identifies some specific options and/or strategies for optimizing social and economic benefits. The examples discussed focus on (1) competitive fishing (i.e., tournaments), and (2) establishing improved control over exploitation by controlling access, perhaps through the exercise of some form of property rights. Of course, harvest regulations provide another avenue for controlling exploitation.

3.5 OPTIONS FOR OPTIMIZING SOCIAL & ECONOMIC BENEFITS

The previous section demonstrates two important points. First, under a restored recreational fishery, large gains in angler opportunities, either through the recovery of depleted populations, and/or through increased use of underutilized species, and/or access to new areas. Substantial increases in the populations of many species are possible with appropriate management. Second, with appropriate controls over exploitation, the larger fish stocks can accommodate large increases in angling which, in turn, will increase the economic benefits from recreational fishing activities. Realization of these benefits will depend, in large measure on the maintenance of appropriate mix of angling opportunities.

With these points in mind, the most pressing question becomes: what is the best way to realize this potential? To answer these questions we have reviewed fisheries management alternatives looking for the most promising approach for New Brunswick to follow.

Tournaments may have some part to play in this process, primarily as vehicles to promote particular species to anglers. They also have an important educational role as is discussed below.

Generally speaking, however, we find that an effective mechanism for controlling exploitation and/or access to the fish stocks appears to be at the heart of the matter. Such a mechanism provides both a management regime capable of creating and sustaining a viable fishery over time and a means of capturing the maximum economic benefits from the resource, particularly for local areas where stocks reside.

The main feature for the control mechanism is the assignment of an actual or quasi property right over the fish resource. The owner of the resource (or the quasi-owner who acts for the Crown, where the resource is Crown owned) is induced to manage the resource in a

manner that sustains the quality of the fishing experience and the economic benefits over time. This makes sense since the economic benefits depend directly on the fishing experience over time. In effect, you cannot have the first without the second. As is shown below, by vesting control in this way, capturing some or all of the anglers' willingness to pay is possible and these revenues can be used to fund the management function. The mechanisms discussed also show how to increase local community involvement in fisheries management in important ways.

The next section outlines the role of tournaments in realizing economic potential. Subsequent sections outline several examples of control mechanisms that demonstrate the success of the property rights-based approach to recreational fisheries management.

3.5.1 Tournaments

One idea suggested to increase the economic impacts of the recreational fishery is through the promotion of additional tournaments. We examined the smallmouth bass tournaments in New Brunswick and have presented the findings for three tournaments as case studies in Appendix I. The Harvey Lake tournament represents one of the oldest organized tournaments in the province (Ken Weeks, pers. comm). The Woodstock tournament, one of the newer tournaments, is currently the largest tournament in New Brunswick (Carl Ash, pers. comm). The Johnson Evinrude tournament in Mactaquac is a medium to large size tournament which has consistently drawn a loyal group of followers (Greg Davidson, pers. comm).

How would one measure the benefits of the tournaments? As compared with other recreational fisheries in the province, the economic impacts of the tournaments are relatively small. The more important impacts appear to be at the community, social, and cultural levels. The tournaments provide social and educational benefits. The smallmouth bass tournaments have done much to educate people on the importance of the "hook and release" concept in sportfishing. Organizers of the tournaments say the resident bass fisherman was created by the smallmouth bass tournaments and between tournaments, the bass fishermen are now purchasing materials to fish for bass throughout the season. This has additional spin-off effects for the economy.

The economic impacts of the tournaments are mainly distributional. The majority of participants (80% on average) are usually from elsewhere in New Brunswick, whereas the remaining 20% from outside the province bring additional economic activity to the economy.

Although there does not seem to be much room for growth with the smallmouth bass tournaments and derbies in New Brunswick, there may be more room for expansion with non-traditional species. Other types of derbies, (such as sea derbies for striped bass for example), may provide a useful promotional venue to expose anglers to alternative sportfishing potential in the province as well as provide additional incremental economic activity.

3.5.2 The European Example

In an address to a Ministers' colloquium on wildlife policy in Canada, Pearse (1986) discussed examples of wildlife management in Britain and Europe where the management of resources is most often operated by local community organizations. Pearse pointed out that fisheries and wildlife in those countries are among the best managed and protected fisheries and wildlife resources anywhere in the world, and that the hunting and fishing opportunities attract substantial incremental economic benefits. In both western and eastern Europe, game is well protected and managed because it is regarded as a valuable resource. People possess rights that enable them to protect those values - not unlike the way Canadian ranchers and farmers protect and husband cattle or care for their land. The general thrust of European fisheries and wildlife management can be summarized in the following points which are paraphrased from Pearse's report.

- A remarkable standard of sport fishery management is maintained throughout Europe and it is done with remarkably little effort on the part of the government.
- Sportsmen from around the world pay handsomely to hunt deer in Czechoslovakia, wild boar in France, partridge in Spain, grouse in Scotland and pheasants in Denmark and Belgium.
- Austria is less than one-tenth the size of British Columbia, and much more intensely populated and developed. Yet each year Austrians harvest nearly double the number of big game animals taken in all of British Columbia.
- The small game harvest is even more impressive. The European wildlife represents valuable assets and are treated as such.
- Consumers have access to venison, partridge and other delicacies in shops and restaurants everywhere and game supports a significant food industry.
- Landowners cultivate their wildlife and work hard to integrate it with forest and agricultural crops.

3.5.3 The Forest Analogy

Pearse (1986) also argues that Canadian forestry resource management can provide a useful example for recreational fisheries management. Canadian forestry management is often based on contractual arrangements between timber companies and the Crown. These contractual arrangements provide the link between the public landlord and the private user, assigning rights and responsibilities to each.

According to Pearse, some of the best managed public forests in most provinces are under forest management agreements or tree farm licences under the general surveillance of

provincial forestry departments. Unfortunately, for the most part, as they stand now, these arrangements often have no incentive to protect or enhance the Crown's fish and wildlife. An exception to this, the Fraser Inc. experience, is discussed below.

Perhaps the experience learned from forest tenure arrangements could be adapted to call forth private resources for recreational fisheries management. There are many possibilities associated with this type of arrangement:

- Local outfitting shops could be licensed to manage fisheries resources in small areas on behalf of their members, as they do in England and Scotland.
- This would help the government, because the additional manpower would be directed toward population assessment, enforcement, and enhancement under approved plans (just as private parties undertake forest management).
- In some situations, if a company had a licence to manage timber in an area, it could also apply for a licence to manage the fisheries contained within its woodlands.
- This kind of scheme would not be complete privatization. It would still entail public ownership of the Crown's fisheries resource with private management of these resources.
- This also does not imply that governments should give up all of their responsibilities for fisheries management. Whether they contract out some rights and obligations under licences or not, they must remain ultimately responsible and accountable for fisheries management.

3.5.4 Zones d'exploitation contrôlée (ZECs)

Quebec, which has complete jurisdiction over its fishery, has turned the management of many local rivers over to community-based associations. The areas managed by these association are referred to as zones d'exploitation contrôlée or ZECs. In English, they are called controlled exploitation zones. The management associations operate the zones in a variety of ways, but the underlying philosophies are to ensure that the economic benefits stay in the area adjacent to the rivers and to increase the accessibility to angling opportunities. ZECs have been established for fishing, small game, moose, white-tailed deer and black bear. The main points of the system that are relevant to angling, as derived from the following references (Boulet, pers. comm; Beamish et al. 1988; Gouvernement du Québec, undated; Lemieux 1987; MCLP unpubl. data, misc. publ.; Pearse 1988), can be summarized as follows:

- Within the province of Quebec there are 67 ZECs which offer, to the recreational fishers, a variety of opportunities. The ZECs are managed by private associations, normally comprised of local fishers and hunters, businessmen, and sometimes even wildlife technicians.

- The ZECs are supported financially by the provincial government by a small degree, but for the most part, are self-supporting.
- The maximum ZEC fee for fishing in non-salmon ZECs in 1992 was \$15 per person per day for the regular fishing areas, \$35 per person per day for unlimited access salmon ZECs and \$75 per person per day for limited access salmon ZECs. Additional costs for the use of roads are often included. Seasonal membership fees may vary from \$50 to \$200 for the regular fishing areas. The exact amount is decided upon by each association but must be within the government limits.
- The above fees are in addition to the purchase price for an annual fishing permit which is required to fish anywhere in the province including "territoires libres" (all provincial parks, reserves, etc.), for uncontrolled areas, and for ZECs. The price of this permit is currently about \$11 for Québec residents and \$42 for non-residents.
- The lakes within the ZECs are managed on a quota system, similar to the lakes in parks and reserves. Limited data was available for most areas and when the ZECs were formed, a province-wide methodology was applied to establish quotas in all lakes within the ZECs.
- ZECs are responsible for operating the registration stations which usually cover most access points to a territory. Every year, prior to the fishing season, resource technicians visit the registration stations to provide the ZEC employees with the necessary statistical forms and instructions needed to collect the fishing statistics regarding species populations and fishing effort.
- Once quotas for given lakes are reached, the ZECs contact the provincial fisheries department to make the closure of the lake official. Many of the more important lakes are monitored directly by the provincial government's own technicians.
- Other management strategies are sometimes used to ensure fishing waters are open longer such as reductions in catch limits and/or weight limits, minimum length requirements, modifications in the length of the season, restrictions on fishing gear, and improved access to under-utilized areas to relieve pressure on the overexploited lakes and streams.

3.5.5 A Native Fisheries Management Success Story⁸

A fisheries management scheme on the Cascapedia River in Quebec, one of the best Atlantic salmon streams in the world, provides a good example of local management (Pearse 1988). It shows that successfully negotiated agreements between native people and others interested in fisheries management are possible.

⁸ The Casacapedia example is paraphrased from Pearse (1988).

The Micmac Indians of the Maria Reserve in Quebec have traditionally depended on salmon in the Cascapedia River. For some years they have gill-netted them at the mouth of the river near the reserve. Fishing in the upper reaches was locked up by the private clubs that owned and leased the fishing rights. In the mid 1970s, problems became acute when sport fishermen demanded a greater share of the catch. Friction developed among Indians, salmon clubs, sport fishermen and government. Biologists reported that the salmon were on the way to depletion, and serious confrontations occurred between the natives and government authorities. The steps taken to revive the fishery and the results of the management scheme set in place are as follows:

- The government of Quebec responded by striking a task force, including natives, to determine the yield potential of the Cascapedia, identify the interests of all groups, and work out a management plan.
- The provincial government developed a society to regulate fishing on the river under a co-management approach. Half the management board were natives and the rest were representatives from various other interest groups.
- The society was set up to be self-financing and was given responsibility for the day-to-day operation of the fisheries without the help of government.
- The federal and provincial governments retained the right to set bag limits, length of season and other normal regulatory limits.

Today the salmon stocks have recovered significantly because of changes in sportfishing regulations, the elimination of the Gaspe commercial fishery and the reduction of high season salmon fishing.

- Sport fishing has become the main source of income for the Maria band and as a result the Indians are planning to build a lodge. They offer professionally guided fishing for salmon at \$375 per day and the members enjoy revenues exceeding \$1.5 million.
- In addition to the economic benefits, the Indians are now very involved in managing a resource which they fought for and which they regard as their heritage. The total benefits to this band of less than 500 members have been increased not only in terms of employment and income but also in human terms.

The Cascapedia River may be a model for similar initiatives on New Brunswick bodies of water, especially where highly valued species such as Atlantic salmon are involved. Application of its principles need not be restricted to situations involving native fishing rights, i.e., the principals involved could also be applied equally well to outfitting operations run by non-natives.

3.5.6 The Newfoundland Proposal

The province of Newfoundland is considering ways to increase the socio-economic impact of salmon angling in Newfoundland and Labrador with specific reference to rural communities. In total, there are more than 170 licensed rivers in Newfoundland and Labrador which, under proper management, have the capacity to make salmon angling a major contribution to the provincial economy. Three rivers on the island of Newfoundland (the Humber, the Exploits, and the Gander) are classed as urban rivers and already have responsible organizations in place working on enhancement and maintenance. Under proposed management plans, these rivers are considered separately, and would be enhanced and restored as required as long as funds can be made available. Most other rivers can be considered rural, with a small number being considered wilderness. Some of the main points of this proposal include:

- Three demonstration rivers for specific management approaches would be selected. The rivers would have good salmon potential and be in areas where existing community groups have demonstrated competence in other endeavours. Once a river and community group have been selected they would become responsible for all activities on the river. In this way, they will be able to ensure that the socio-economic benefit will impact mainly in that rural area of Newfoundland.
- Management of the river would include hiring wardens in conjunction with Department of Fisheries and Oceans, perhaps on a contractual basis.
- The community group would be responsible for managing all fisheries enhancement and maintenance programs and, in conjunction with the advice from provincial and federal authorities, they would licence a number of outfitters along the river.
- The outfitters would control the number of non-resident anglers on specific pools of the river at any one time (to control the over crowding problems). The community group would vary by area of the province, but would reflect the most appropriate management of the river in each particular rural locality.
- The local community organization would be self-funded through the sale of a required stamp to fish on the river. The stamp would be sold through local outfitters so that anglers benefiting from pool rotation would pay a premium.

Central to the success of this strategy is vesting control and management of the fisheries resource with local groups.

3.5.7 The New Brunswick Situation

The examples given so far show how fisheries management in other areas makes use of property rights as a control mechanism. New Brunswick has such examples, although the bulk of its fisheries resources have mainly been open access. Some rivers, or stretches of rivers,

are privately owned and access is limited, particularly for salmon fishing. The examples we discuss next, Fraser Freehold Lands and the Crown Reserve system, show the use property rights and quasi-property rights as control mechanisms. In our view, they are important steps in the direction advocated here: broader public involvement in the management and control of the fishing resource through the use of a property rights based mechanism.

Fraser Freehold Lands

Fraser Inc.'s freehold lands total 304,000 hectares and include at least 60 lakes and 2,250 km of streams (Woods 1992). In 1985, these lands accounted for roughly 52,000 days of angler effort, or about 5 % of the provincial total. Prior to 1988, the DNRE and the DFO were responsible for managing the fisheries on these lands. Activities carried out by these agencies included fish population inventories, stocking of trout and salmon and habitat improvement. Unfortunately, unrestricted public access, where the public treated sport fishing as a free good, resulted in over-harvesting of trout resources. Under existing government incentives, anglers had no incentive to protect trout resources and coupled with better road access to wilderness waters, better angling technical capability and trout catch levels, nature's ability to replace trout stocks was overwhelmed.

- With the exception of four lakes leased to an outfitter, public access to Fraser Inc. lands was not restricted until 1988. Increasing demand for sport fishing and hunting caused populations to drop to remnant levels in most area.
- In response to the declines in fish stocks, in 1987, Fraser Inc. made improvements in mitigating the effects of forest harvest practices on fish habitat. As well, in 1988, the company implemented a gate-user pay system for forest land users.
- In 1991, in recognition of the recreational potential of the fishery and the need for improved management of the fishery resources, Fraser Inc. invited the DFO and the DNRE and angler associations to participate in the management of the fishery and in the development of a strategic plan (Woods 1992; Woods and Fournier 1992).

An examination Fraser Inc.'s management plan is presented in Appendix J, as a case study. It outlines the long term strategies and solutions being implemented by Fraser Inc. that are producing better angling for the benefit of both the public and Fraser Inc.

Crown Reserves

This system amounts to a form of temporary quasi-private ownership of rivers. The province allocates access to certain special angling waters through a lottery system. These stretches of rivers are owned by the province of New Brunswick and are set aside for the exclusive angling use of resident anglers. The current distribution of Crown Reserve waters are shown in Appendix K. Only those persons defined as residents of New Brunswick may apply for Special Angling Waters. These waters provide an opportunity to fish good to excellent salmon waters under relatively uncrowded, semi-wilderness conditions; they also

serve as a valuable conservation and management tool. The detailed Crown Reserve creel census allows biologists to adjust salmon harvests along these stretches of rivers. As a result of this system, substantial areas appropriate for salmon fishing are not available to the general public as a common property resource.

- Regular Crown reserve waters are available on the Miramichi, Restigouche and Patapedia drainages. These waters are allotted from submitted applications. Public drawings are held to determine who will receive an offer of reservations for one of their choices, in the drainage of their choice. Each of the applicants' five choices of fishing starting dates and stretches will be considered when drawn.
- Daily Crown Reserve waters are available for those who may not wish to commit to long range planning for fishing trips but who enjoy access to waters without over crowding problems. Several sites are available on the Restigouche system for Daily Crown Reserve fishing.
- A new Daily Crown Reserve has been established for trout angling on the Upper, Middle and Lower Peaked Mountain Lakes on the Miramichi.
- Applications for Daily Crown Reserve can be made in person or over the telephone for a maximum of two person fishing parties.

3.5.8 Conclusion

The purpose of this section was to examine how New Brunswick could best realize the economic potential of its recreational fishery. Several key points follow from the analysis:

- Based on the fisheries management experience in other places, successful management and control systems appear to involve the control of access through the exercise of some form of property right.
- Assigning these rights to local organizations to manage and control rivers, parts of rivers or lakes has met with success, and provides a good model to follow.
- The ZEC system in Quebec provides useful operating experience which New Brunswick could adapt, perhaps initially on an experimental basis, to suit its own needs. Such a system could use a price system or a lottery system to allocate access.
- Use of the price mechanism to control access allows the controlling organization to generate its own revenue. This will help to reduce the need for government resources. It also means that some or all of the willingness to pay for angling is actually captured from those who benefit from the use of the resource.

- Local community involvement has two important features including (1) relieving the government from providing the personnel for monitoring and control, and (2) employing local people. Maximizing the retention of economic benefits in the local area is an important consideration. Tournaments, outfitter operations and ZEC-like management systems all provide mechanisms for generating economic benefits at the local level. The sustainability of these benefits over time depends primarily upon the maintenance of a healthy fishery resource.

4.0 A Strategy for NB Recreational Fisheries

4.1 GOALS

The objectives for developing a strategy for New Brunswick recreational fisheries were defined initially by the project sponsors (see Section 1.2). Through the consultative strategy development process, the goals of the strategy were reaffirmed and extended to include the following key long-term goals:

To restore degraded fish stocks and manage the fisheries resources in New Brunswick to provide a diversity of sustainable fishing opportunities based upon a healthy environment and naturally sustaining fish populations.

To establish cooperative management of the fisheries resource by all resource users.

To provide the basis for sustainable social and economic benefits derived from the fisheries resource.

Although the strategy has been developed under the auspices of a cooperative Federal - Provincial program which has a limited time span, the goals of the strategy and the necessary strategic initiatives identified have a much longer term significance.

4.2 GUIDING PRINCIPLES

The following guiding principles were derived from discussions during the strategy development workshop (Section 1.3.3, pg. 9), comments received during the initial public consultation (Section 1.3.2, pg. 6), interviews with agency personnel, and published documents, including but not limited to, the Pearse report (1988), the report by Beamish et al. (1986) on freshwater fisheries in Canada, numerous DNRE reports, DFO reports including the report on the Ludlow workshop (DFO 1993), and reports on strategic planning initiatives in Ontario (OMNR 1992), British Columbia (BC Environment 1991) and elsewhere:

- 1) **Primacy of Conservation** - Conservation of the resource, including fish and their habitat, takes precedence. The question "what is best for the resource?" should guide all management decisions.

Included in this conservation ethic is an explicit recognition of the fundamental need to maintain biodiversity.

- 2) **Sustainable Development** - Present-day use and management of the resource must be ecologically sound and must enhance the ability of the resource to provide social and economic benefits to future generations.

- 3) **An Ecological Basis for Management** - The NB recreational fisheries strategy and projects undertaken to support the strategy should be based upon the premise that fish populations are to be managed on a self-sustaining basis. Thus, resource harvest should occur only within the productive capacity of the natural resource base. Some exceptions are allowed, provided that they are conducted in a manner so as not to degrade any desired naturally-produced fish stocks.

This approach to management explicitly recognizes

- a) *the need for sound, scientifically-based information about the resource, its users, and its use*, on which to base management decisions;
 - b) *the limits to the natural productive capacity of aquatic ecosystems*. These limits impose constraints on the amount of fish that can be produced by, and harvested from, those systems;
 - c) *the need to plan on the basis of watersheds rather than on the basis of individual species*. Management of the resource will be most effective if management units are based upon biologically meaningful boundaries (e.g., watersheds, sub-watershed) rather than on artificial administrative boundaries. A watershed-based approach will focus attention on fish communities rather than on individual species;
 - d) *the need for integrated and cooperative resource management that involves all major users of the resource* (e.g. the public, native groups, interest groups, industry including agriculture, utilities, municipal and other forms of government, major landowners).
- 4) **Reliance upon Natural Production** - With effective management, naturally reproducing fish communities based upon native populations can provide reliable and sustainable long-term social and economic benefits with minimal long-term costs.

Despite the above, it is recognized that there are situations where the stocking of hatchery fish, if undertaken with due consideration to long-term ecological and socio-economic costs and benefits, may be a viable management tool, particularly in high demand areas.

The introduction of new fish species into the province should be strongly discouraged. Transfers of fish species from one part of the province to new parts should only be undertaken after careful consideration of potential biological and socio-economic impacts.

- 5) **Equitable Allocation of Societal Benefits** - Various user group aspirations and needs must be recognized, including the explicit recognition of native rights to fish.

- 6) **Cooperative Management** - Effective management of the resource requires improved cooperation among the government agencies responsible for management of the resource, and the formation of meaningful partnerships between resource agencies, natives and users of the resource.
- 7) **Quality of Angling Experience** - The resource should be managed in such a way as to ensure a diversity of angling opportunities that are reflective of the desires of the angling public.

4.3 STRATEGIC INITIATIVES: OBSERVATIONS AND RECOMMENDATIONS

The recommended strategy for New Brunswick's recreational fisheries includes six major strategic components

- Establishing a new management framework that directly involves resource stakeholders in management decision making,
- Increasing communication between all resource stakeholders with regard to the status and potential of the resource,
- Increasing the knowledge needed to successfully manage the fisheries resource and its use,
- Developing specific allocation agreements between users,
- Increasing opportunities for sustainable resource use, and
- Managing resource harvests to ensure the sustainability of the fishery and of the benefits accruing from its use.

An overview of the strategy is presented in Figure 7.

Although this report has been written by the project technical team, the reader should bear in mind that the strategy described in the following sections reflects the collective thinking and effort of all members of the project team, resource users consulted during the strategy development and the participants who attended each of the project workshops. Recommendations included that reflect specific views of the authors are identified by the symbol "Φ".

4.3.1 Establish a New Management Framework

4.3.1.1 Co-Management with Resource Users

Resource users identified a significant number of issues related to the management of the recreational fishery which could be addressed, at least in part, through co-management agreements with resource users. They are: (1) inadequate management of the fishery resource due to insufficient financial and staff resources, an inadequate level of inter-agency coordination, confusion about agency jurisdiction, lack of regional fisheries/resource

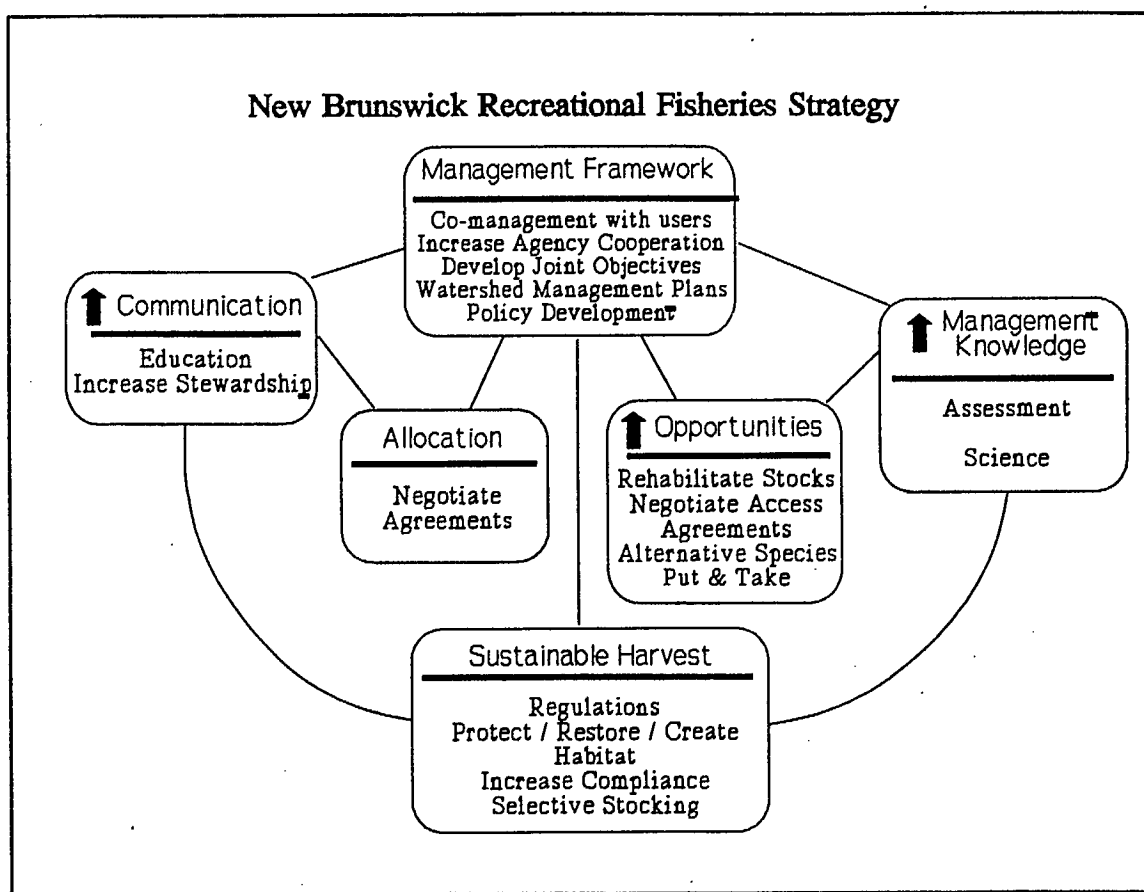


Figure 7. Overview of the Strategy for New Brunswick's Recreational Fisheries.

management plans including river and/or lake specific plans, insufficient assessment data (habitat, stocks, harvests), and a lack of public and First Nation involvement in management decisions and in hands-on management; (2) inadequate enforcement; and (3) conflicts related to the allocation of recreationally-desirable fish species between natives and non-natives, and between recreational fisherman and commercial fisherman. We recommend the following:

Establish a mechanism for the collaborative involvement of resource users in management.

This should take the form of a formalized co-management framework which coordinates the activities of the DFO and the DNRE and which provides a mechanism for meaningful public/user group participation in resource management, in the development of management plans, and in initiatives focused on sustainable resource use. Communication within this group should flow freely between all stakeholders. The composition of the groups involved should vary regionally to reflect the local mix of resource users. To be effective, these groups will need technical assistance from the DNRE and the DFO. The mechanism for ensuring input from agency personnel needs to be workable from the perspective of the logistics of interaction with the lead management agencies. For example, creating a large number of such forums focused on very restricted areas would likely be unmanageable. A regional approach which focuses on sub-drainages within larger watersheds may be feasible. We therefore recommend the following.

Create a sport fish advisory committee, the Sports Fish Advisory Board, whose structure would encourage input from a wide variety of user groups and stakeholders.

This committee should function in an advisory capacity, rather than a decision-making capacity such as might be expected with a commission.

Structure and Broad Mandate

The recommended structure for the co-management framework is illustrated in Figure 8. Briefly, the framework structure and mandate (as described in the J. Heber Brown Ltd. report and the Cooperation Agreement Blue Book) include:

- The Co-operation Agreement Management Committee (CAMC), which reviews the recommendations of the Sports Fish Advisory Board (SFAB) and makes recommendations to senior management. Details of the responsibility of the CAMC are outlined in the Cooperation Agreement Blue Book.
- The SFAB reports and provides advice to the CAMC and considers advice and recommendations received from the Regional Watershed Committees (RWCs). As required, the SFAB would provide direction to and coordinate the activities of the RWCs. From time to time, the SFAB may also assign tasks to the Science Advisory Committee (SAC) or may request expert opinion from the committee.
- The SAC reports to the SFAB and undertakes tasks assigned to it by the SFAB. The membership of the SAC includes technical specialists from government and other organizations as appropriate.
- Five RWCs, which report to, provide recommendations to, and seek direction from the SFAB should be formed. The RWCs are responsible for directing and coordinating the development of watershed-wide fisheries management plan for each of five major watersheds in the Province (for a composite map, see Figure 5; for individual watershed maps, see Appendix L). Each watershed fisheries management plan must integrate the sub-watershed fisheries management plans developed by the Local Watershed Committees (LWCs). The proposed structure of the RWCs, as identified by J. Heber Brown Ltd., is reasonable.
- The LWCs, which report to the RWC, are responsible for developing sub-watershed fisheries management plans under the direction of their RWCs.

The structure and broad mandate described above appears reasonable in virtually all respects. However, the creation of two additional advisory committees may be warranted.

Consideration should also be given to the establishment of (1) an Education Advisory Committee and (2) a Stocking and Disease Control Advisory Committee that includes representation from all concerned government agencies.

Composition

The composition of the Co-operation Agreement Management Committee includes four voting members who are full time employees of the governments they represent, one of whom is to be appointed as co-chairperson by the Federal Implementing Minister; one of whom is to be appointed by the Federal Minister; and two to be appointed one by each of the Provincial Ministers, one of whom will be the co-chairperson.

We strongly recommend that the Chairperson from the Sports Fish Advisory Board be included on this committee.

The composition of the Sports Fish Advisory Board, the Regional Watershed Committees and the Local Watershed Committees, as proposed by J. Heber Brown (1993), are reasonable and are summarized below with some modifications. Some discussion concerning the lack of voting rights for government members is warranted.

SFAB 11 voting members including: user groups - 1 seat each for the NBWF, NBSC, NBOA, and the ASF; natives - 2 seats (Micmac and Maliseet); Regional Watershed Committee - 5 seats; and 5 non-voting members including: DFO - 2 seats (Gulf and Scotia-Fundy Region); DNRE - 2 seats (headquarters and one regional biologist); and Dept. Tourism and Recreation - 1 seat.

RWC 8-20 members including seats for native bands, angler groups organized on a watershed basis, industries, major landholders, and government.

LWC similar to RWC structure with the addition of municipal representatives and other groups as applicable.

Mandate of the SFAB

The mandate of the SFAB is as follows:

- Guide the formulation of watershed management plans. While this will initially focus on fisheries management, it should be extended as soon as possible to include other resource plans.
- Advise on the adequacy of and the social & economic effects of government proposed changes in regulations.
- Recommend changes to regulations as needed to provide adequate resource protection.
- Identify areas or stocks that require special rehabilitation (e.g. habitat enhancement) or protection (e.g. temporarily stringent regulations).

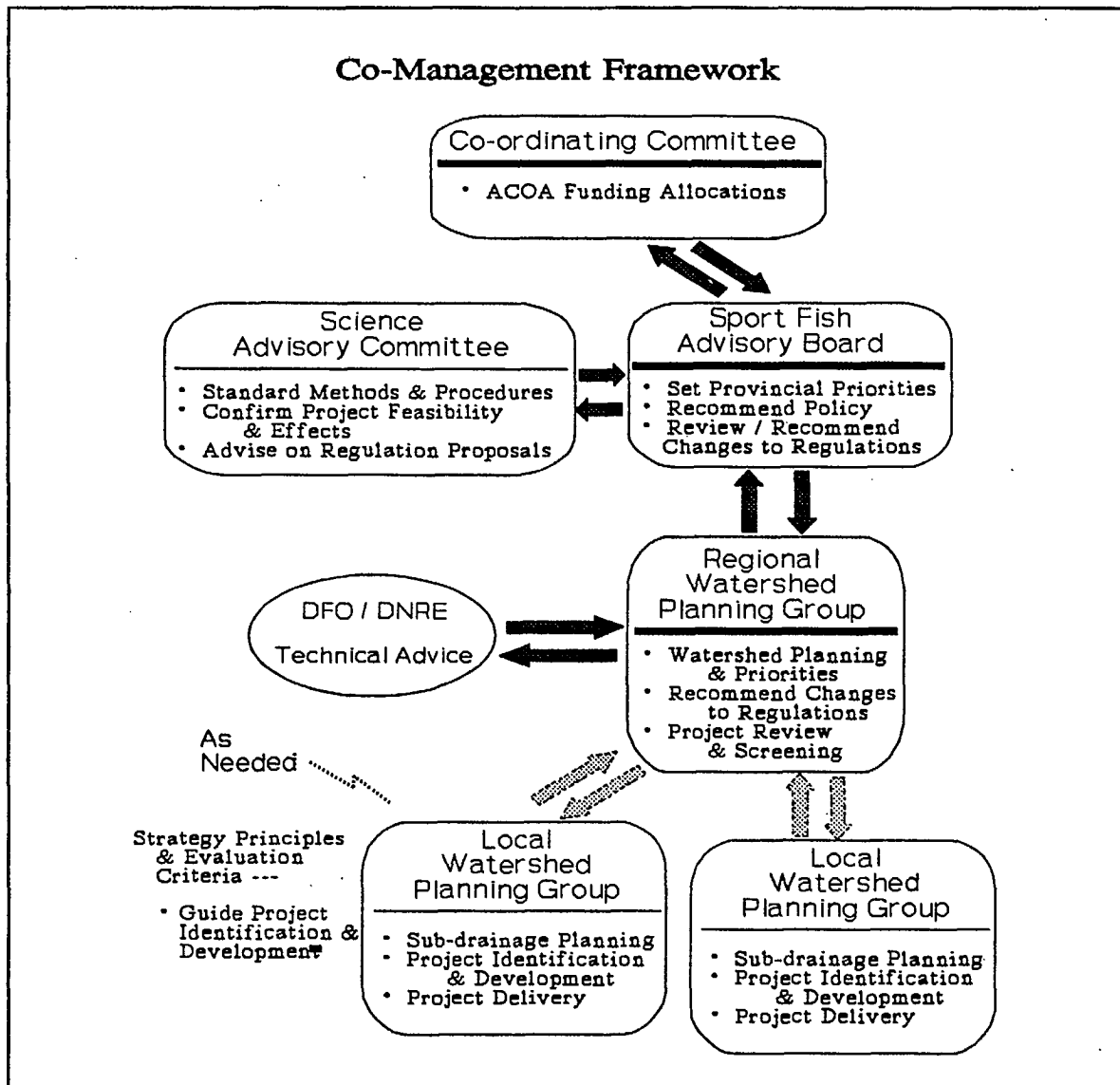


Figure 8 Overview of the Proposed Management Framework for New Brunswick Recreational Fisheries.

- Provide a formal vehicle for the communication of public concern regarding resource management (e.g. open public meetings should be held annually).

Implementation

There do not appear to be sufficient human and financial resources dedicated to the management of the recreational fishery. Virtually all of the management resources currently dedicated to the fishery are government. Non-government input to management is very limited.

Strategic Plan funds should be made available to cover travel and other costs associated with the conduct of the activities of the committees.

Funding should be allocated from fishing licence revenues; in the interim, specific funding allotments should be made from the Recreational Fisheries program and supported by additional commitments from the province.

The DFO, which has constitutional jurisdiction over coastal and inland fisheries and is responsible for the conservation of fish and the protection of fish habitat, appears to be allocating sufficient human and financial resources to the management of anadromous Atlantic salmon, but provides fewer resources for managing other recreational species such as shad, striped bass, rainbow smelt, and perhaps other species such as gaspereau.

The DFO should continue to provide scientific advice and play a lead role in the management of those species which it has agreed to manage under the draft Canada-New Brunswick MOU.

The DNRE has constitutional jurisdiction over private and public lands in the Province and the right to licence access to the sport fishery. The agency also has a proprietary interest in fish inhabiting waters on provincial Crown lands but does not have a clear mandate to manage the overall inland recreational fishery. Despite this, the DNRE is the principal agency involved in managing inland fish species in the Province (with the exception of sea-run Atlantic salmon). However, it has not allocated sufficient staff and/or funds to manage the inland fishery, either in the past or present. This is undoubtedly due to the absence of a clear mandate to do so. Few of DNRE's regional staff have been dedicated on a full-time basis to management of the fishery.

If, as proposed in the draft Memorandum Of Understanding (MOU) developed by the two agencies, the lead role in managing the inland recreational fisheries is formally retained by the DNRE, then the DNRE will need to allocate more staff and funds to fisheries management.

As a minimum, two biologists and two technicians will be required in each DNRE region.

Although it is often difficult for government agencies to justify additional expenditures of public funds, particularly in difficult economic times, the predicted benefits (see Section 3) to be derived from a well managed fishery should significantly outweigh the costs involved. As noted earlier, a doubling of the economic benefits to be derived from the province's inland and anadromous fishery appears both reasonable and achievable (i.e., from $\approx$ \$50 million under present conditions to $\approx$ \$100 million under optimal use). However, attainment of these socio-economic benefits requires adequate staffing.

A significant investment of time will be required to improve management. This will require both technical and financial support. The need will be greatest over the next few years

as agencies address critical management information deficiencies and enter into cooperative planning exercises with the public.

A long term commitment - not limited to the Federal-Provincial agreement - will be key to successful implementation of the Federal-Provincial Recreational Fish Strategy and the derivation of sustainable resource and socio-economic benefits.

The scientific expertise needed for sound management of the resource is concentrated primarily in government agencies or private sector firms.

Government agencies must provide essential technical support.

Until recently, there has been only limited consultation between personnel from the DFO and the DNRE concerning management of the inland recreational fishery. Furthermore, resource users have knowledge relevant to local conditions of the fishery and of social and economic objectives for resource use, but have had little input into management. Achieving conservation objectives will require the support of the community of resource users and a commitment by the agencies responsible for resource management. This may be best accomplished through the co-management framework, the SFAB and the regional and local watershed committees.

Committees must have a formal terms of reference. These should be formulated as soon as possible. These could be developed by the Sports Fish Advisory Board.

As requested by various native representatives, special efforts should be made to assist the native community to decide how they will choose to participate within the resource management framework.

In two or three locations, experimental application of an expanded mandate along the lines of the ZEC system used in Quebec should be undertaken to give greater authority to the ZEC management group to define and implement management strategies. Discussions between Quebec and New Brunswick should be initiated to encourage testing this experimental approach on large private holdings or in selected Crown waters.

4.3.1.2 Inter-agency cooperation

Until recently there was little formal co-operation or communication between the DNRE and the DFO concerning inland recreational fisheries.

A formal agreement needs to be developed between the DNRE and the DFO, defining their joint approach to fisheries management in New Brunswick.

There has been and continues to be uncertainty within the public/user groups and among agency staff about the responsibilities of the management agencies.

Clearly define, in a Memorandum of Understanding (MOU), the DFO's and the DNRE's responsibilities for the management of all recreational species. Ensure that the assigned responsibilities are reasonable in light of human and financial resources.

Once the MOU has been adopted, clearly communicate the responsibility and accountability of each agency to the public and to agency staff.

The two agencies plan to enter into an agreement and will sign a MOU as early as the spring of 1993. Such agreements can differ substantially with regard to their approach to defining management responsibility and the level of detail provided. A detailed document may be required in order to provide the clarity needed to make substantial gains in inter-agency coordination.

In this regard, it is recommended that the MOU should provide a significant amount of detail on the following issues:

- *joint management objectives;*
- *an overall approach to the allocation of responsibility between the two agencies (this could be achieved with a variety of different models - e.g. by function, by objective, by species grouping, etc.); and,*
- *mechanisms for implementation, especially a communications framework for consultation on resource management.*

The MOU should also establish a clear mandate and protocol for communication and collaboration at staff levels.

The policies of other government agencies may impact either directly or indirectly on the resource or its use. Without the explicit agreement and cooperation of those agencies (e.g. federal/provincial ministries of environment, tourism, highways etc.), elements of the strategic plan may either be frustrated or compromised.

Expand the MOU to include other government agencies whose policies may impact either directly or indirectly on the resource or its use.

The actions of resource shareholders also have the potential to affect the achievement of the goals of the strategic plan.

Therefore, the MOU could be expanded to include other resource shareholders, or separate but complementary multi-party agreements could be established among all shareholders (e.g. native bands, major land-holders, user groups, management agencies).

Reports of Atlantic salmon poaching to provincial crime stoppers programs have not always been forwarded to federal authorities responsible for management of this species.

Enforcement efforts should be coordinated between the two agencies. Authority to undertake these efforts should be delegated to field enforcement officers.

4.3.1.3 Develop Joint Management Objectives

In the absence of close cooperation between agencies in such matters as the development of watershed-specific fisheries management plans, each agency's management objectives within watersheds are sometimes in conflict.

Specific management objectives for fish communities within watersheds and sub-watersheds should be developed in consultation with resource stakeholders within the co-management framework. Further, management objectives should be consistent with the goals and principles of the strategy and should reflect the natural sustainable capacity of the resource.

4.3.1.4 Develop Watershed-Specific Resource Management Plans

For virtually all species except Atlantic salmon, there is insufficient information available to support rational planning. There has been little peer review or public consultation in the development of species management plans.

Clear escapement targets have been established for Atlantic salmon for all major salmon-producing systems. However, clear management plans which explicitly describe the management strategy in each system are not readily available. The degree of public involvement and/or consultation with other agencies (i.e., DNRE) in the management planning and target setting processes for Atlantic salmon is unclear.

In most parts of the Province, watershed-based, fisheries management plans for species other than Atlantic salmon have not been developed. Although some progress has been made in the development of management plans in several DNRE regions, these plans are not yet complete and the degree of public involvement into their formulation is unclear. Critical information needed to formulate rational management plans is lacking in all areas.

Most of the existing management plans for species other than Atlantic salmon are focused on individual species and do not explicitly consider community interactions. Further, they have not been integrated into comprehensive, watershed-based fisheries management plans.

We suggest that watershed management plans should be developed by the DNRE and the DFO in close cooperation with the regional watershed co-management committees (see also Section 4.3.1.1, pg. 68). Plans should be subject to broad public review at the local level, and to review by the DFO, the DNRE and the Sports Fish Advisory Board at the Provincial/Federal levels. These plans should be consistent with the goals and principles of the strategy and, by focusing on watersheds, should adopt an ecological approach to

management, rather than a single species focus. Guidelines for the preparation of fisheries management plans are available from other jurisdictions. In the short term, these watershed management plans may take the form of fisheries management plans. In the longer term, these plans should become integrated resource management plans.

Fisheries management plans need to be developed on the basis of natural bio-physical units such as watersheds/drainage basins (e.g., the Miramichi watershed) as opposed to artificial administrative boundaries. In most parts of the Province, watershed-based, fisheries management plans for species other than Atlantic salmon have not been developed. As needed, these plans should specifically address sub-watershed (e.g., river-specific) requirements.

Fisheries management plans should be based on the natural resource capacity and should contain scientifically rational estimates of resource potential. They should consider possible adjustments for revised access, sustainable harvest estimates, reduced harvest targets where necessary to rebuild stocks, and should contain recommendations for changes to regulations.

At the discretion of the Regional Watershed Co-management committees, watershed management plans can include provisions for the establishment of artificial fisheries, particularly in areas where the demand for fishing opportunities is expected to exceed the natural supply. However, in most areas, priority must be given to the conservation of wild stocks.

4.3.2 Increase Communication

There does not appear to be a strong sense of commitment to resource stewardship. Increasing the awareness of all parties of the value placed on the resource by other stakeholders is important to achieving the long term objectives for the New Brunswick recreational fishery.

In broad terms, the public has a limited understanding of the fundamental principals of fisheries management and of the strengths and limitations of fishery management techniques. This is reflected in an over-estimation of the value of stocking, and in a limited understanding of the concept of resource carrying capacities, the consequences of overexploitation, and the need for an ecological basis for management.

The following types of information need to be exchanged between stakeholders: the current status of the resource, user's aspirations and values placed on the resource, potential social and economic benefits of a sustainable resource, effects of human influence on fish habitats and the fishery, the biological basis for management and productive potential of the resource, and techniques for conservation.

This information exchange needs to be pursued in two ways: through formal communications and/or education programs (such as the Education and Public Awareness EPAP program of the Atlantic Salmon Federation), and through the direct exchange of information between stakeholders involved in local resource management.

Formal Communications/Education Programs

There is a need for education programs focusing on anglers, native groups, children, and the judicial system.

Communication and education programs need to be adapted to specifically focus on increasing the understanding of anglers, professionals within the judicial system, local interest groups and natives. These programs should provide the public with a basic understanding of how fish populations work (e.g. natural mortality rates, influence of habitat). Merely conveying an understanding of the need for conservation is insufficient - knowledge of the resource is essential for users.

The Education and Public Awareness Program (EPAP), initiated by the Atlantic Salmon Federation with the support of the Atlantic Canada Opportunities Agency, provides an established vehicle for communicating to a broad audience. The EPAP program has developed several teaching aids and packages for use in the classroom, a variety of posters to promote conservation and habitat rehabilitation and a broadly distributed news letter.

Additional materials on the current status of the resource, the need to reduce harvest through conservation fishing techniques and initiatives related to the strategy should be communicated through this forum.

Consideration should be given to increased use of television and/or radio to enhance communications.

Consideration should be given to the creation of an Education Advisory Committee which reports to the Sports Fish Advisory Board.

Existing education programs do not appear to have been widely vetted by key stakeholders, resource managers and biologists.

A greater opportunity for input to and review of educational materials should be provided to the Sports Fish Advisory Board, regional committees and other persons directed involved at the field level in delivering educational programs. All educational materials must be reviewed by biologists.

Direct Exchange of Information

While there are many groups throughout the province with a strong interest in the resource (e.g. Native bands, NBWF, ASF, tourist industry), communication between these groups has

been limited. In this climate, misunderstanding can persist and opportunities for useful collaboration are missed. While various user groups have much to offer, leadership is needed to establish a useful framework.

A mechanism is needed to foster the direct exchange of information specific to local management among stakeholders.

Agency Communications

Management agencies have not kept the public and other user groups adequately informed of the rationale for management decisions.

Agency personnel must ensure that the public is kept informed of the progress made in the Canada - New Brunswick recreational fisheries program, of management issues, of opportunities for the provision of input to management decisions and of the management decisions themselves.

Research personnel have not been effective at communicating new science to resource managers. Similarly, resource managers have not effectively communicated their research needs to science personnel.

Resource management and research personnel must be encouraged to communicate more effectively.

4.3.3 Increase the Knowledge Needed to Manage Effectively

4.3.3.1 Assessment

The DFO is responsible for coordinating assessment efforts for Atlantic salmon. However, the DNRE plays an important role in the management of Atlantic salmon. DNRE personnel are involved in the protection of stocks and habitat, and in stock, habitat and harvest assessment.

With the exception of Atlantic salmon, the fundamental information required to effectively manage the recreational fishery to provide sustainable social and economic benefits is not available. In particular, the basic information and tools needed to predict the effects of management actions on fish stocks and, in turn, the effects of changes in stock status on socio-economic benefits, are not available.

For most species other than Atlantic salmon, much of the available information on habitat, stock status, harvest rates and angler expectations is inadequate in that it is either anecdotal, out-of-date, or of questionable accuracy. The information that is available for Atlantic salmon is reasonably good, but better site-specific escapement information would be useful.

Specific information needs and the appropriate strategies for data gathering (e.g. habitat, stock and harvest assessment surveys) should be defined, for all species and areas, based upon technical requirements identified in a workshop setting. Information needs at the local level can be based upon the priorities identified through the regional watershed planning process.

Much of the information that has been collected on inland species and fisheries has not been collated and/or analyzed, and is not readily available to managers.

Collate, analyze and review the assessment information that is available. Distribute and/or communicate this information. Produce status report if warranted.

There do not appear to be any explicitly defined policies guiding the assessment and/or monitoring of fish stocks, angler effort and habitats.

A jointly-developed, federal-provincial policy on monitoring and assessment is required. Among other things, this policy should clearly define minimum assessment requirements and standards, agency responsibilities, and reporting requirements.

With the exception of some cooperative programs dealing with the assessment and management of Atlantic salmon, there are few cooperative programs focusing on other species.

To facilitate co-operative assessment, consideration should be given to identifying an "assessment coordinator" for all non-anadromous species. Coordinate assessment programs amongst agencies and others.

Standardized assessment, data handling and analysis methods and procedures suitable for application to the inland fishery are urgently required.

For priority species, standardized assessment methods, sampling protocols, survey schedules, and analytical techniques to guide the collection and analysis of habitat, stock and harvest data need to be developed. The development of rapid assessment methodologies for estimating the productive capacity of water bodies and for the identification of overexploitation is also required. Techniques or tools that have been developed elsewhere should be identified and, if appropriate, adapted to the needs of New Brunswick. These techniques and/or protocols should be subjected to peer review and, once approved, should be made broadly available throughout the Province. They should be developed in recognition of fiscal realities and analytical and information system requirements and capabilities.

Standardized but flexible information management systems such as database systems, geographic information systems, and analytical procedures and (software) packages

should be developed. Existing software and programs in other jurisdictions⁹ could be used. Solicit corporate support for equipment, as well as advice and access to products from other jurisdictions.

The DNRE's regional fisheries biologists, who play a lead role in the management of the inland fishery, have neither a clear mandate, nor the time to collect or the tools to analyze, management information.

Acquire the staff and funding resources needed to collect and analyze the required assessment information. Since new funds or additional (or re-allocated) staff may not be available in the long term, the public should be involved in the collection of assessment information. Training and quality control will be required.

Recognizing that better assessment information is essential to sound resource management, and that baseline data requirements could likely be met within a few years of intensive effort, a high priority should be assigned to initiatives which seek to use Strategic Plan funds to acquire these data. A coordinated, province-wide program is essential.

All staff involved in or supervising the collection and analysis of assessment information must be familiar with the standardized methodologies. Staff should be provided with the training in these methods needed to fulfill their mandateΦ.

Ensure that the staff responsible for data management and analysis have access to the proper equipmentΦ.

Standardized analysis and reporting requirements should also be developedΦ.

The "index river" assessment program for Atlantic salmon provides good quality information at reasonable cost.

This program should be expanded if feasible to address other important fish speciesΦ.

Comparable "index river" or "index lake" sampling programs are urgently required to ensure the cost effective collection of critical assessment and trend-through-time information for species other than Atlantic salmon.

Index sampling programs targeted to guide the collection of critical assessment for species other than Atlantic salmon should be adopted.

⁹ For example, the Ontario government has developed software/data management systems for (1) the local capture and analysis of field data, (2) a provincial fisheries information library, (3) a provincial fisheries data archive system, and (4) a fisheries data dictionary which identifies provincial standards for fisheries data. This software may be available at nominal fee or no cost. Some adaptation of the software might be required to make it suitable to the needs of New Brunswick.

The DFO's index program should be used to guide the development of index programs for other species. Progress in the use of index water bodies for the collection of critical assessment information in other jurisdictions, such as Ontario, should be reviewed.

4.3.3.2 Science

For some species, the scientific basis for management is not well understood. This is particularly true of species such as shad and striped bass, but is also true for many inland species such as brook trout and smallmouth bass for which resource carrying capacities and sustainable harvest rates are not well-established. In many cases, basic biological information is also lacking.

Science needs must be identified and prioritized. The Sports Fish Advisory Board should have significant input into this process. Research proposals should be subjected to peer review prior to their implementation.

Within the government sector, most of the research capability is housed within the DFO.

There are several non-government organizations in the Province, such as universities or the Huntsman Marine Science Centre, which are capable of conducting fisheries research.

The DFO should remain the principal agency responsible for research. However, partnerships should be established between the DFO and the DNRE, and with other institutions such as universities and the Huntsman Marine Science Centre, and/or with appropriately qualified user groups such as the Atlantic Salmon Federation.Φ

The DFO, Scotia-Fundy Region, should consider basing some science personnel in New Brunswick instead of Halifax, since accessibility is important.Φ

The DFO has historically dedicated, and continues to dedicate, virtually all of its research effort towards Atlantic salmon, and has/continues to dedicate relatively limited funds to other recreational species, whether inland or anadromous.

Although it has undertaken some studies, the DNRE has neither the funding nor the staff to undertake a research program directed towards inland species and fisheries. However, there are some urgent research needs.

As needed, the DFO should provide scientific support to the DNRE to address priority inland fishery problems. This should be recognized in the Canada - New Brunswick MOU. Consideration should be given to the identification of a Science Liaison Officer whose role it would be to provide an interface between the DFO's science personnel and the DNRE's biologists.Φ

There do not appear to be any explicitly identified policies and procedures for managing lakes and rivers with similar characteristics.

Develop joint management policies, including a policy on experimental management, as required.

Promote experimental management. Where possible and practical, involve the public in experimental management studies. For example, anglers could be involved in studies which examine the effects on stock dynamics of various harvest regulations.

Scientists need to communicate their messages more effectively, both to the public and to resource managers (see also Section 4.3.2, pg. 77).

4.3.3.3 Atlantic Salmon

Reasonable information is available on which to base management decisions for this species.

The scientific basis for management is relatively well-understood and assessment methodologies are reasonable. However, some important research questions remain such as the identification of the factors affecting ocean survival.

Providing that commercial harvests, both directed and incidental, can be controlled and/or eliminated, the stage is set for a substantial recovery of this species.

4.3.3.4 Trout and Smallmouth Bass

Effective management of these species is constrained by inadequate area specific information on stock status, habitats and harvest rates. In the absence of these data, reliable predictions of production potential and, in turn, potential economic benefits cannot be made.

In broad terms, the scientific basis for management is reasonably well-understood; these species are successfully managed in other jurisdictions. Directed research related to the development of management tools, the prediction of carrying capacities and responses to exploitation, is required.

4.3.3.5 Other Inland Species

The area specific information needed to effectively manage species such as chain pickerel and white and yellow perch is not available. In the absence of these data, reliable predictions of production potential and, in turn, potential economic benefits cannot be made.

The scientific basis for the management of these species is not well understood.

4.3.3.6 Alternative Anadromous Species

The area specific information needed to effectively manage species such as striped bass and shad on a sustainable basis is not available. Reliable assessment data and estimates of production potential do not exist. As well, basic biological information on stock dynamics, escapement requirements, habitat requirements, habitat use, and distribution and migration patterns are lacking.

The feasibility of predicting the potential socio-economic benefits that might accrue from the development of recreational fisheries for these species is constrained by the above limitations and by a limited understanding of potential angler interest in these species.

4.3.4 Allocation

4.3.4.1 Negotiate Agreements

The rising demands for sport fishing and back country recreation are placing increasing pressure on the fisheries. Consequently, there is a need to develop an allocation mechanism capable of maintaining harvests within sustainable levels and review access rights within different areas of the province. The most effective mechanism may be to negotiate mutual allocation agreements among the user groups in specific local areas.

The negotiation of mutual allocation agreements among user groups in specific local areas should be pursued through the recommended Co-management Framework (see Section 4.3.1.1, pg. ?)Φ.

4.3.4.2 Native/Non-native

Resolution of the allocation issue with the natives is urgent. The resolution of the allocation issue in a fair and just manner is fundamental to the successful implementation of the Strategic Plan.

Negotiate equitable allocation agreements with natives. Other resource users should be encouraged to participate in the negotiations, at least as observers. Members of the Core Team identified earlier in this report would be reasonable candidate participants.

Public education/awareness programs need to be initiated during this process, especially at the time of agreement.

4.3.4.3 Commercial/Recreational

By-catches and/or directed catches of important or potentially important sports fish species are affecting population levels of those species. Allocation of catches needs to be defined.

The problem of by-catches and/or directed catches of important or potentially important sports fish species must be addressed.

Resolution and/or prevention of existing/potential allocation problems for species such as striped bass or shad are required before allocation problems become serious and/or before some management programs (such as stocking) are initiated.

Strategies to reduce or eliminate the by-catch and/or directed catch of species such as striped bass and Atlantic salmon need to be adopted and monitored. This will require (1) changes to regulations, (2) the (re-) negotiation of allocation agreements, and/or (3) buy-out of some fishing licences.

The impacts of the remaining offshore interceptory fisheries on Atlantic salmon need to be assessed and quotas should be revised. If feasible, the commercial fisheries should be eliminated.

4.3.4.4 Amongst Anglers/Non-consumptive Users

Anglers hold conflicting views about the management focus in some areas. This is reflected by differences in species preference, and by disagreements over the appropriateness of certain management actions, such as those that affect the availability of certain sports fish to anglers. For example, most anglers who fish the Tobique system support the continued trucking of Atlantic salmon spawners from the Mactaquac Dam to the Tobique River; in contrast, some anglers along the Mactaquac headpond would prefer to see an effective fishway constructed at the Mactaquac dam so that spawners could be angled as they swim upstream through the headpond.

Conflicts amongst anglers should be addressed through the Regional Watershed Planning process in which aspirations for the local resources will be identified, and appropriate objectives and programs will be established.

4.3.4.5 Anglers/Other Resource Users

Conflicts have been reported between anglers and other users of the resource. For example, in some areas at some times of year, canoeists may interfere with anglers by paddling through prime fishing areas such as pools. Although this is undoubtedly true, it is likely that canoeists would perceive the problem somewhat differently. Recognizing that both resource users have essentially equal rights to use the resource and that both forms of recreation

provide social and economic benefits, creative solutions to this kind of allocation problem must be found. Solutions may best be found through consultations between such groups.

4.3.5 Increase Fishing Opportunities

This component of the strategy directly relates to the underlying goal to provide increased economic benefit to New Brunswick through the wise use of its recreational fish resources. Most of the strategic initiatives support this goal, although indirectly through their contribution to healthier stocks. There are, however, several actions which can be taken to directly address this goal.

4.3.5.1 Negotiate Access Agreements

Physical access to water bodies has increased dramatically in recent years as a result of the construction of logging roads, the increased use of off-road vehicles, more leisure time, etc. Despite this, angling in some areas remains limited by the lack of boat launching facilities.

Access to angling opportunities in the Province is limited due to private ownership of large tracts of land, riparian rights which restrict fishing along some water bodies, and the Province's crown reserve and crown lease systems. While some resource users feel that the current land tenure system is unfair, it has played an important role in protecting the fisheries resource.

The land tenure systems, specifically that system which established riparian rights should be reviewed, and the crown lease and crown reserve systems should be re-evaluated.

Further, the ability of anglers to access high quality angling experiences has declined over the past few decades as a result of changing demographics, such as the increased human population, leading to more anglers, and reduced fish stock levels.

There appears to be significant potential to increase angling opportunities through the negotiation of agreements to allow fishing on some private lands and/or through ZEC-like arrangements in other areas.

A watershed or regional review of the current mix of access options could identify opportunities for increased access to fishing and, in turn, opportunities to enhance social and/or economic benefits. Several broad types of options, each with a number of variations, could be considered. By combining these options and/or option variations in different ways, it may be possible to generate a relatively large number of potential solutions for increasing access in each target area.

Increasing the total area in crown reserves (by conversion from crown closed) could provide additional quality fishing opportunities. Alternatively, agreements might be struck

with local angling groups to manage currently closed crown areas for publicly accessible fishing. By managing such areas on a catch and release basis, impacts on stocks could be minimized.

Similarly, agreements with large land holders could increase fishing opportunities. In one case, the Fraser Company has already developed a management plan for a limited access fishery (see also Section 3.5.7, pg.62).

The development of outfitter operations on large blocks of private land should be promoted. These operations could provide economic benefits to the landowner, the outfitter and others, while providing social benefits in the form of a high quality angling experience in a restricted access fishery. Conservative regulations should be adopted to minimize the risk of overexploitation.

Access could be increased to some presently-closed areas, while protecting stocks, by allowing catch and release fishing only.

Promote the adoption of open or limited-access fisheries on some private lands, where anglers pay a fee to the landholder for the right to fish. Conservative regulations including (but not limited to) hook and release, should be adopted to minimize the risk of overexploitation.

4.3.5.2 Regulatory Changes

Some opportunities may exist for increasing fishing opportunities through season extensions (e.g., the fall salmon and/or spring kelt fishery in some waters), or by opening some waters which are presently closed to certain types of fishing (e.g., at present kelt fishing is not allowed on the Restigouche and Nepisiquit rivers).

Opportunities for increasing fishing opportunities through the above-described or similar mechanisms should be explored. However, recognizing that the first priority of managers is to ensure that conservation requirements are met, changes may not be desirable in many water bodies. Proposals for change should be approved at the local level and channelled through the SFAB.

4.3.5.3 Use Put (Grow) and Take Fishing Opportunities

Privately and/or publicly operated put (grow) and take fisheries are growing in importance, particularly near urban centres.

In order to meet the apparent demand for angling opportunities near urban centres, and to relieve pressure on natural fish stocks in those areas, privately-owned and/or

government-operated put (grow) and take fisheries should be promoted. The growth potential, i.e., demand, of these types of fisheries will have to be assessed.

In recognition of the public's strong preference for fisheries based upon natural production, as identified during the public consultation process, put (grow) and take fisheries should, as a first priority, be established in self contained ponds or reservoirs where the risks to natural fish communities are minimal.

Put (grow) and take fisheries should be allowed only in natural waters: 1) if the establishment of such fisheries is consistent with principles, objectives and implementation strategy as described in the regional watershed fisheries management plans; and 2) if the potential environmental risks have been evaluated and are deemed acceptable by the Regional Watershed Committee and the Sports Fish Advisory Board. In addition, the other criteria identified for screening proposed actions under this strategy should be applied to such initiatives (see Section 5.2).

4.3.5.4 Rehabilitate Native Fish Stocks

Based upon an assessment of historical stock conditions and stock potential, and upon a review of the 5-year reviews of sport fishing in the Province, it is clear that there is considerable potential for increasing the social and economic benefits that are derived from the resource.

According to the recreational fishing surveys, angling effort for the most commonly sought species (brook trout) has declined in recent years. This decline can be attributed to the depleted condition of populations. Interest in most other species is stable or increasing.

Rehabilitate degraded stocks. Priority should be placed on rehabilitation through regulation. Secondary focus should be on stocking and/or habitat restoration where the potential benefits can be predicted and are sufficiently large to justify the expenditure of funds. (See also Section 4.3.6).

Manage sustainably. Estimate productive capacity of water bodies, set conservative regulations, monitor catches and stock status, modify regulations as required.

4.3.5.5 Use Previously Unexploited Fish Species

There are a number of previously unexploited species which appear to be capable of supporting a considerable amount of angler effort.

Alternative species should be promoted to increase fishing opportunities and relieve fishing pressure on over-harvested species. Management strategies and practices in other jurisdictions should be critically examined for ideas and strategies.

Before promoting alternative species, regulations should be strengthened, and stock and harvest monitoring programs need to be adopted to ensure that stock stress is detected before serious problems arise.

Inland Species

There appear to be significant opportunities to increase the sustainable socio-economic benefits from certain inland fish species (smallmouth bass, chain pickerel, etc.). However, in the absence of better information, the promotion/marketing of these species should proceed cautiously.

Promote increased, sustainable utilization of inland species. This will require a detailed review of the regulations for each of these species. Some regulations may require strengthening.

Stock and harvest monitoring programs should be adopted to ensure that stock stress is detected before serious problems arise.

Alternative Anadromous Species

Accurate assessment of the potential economic benefits that might result from the development of recreational fisheries around species such as striped bass and shad is seriously constrained by the lack of information. However, using the best information available to estimate potential production of species such as striped bass and shad, and comparing this with the socio-economic benefits that have been derived from these species in the U.S., it appears that there is considerable economic potential in developing recreational fisheries for these species. However, in the absence of better information, the promotion/marketing of these species should proceed cautiously.

Promote, through regulation and other means, the recovery of shad and striped bass populations. Tighten existing regulations for striped bass and implement new regulations for shad.

Critically examine management strategies and practices in other jurisdictions. Use this information to set reasonable targets, catch limits, etc., to be adopted in new Brunswick during the stock recovery phase and once stocks have recovered.

Cautiously promote the development and/or expansion of striped bass and shad fisheries. Marketing efforts could focus on the northeastern U.S.A.

Stock and harvest monitoring programs should be adopted to ensure that stock stress is detected before serious problems arise.

4.3.6 Reduce Harvest to Sustainable Levels

4.3.6.1 Employ More Stringent Regulations

With few exceptions, the principal cause of fish stock depletion in New Brunswick is over-exploitation, either in the recreational fishery (e.g., brook trout, sea-trout) and/or in the commercial fisheries (e.g., Atlantic salmon, striped bass). Unfortunately, in the absence of better data, it is not possible to determine the degree to which other factors such as habitat degradation, or increased angler effectiveness as a result of the availability of improved gear, have also affected stock size. However, the general view among most fisheries managers in the Province is that these factors are not the major cause of stock decline.

At present, Atlantic salmon stocks are not being over-exploited in the recreational fishery. However, overexploitation remains a problem in other recreational fisheries, most notably in brook trout and sea-run trout stocks. There are also signs of over-exploitation in some warmwater fisheries. For example, the gradual reduction in the mean size of smallmouth bass from some populations is a clear indication of stock stress.

It can therefore be concluded that past regulations, or their enforcement, have not been sufficiently stringent for most species.

In the absence of good information on stock status and allowable harvest rates, but where professional staff involved in resource management suspect that regulations are too liberal, the regulations should be made more conservative so as to minimize the risk to the resource. It should not be considered acceptable to wait until all the required data have been collected to establish conservative regulations.

Prior to the adoption of the "consolidated regulations" (see below), the process for revising regulations has, historically, been cumbersome and slow. There was a strong sense among some staff that recommendations for changes to the regulations originating from the field were often not acted upon. The effect was that the adoption of appropriately stringent and area-specific regulations was hindered.

The newly released Maritime Provinces Fishery Regulations known as the "consolidated regulations", (Canada, undated) represent a significant advance over the previous regulations because (1) the variation order process has been changed leading to a considerable increase in flexibility, and (2) seasons and size and bag limits can now be varied to meet local needs. Despite these advances, some deficiencies remain. To be fair, however, it should be noted that the terms of reference which guided the preparation of the "consolidated regulations" prohibited major changes. The major deficiencies are

- For some species, such as brook trout, the new catch limits may not be sufficiently stringent to reverse stock declines or to permit stock recovery even though they may be considerably stricter than the previous catch limits. For example, halving the catch limits for a given species from 10 fish/day to 5 fish/day will not prevent continued exploitation of a fish stock if the average angler is only able to catch 4 fish per/day since the new catch limit is still greater than the average angler's catch. More stringent regulations are urgently required.
- Other species, such as shad, remain unregulated. All species of recreational interest must be regulated even if the risk of over-exploitation is low. The lack of season and/or catch limits on a species confers a sense of "low value" to the species. Revisions to the regulations are required.
- Other species such as chain pickerel and white perch are only partially regulated - they have season limits but no catch limits. Even though angling pressure on these stocks may be very limited and they face little risk of over-exploitation in the near term, catch limits should be adopted.

The consolidated regulations should be revised on an area-by-area basis, as soon as possible to make them more stringent (e.g., brook trout), and to expand their scope to include the provision of limits on species that are presently unregulated (e.g., shad) or for which there are no catch limits (e.g., sturgeon, white perch, chain pickerel).

Prior to submission for approval, revised regulations need to be subjected to peer review by provincial biologists and enforcement staff, and by federal science and enforcement staff.

Considerable dissatisfaction was expressed regarding the lack of public input into the development and review of the "consolidated regulations".

The revision of the "consolidated regulations" needs to be undertaken in consultation with the users of the resource, resource managers and the Sports Fish Advisory Board.

A carefully-planned information/public education program is required during the revision process.

A greater emphasis should be placed on managing the demand side of fisheries rather than simply being concerned with supplying more fish. Conservation fishing is one tool that can be effectively used in some situations to reduce the effect of angling on fish stocks (Johnston 1986). In his report, Johnston noted that in some parts of Canada, outfitters, who have a vested interest in ensuring the sustainability of fisheries over time, are strong proponents of non-consumptive angling.

Consider increasing licence fees so that fees are more in line with the value of the resource. Since the willingness of many anglers to pay higher licence fees is contingent

upon allocation of any additional funds to the management of the resource, and since a mechanism to dedicate licence revenues to the management of the fishery (i.e., to DNRE) does not exist, consideration should be given to establishing a "fish stamp" or similar program. Funds generated from the program could be kept separate from the regular licence revenues and their use could be controlled by the Sports Fish Advisory Board or some other non-government organization.

Emphasis should be placed on hook and release fishing in some water bodies.

Consideration should be given to the development of a "conservation licence" for those anglers who are interested in the angling experience but who agree to release their catches.

Upon completion of the regional watershed planning process, revise regulations as necessary.

In the absence of good data on the status of stocks, harvest rates, and sustainable harvest levels, regulations must be conservative.

4.3.6.2 Protect, Restore and Create Fish Habitat

The amount of fish habitat that has been destroyed, altered or degraded as a result of a variety of land use practices including logging, mining, industry, agriculture, dams, urban development and road construction, has not been accurately quantified, although it is thought to be significant.

Habitat destruction, alteration or degradation has contributed to the decline of some fish stocks; however, the principal cause is over-exploitation. Habitat alteration (via the construction of dams and headponds) is the principal cause of decline of some stocks (e.g., Atlantic salmon and striped bass in Saint John River).

There is a great deal of interest in habitat restoration. A considerable amount of effort and funds have been expended on restoration projects. Some projects have been successful, but others have not.

It is essential that habitat survey techniques and analysis and data management systems be standardized, and that habitat restoration guidelines or manuals be adapted or developed.

Habitat restoration is expensive, and habitat restoration projects could easily use up all of the Strategic Plan funds. The benefits from restoration initiatives can be sustained if and only if the causes of habitat degradation are addressed, and if projects receive multi-disciplinary input when required. Failure to address either of these will lead to failures or, at best, short-term benefits.

The magnitude of the benefits resulting from habitat restoration projects is highly variable and needs to be clearly identified when projects are proposed.

Land use practices have improved in recent years, and the rate of habitat destruction is thought to have declined.

Some previously degraded habitats are recovering naturally; others are not.

Better information and planning, and improved science is required. Training, at all levels, is essential.

Most habitat restoration projects undertaken in the Province have been managed by biologists, yet many habitat restoration projects require input from both biological and physical (e.g., water resource engineering) disciplines if they are to be successful in the long term.

Most habitat restoration projects have been conducted without clear predictions of resource benefits. For example, most projects have been undertaken without knowing if the targeted fish populations were habitat-limited and, if so, which life stages.

Few habitat restoration projects have been properly evaluated.

High quality guidelines are available from other jurisdictions, and some of these could be adopted for use in New Brunswick without requiring significant modification to "fit" the conditions in the Province.

The prediction of resource benefits of habitat restoration projects is difficult. Predicting the economic benefits that accrue from them is more difficult.

Determine information needs. These should be adapted to local needs and conditions.

Standardize habitat survey techniques as well as analysis and data management systems.

Conduct surveys focusing initially on priority areas.

Identify high priority areas for protection, such critical spawning, nursery and/or holding habitats.

Identify high priority areas for habitat restoration.

Develop/adopt habitat restoration guidelines/manuals. Do not re-invent the wheel.

Restore high priority habitats.

The potential ecological and socio-economic consequences of habitat creation/range extension projects such as the Grand Falls fishway must be subjected to an environmental

assessment. All federally regulated or funded projects (such as those funded through the Strategic Plan) must follow the Environmental Assessment and Review Process (EARP). All such projects should be reviewed and recommended for approval by the Sports Fish Advisory Board prior to implementation.

4.3.6.3 Increase Compliance with Fishing Regulations

Changing attitudes is the most effective way to increase compliance with existing regulations. This can be accomplished through

- education programs aimed at user groups including natives, the general public, school children, and others;
- education initiatives directed at the justice system; and
- consistent application of penalties.

Under the Aboriginal Fisheries Strategy, native guardians will play an increased role in enforcement.

The lack of stringent regulations on some species, in combination with the inadequate penalties, has resulted in low social values being attached to some species.

Fines for poaching of some species support the notion of low value.

Legislation and regulations regarding the adequacy of penalties, the existence of minimum penalties, and the enforceability of regulations should be reviewed, and penalties should be increased where required.

There appears to be an inadequate level of coordination of enforcement effort between the DFO and the DNRE.

Improve coordination and cooperation between federal and provincial enforcement personnel.

Increase the visibility of enforcement efforts and enforcement personnel. In particular, publicize cases and fines.

Promote programs which encourage anglers to be self-policing.

The DNRE has few if any enforcement personnel dedicated solely to the fisheries.

At the provincial level, dedicate a specific number of enforcement personnel in each region to the fisheries.

Compliance with regulations appears to be relatively high in controlled access situations such as Crown Lease and Crown Reserve waters. Abuses of regulations are more common in open access areas.

Where possible, the public's support or active involvement in enforcement should be encouraged. Programs such as the volunteer River Watch program should be expanded.

Innovative management systems which increase the number of (non-government) enforcement personnel within an area are needed. This might allow re-allocation of government enforcement personnel to other areas.

A ZEC-like system could be adopted on an experimental basis.

4.3.6.4 Use Selective Stocking Programs

The DFO appears to have made, and continues to make, judicious use of stocking as a management tool. All stocking programs undertaken by the federal government are directed either to accelerate the recovery of depleted Atlantic salmon stocks, primarily in the Restigouche and the Miramichi river systems; or to compensate for the loss of productive capacity in the upper Saint John River system resulting from the construction of the Mactaquac dam. The DFO does not support sustained stocking once targeted stocks have recovered. The most significant deficiency in the DFO's stocking program has been the limited assessment.

The DNRE appears to have placed a heavier reliance upon stocking than has the DFO. The DNRE's stocking programs have been aimed at accelerating the recovery of depleted stocks, creating new/different angling opportunities in selected areas, and supplementing stocks in areas experiencing high angling pressure. Concern was expressed that some historical stocking programs were undertaken without adequate consultation with DNRE regional staff, and that in recent years, some stocking initiatives have been undertaken in response to pressure from angling groups or prior to the establishment of reasonable bag limits. Additional concerns were expressed over the stocking of hybrids, the stocking of private waters, the lack of assessment and, in some cases, the absence of public input into local stocking plans.

While selective stocking programs will accelerate the recovery of depleted stocks, there is a need to develop a joint federal-provincial policy on the use of hatchery fish.

Stocking or introduction programs involving exotics should be discouraged.

Review and, if required, revise the federal and provincial stocking policies and protocols. Integrate into joint federal/provincial policy/protocol documents.

- *this review should be coordinated through the SFAB,*
- *all relevant government agencies should be involved, and*
- *the policy must be consistent with the strategic plan.*

Proposals to transplant species within the province should be subject to rigorous review and should originate from the regional watershed co-management committees. Reviews could be coordinated by the SFAB and should involve technical specialists.

The intent, expected duration and expected benefits, both resource and socio-economic, of all stocking programs should be explicitly identified.

Historically, assessment of the success of stocking programs has been inadequate. Monitoring is now required for federal stocking programs. No such requirement exists for provincial stocking programs.

There needs to be a commitment to evaluate the effectiveness of stocking programs. Where it is not feasible to evaluate the effectiveness of all stocking programs, evaluations should be conducted at index sites.

Public participation in assessment should be required since the public, through its participation on the regional watershed coordinating committees, will have been involved in the formulation of, and will benefit from, the fisheries management plans.

There is a perception within the general public, within some native communities, and within the membership of some organized user groups, that stocking is the most effective solution to the lack of fish. Over-exploitation of a finite resource does not appear to be widely recognized as a cause of stock decline.

Education programs are required to increase the public's understanding of the role and risks of stocking.

The public must realize that there are limits to natural production.

Promote put and take fisheries on an as-required basis near urban centres as a means of increasing local fishing opportunities.

5.0 Strategy Implementation

5.1 PRIORITIES

The goals, principles and components of the strategy outlined in Section 4 were reaffirmed by participants at the strategy review and implementation workshop. While some of the strategic initiatives were identified as being difficult to achieve (e.g. to increase or rationalize access), none were discarded as unimportant or inappropriate. A small number of actions, however, were identified as being fundamental to achieving the goals of the strategy for deriving long term sustainable economic benefit. These actions are:

1. establishing a multi-user framework for cooperative resource management; and
2. increasing public and management agency understanding of both the state of the resource and the actions needed for its rehabilitation.

The essential minimum set of steps needed to implement the strategy include:

1. Forming and enabling the proposed co-management framework.
2. Within the co-management framework, begin the development of watershed-based fisheries management plans. This in turn requires
 - identifying critical information needs for managing the fisheries at the watershed level (also at the Provincial scale), and
 - identifying and ranking critical actions for the restoration of targeted fisheries in each area.
3. Using the best information currently available, modify regulations in each area, as required, to ensure a high level of resource conservation.
4. Initiating education/training programs aimed at anglers, natives, the judicial system, school children, and industry (e.g. farmers, loggers).

Initiatives #1 and #2, above, will enable the identification and selection of specific project proposals for funding under the Cooperative Fisheries Agreement. A discussion of the actions and strategies needed to implement the strategy may be found in Section 4.0.

5.2 EVALUATION & SELECTION OF DEVELOPMENT INITIATIVES

The Canada-New Brunswick Cooperative Recreational Fisheries program will work in direct partnership with resource users to achieve a sustainable rehabilitated fishery. In doing so, some of the program funds will be allocated to support initiatives proposed by various user

groups throughout the province. The total amount of funding within the program is substantial. The New Brunswick recreational fishery, however, is based not on just one stock or even one species but on a variety of species and stocks dispersed throughout the province's lakes and rivers. In this context, it is reasonable to expect that there will be much more that could be done than can be done with the available funds. Therefore it is likely that the people who implement the program will be faced with the difficult task of having to choose to support one good project over another. Should this be the case, the objectives of the approach to selecting between alternative proposals are to ensure:

- projects supported are consistent with the strategy (outlined in section 4 of this report);
- the need for a proposed project is clear and directly relevant to the improvement and/or future management of the fishery resource;
- the action proposed represents an appropriate, cost effective and sustainable approach to addressing the need;
- if supported, the action can and will be successfully implemented; and
- alternative projects are subjected to a fair, unbiased evaluation.

To meet these objectives, the process of project selection will involve evaluating each project proposal against a series of eight criteria developed during the strategic planning process.

5.2.1 Project Evaluation Criteria

The following eight criteria have been developed as a part of the strategy development process. They are intended to both guide proposal development and to provide a basis for the unfortunate but likely necessary exercise of deciding how best to allocate available funds among the wide variety of anticipated proposals. These seven criteria have been adopted from a larger initial set of criteria developed immediately following the strategy design workshop. A trial application of criteria to sample proposals during the second stage of the strategy review and implementation workshop (section 1.3.3, ?) confirmed the usefulness of the criteria in proposal analysis. The experience gained in this trial application indicated that the criteria may be particularly useful, not simply as a basis to accept or reject a proposal, but more importantly as a mechanism to help identify important changes to proposals needed to ensure that the project undertaken will maintain high value initiatives consistent with the goals of the strategy.

- 1) *Consistency with the Strategic Planning Principles* - The criterion is met if the proposed initiative is consistent with the principles that form the foundation of the strategic plan. This criterion is **mandatory**, and failure to meet it will lead to a proposal's rejection.

- 2) *Multi-User Planning Group* - This criterion is satisfied if the proposed project reflects the interests and/or concerns of multiple user groups. This criterion would be met whenever a proposed project is identified by a multi-interest, sub-watershed planning group preferably composed of representatives from all user groups within a watershed, including native people.¹⁰ This criterion is **mandatory**.

Where a formal local watershed planning group does not exist, this criterion may be met if the project sponsors have contacted all potentially affected users / stakeholders and involved them in developing the project proposal.

In addition, projects that will support the development of a multi-user local watershed planning group meet this criterion.

- 3) *Planning context* - This criterion means that the need for a proposed project within a watershed or sub-watershed is clearly understood. Both the need for action and the merit of the proposed action should be evident. Hence, in order for this criterion to be met for projects which propose physical interventions such as habitat alteration, fish stocking or rearing, the determination of need and appropriate action should be based upon a current assessment of the state of the resource. For example, for habitat restoration projects, the type of habitat limiting production should be known, since the problem may be over harvesting, rather than habitat limitations.

Wherever the current understanding of the state of the resource is insufficient, this criterion can be met by projects that will provide the information needed to determine the most appropriate course of action.

- 4) *Positive Benefit-Cost Ratio* - This **mandatory** criterion is met if a proposed initiative has a positive cost-benefit ratio (i.e. the future economic benefits of the project are greater than the costs required to implement and sustain it). Performing the required cost-benefit analysis requires an explicit prediction of *both the project costs and the likely socio/economic benefits*. Predicting future economic benefits will only be feasible if the information needed to develop a reasonable prediction of resource effects is available. Criterion (3) is therefore essential to permit the necessary cost-benefit analysis to be completed.

Proposals that meet this criterion will have a sound project design and must be feasible to implement on the basis of available technology, local capability and funding requirements (both short and long term). One way to ensure project feasibility is to involve people with appropriate technical expertise in designing the proposed project.

¹⁰

This requirement applies to all groups (e.g. natives, salmon federation, governments) irrespective of primary proponent.

Technical staff from both DFO & DNRE (e.g., regional biologist, conservation officers) and/or other sources of expertise (e.g. Atlantic Salmon Federation specialists) should be consulted during the scoping and design of a project proposal. When needed, resource persons should be consulted during project implementation. For example, a proposal that involves habitat restoration should seek advice from advisors with appropriate expertise and/or specific training in hydrological engineering. (There is a natural tendency for intelligent people who are experts in one discipline to assume they are also proficient in another. Unfortunately, this is rarely true.)

In the context of local capability, proposals that meet this criterion will have a reasonable scope of activity. For example, where neither a multi-user planning framework nor the needed resource information are available, a project proposal with a long term vision that was limited to taking critical first steps in the planning process would be considered feasible. Another more ambitious proposal that proposed to do everything at once would likely be seen as having questionable feasibility and hence a doubtful cost-benefit.

For proposals that involve promotion of presently under-utilized resources (e.g. alternative stocks/species), a management plan to ensure that the stock/species does not become over harvested will be an essential component of meeting this criterion.

- 5) *Capacity development* - This criterion will be met by projects that will increase the capability of the proponent(s) to contribute to resource management. For example, a project designed to provide training to resource stakeholders in appropriate methods for habitat assessment or enhancement would meet this criterion. Similarly, this criterion is likely to be met by projects which include relevant training within a broader project context.
- 6) *Increased/awareness* - This criterion would be met if part or all of the proposed project will lead to an increased public awareness of the state of resource, resource needs and/or the need for a planning framework within the community. To meet this criterion, however, it is insufficient simply to include a public information component in a project proposal. The content of the information is critical to the application of this criterion. In particular, the message conveyed must be consistent with the reality of the local context. For example, a project that proposed stream-side rearing and promotion of this technique in an area where it was not needed for rehabilitation or where the need was not known, would be deemed to fail this criterion. Conversely, one which did so in an area where this type of intervention was necessary would be consistent with the intent of this criterion.
- 7) *Project Funding / Continuing Commitment* - To satisfy this criterion, proponents must have secured additional sources of funding to support the initiative in addition to funds requested from the Canada-New Brunswick Cooperative Recreational Fisheries

Program funds. As a general guideline, not less than 20% of the total project cost should be sought from the Cooperative Agreement funds.

This criterion is **mandatory**. However, it may be waived, or the stipulated proportion of additional funds may be reduced for projects that will enable the creation of a multi-user local planning group.

This criterion is further satisfied when there is a long term commitment by the proponent(s) to continue to improve and contribute to the management of the resource. Depending on the nature of the proposal, specific plans for the long term maintenance and operation of a project would be required to satisfy this criterion.

- 8) **Project Monitoring** - Proposals should include a commitment to assess both the project's impacts on the resource as well as the project's economic return. This criterion is intended to provide useful information for improving the capability to make future predictions of project impacts.

Although only four of the criteria are designated as mandatory, all eight criteria will be employed in the evaluation of project proposals. It is not mandatory that a project satisfy all eight criteria. Projects that are consistent with many criteria are likely to be assessed as having greater merit than those that meet fewer criteria, however the assessment of greater need for a proposed project could lead to it's selection over one that rated highly against more criteria.

Although the criteria are intended to be used primarily for screening individual projects, they may also be applied to the evaluation of other types of initiatives or programs (e.g. policy analysis) proposed to improve the New Brunswick recreational fishery.

5.2.2 Estimating the Net Benefit of Proposed Initiatives

One of the mandatory project evaluation criteria (section 5.2) requires that each project supported under the Canada-New Brunswick Recreational Fisheries Agreement have a positive net benefit value. This is necessary to ensure that money spent by the program are not wasted on efforts that would not lead to increased economic benefit for the people of New Brunswick.

The basic rationale for net benefit analysis is not at all complicated. In its simplest form the rationale is merely that doing something which has higher costs than benefits is not a good idea; conversely, it is a good idea to do things which will yield benefits greater than their cost. A more rigorous application of this basic idea simply takes it one step further, that it is a better idea to do something for which the excess (net) of benefits over the costs is greater than some alternative for which this excess is less.

Estimating a projects benefit-cost value can be thought of as requiring three simple calculations

$$\text{Total Costs} = \text{Startup Costs} + \text{Operational Costs} \quad (1)$$

$$\text{Incremental Benefits} = \left(\frac{\text{Total Direct Benefits} + \text{Total Indirect Benefits}}{\text{With Project}} \right) - \left(\frac{\text{Total Direct Benefits} + \text{Total Indirect Benefits}}{\text{Without project}} \right) \quad (2)$$

$$\text{Net Benefits} = \text{Incremental Benefits} - \text{Total Costs} \quad (3)$$

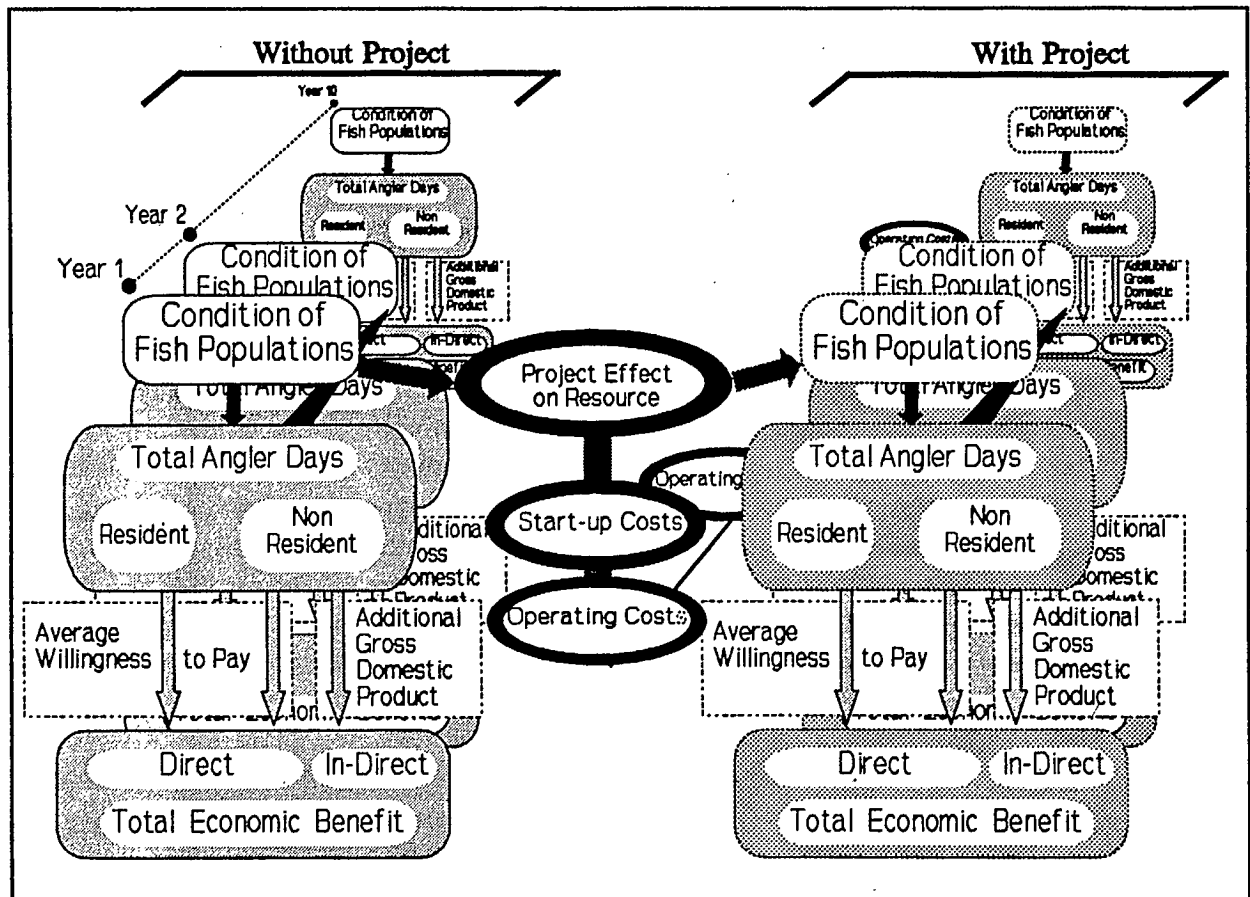


Figure 9: Basic form of *benefit-cost* analysis for proposal evaluation.

Figure 9 provides a pictorial illustration of the form of this basic benefit-cost analysis. Project costs typically exceed project benefits during the first year (or years) following a project's implementation, *Total Costs* (1) and *Incremental Benefits* (2) are usually summed over an evaluation period of several years (e.g. 10 years). The *Net Benefit* (3) on which a project is evaluated, therefore, does not reflect the excess of benefits over costs in just one year but over the entire period of evaluation. When the necessary information about the project costs and benefits is available, these simple calculations do not require much effort.

Obtaining the information needed to complete them can be more difficult, especially the task of estimating benefits.

Projects supported under the *Sustainable Resource Development* component of the Recreational Fisheries will be those which will lead to increased economic benefits by improving the condition of the resource. Figure 9 illustrates two alternative futures: the one on the right includes the project effects and hence corresponding costs and benefits of a proposed project; the one on the left illustrates the resource condition and benefits without the project.

In each case, a series of both direct and indirect annual economic benefits accrue from the number of resident and non-resident angler days. The method for calculating these benefits has been described earlier in Section 1.4, pg 11, and in Section 2.3.2, pg. 22. A detailed template for calculating socio-economic benefits attributable to fishing in New Brunswick is presented in the next section.

Figure 9 further illustrates the commonly accepted phenomenon that fishing effort (angler days) also affects the future state of the resource. Since anglers prefer to fish where the quality of fishing is high the state of the resource clearly influences the number of angler days. The amount of fishing however depends not just on the actual resource condition but also on the anglers' *perception* of fishing quality. For example, it is possible for stocking or habitat improvement projects to produce a greater short-term change in anglers' *perception* of improved resource condition than actually occurs. When this happens the resulting increase in angling based on an incorrect perception of improved resource condition will most likely lead to further resource degradation. Consequently predictions of economic benefit based solely on prediction of change in the number of angler days can lead to inappropriate decisions since real short term benefits can be lost due to the longer-term impacts on the resource. Calculating the net-benefit of a project over a series of years helps to identify such situations, but only if the analysis is based on realistic estimates of the actual short and long-term effects on the resource.

5.2.3 A Template for a Benefit Cost Analysis

5.2.3.1 Prediction of Resource Benefits

What Do We Need to Predict?

To be able to say anything meaningful about whether a fishery is sustainable we must understand the balance between the annual production (addition) of new fish to the population and the total annual mortality. Although the interactions that determine the actual mortality rate for a population can be quite complex, the basic concept is very simple. Over the long term, any population for which the average (total) annual mortality exceeds the populations' average annual production simply can not be sustained. Conversely, it should be possible to maintain long term sustainable harvest (and associated economic benefit) from a population

as long as the average (total) annual mortality remains within the productive capacity of the resource. Therefore, to predict whether future economic benefits will be achieved by some proposed management action or project, we need to be able to **predict the future effect of a proposed action on**

- a) the fishable portion of the population (upon which economic benefit is based), and
- b) the reproductive portion of the population (which determines its' productive capacity).

Finally, in order to predict any future economic benefit, arising from the proposed action we need to be able **predict**

- c) the change in angling that is expected to occur as a result of the predicted (real or perceived) change in the status of the population.

A Simple *Model* of a Fish Population

Figure 10a presents a simple conceptual model of the dynamics of a fish population. The model illustrates the basic processes of reproduction and growth through a series of life stages up to a maximum age of four years. Fish in the population mature at age three and spawn at both age three and age four. During each life stage, some of the population dies due to natural causes (natural mortality) such as disease, starvation, or being eaten by larger fish. By age three, the fish are large enough to be attractive to anglers and consequently some fish of age three and four also die by being caught by anglers.

In the absence of artificial additions to the population (stocking) the reality is that the number of fish at the beginning of any life stage is simply equal to the number that were alive at the the beginning of the previous life stage, minus the number that died in the interim. The fraction of the fish that die during any life stage (e.g. egg, fry, juveniles, parr, adults) is defined as the **total mortality rate** for the life stage.

$$\text{Mortality Rate} = \frac{\text{Number}_{\text{at start}} - \text{Number}_{\text{at end}}}{\text{Number}_{\text{at start}}} \quad (4)$$

While mortality may arise in a number of ways, and we may take actions to reduce part of the total mortality at some stage, the final determining factor of abundance is the **total mortality rate**. A mortality rate always has a value that is between zero and one; if no fish died the mortality rate would zero, and if all died the mortality rate would be one. For any mortality rate there is a corresponding survival rate defined as

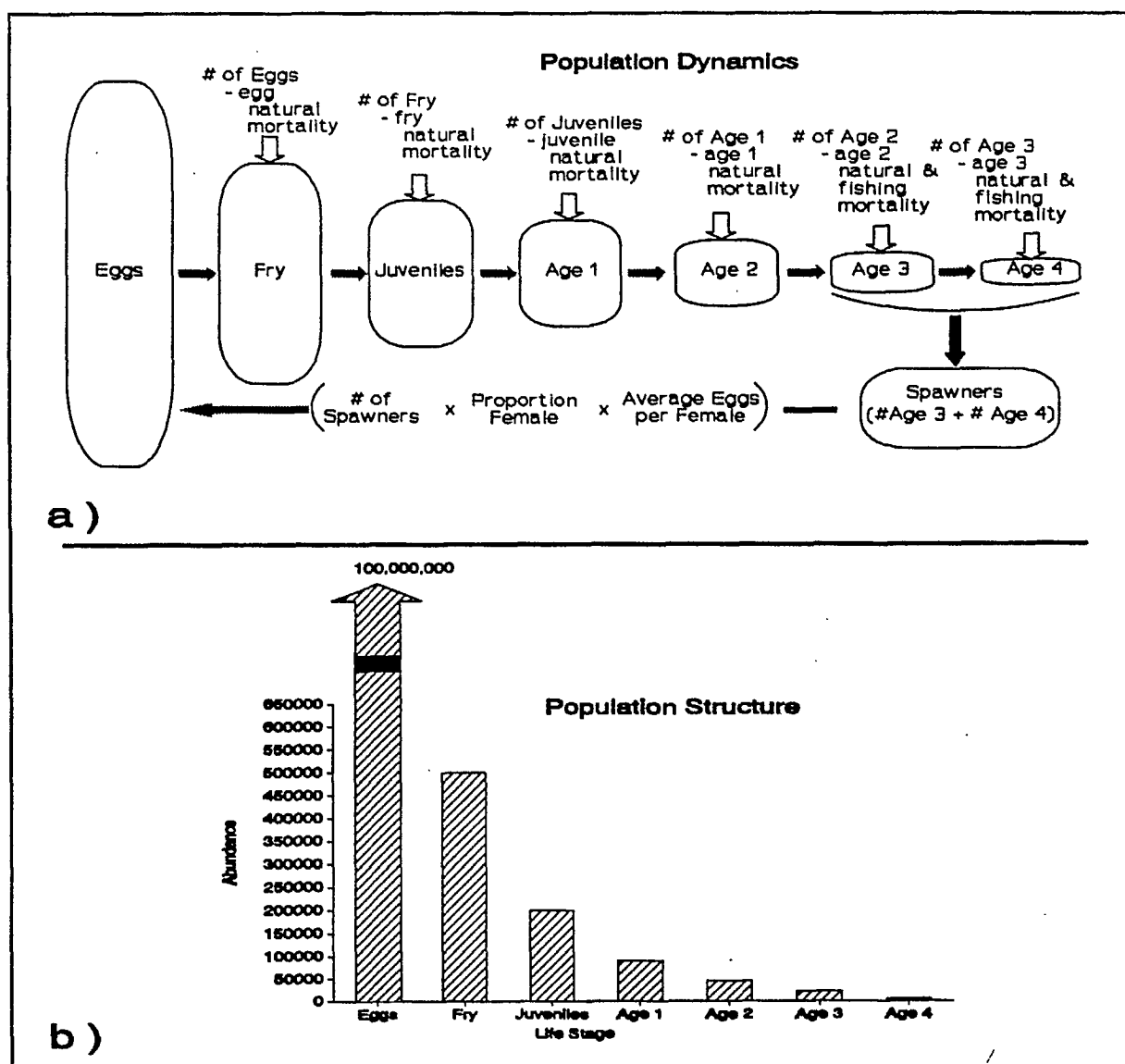


Figure 10: A simple model of fish population dynamics and structure.

$$\text{Survival Rate} = 1 - \text{Mortality Rate.} \quad (5)$$

When an estimate of the mortality rate and hence the survival rate is available, the number of fish which survive any life stage to the beginning of the next life stage is easily calculated as

$$\text{Number}_{\text{(at start of next life stage)}} = \text{Number}_{\text{(at start of previous stage)}} \times \text{Survival Rate}_{\text{(of previous stage)}} \quad (6)$$

Figure 10b and Table 19 illustrate the structure of the example population with some mortality and survival rates typical of many fish populations. A few points are worth noting about the population structure. Egg mortality rates are usually very high relative to other life

stages (the large number of eggs laid by many fish species are an important adaptation needed to sustain their populations). Mortality rates at older ages are often lower (except for some species for which spawning is fatal). Natural mortality rates can be quite high, on the order of 30 to 60 percent annually depending on the species and specific physical and biological environment they inhabit. Note that in Table 19, the total mortality for fish aged three and four years is not simply equal to the sum of the estimated *natural* and *fishing* mortality rates. When more than one *type* of mortality occurs together over time the total rate is slightly lower than the sum of the two independent rates. The calculation required to estimate total mortality from independent estimates of *natural* and *fishing* mortality rates is discussed later in this section.

Project Effects

The basic effect of all of our interactions with a fish population operates by one of two mechanisms: either changes in population productivity due to a change in the carrying capacity of the available habitat (e.g. through range extension); or through some change in natural fishing mortality. Changes in mortality are typical of most interactions, either we increase mortality by fishing or habitat degradation or we reduce (future) mortality through habitat improvement/protection or harvest reduction (often through regulatory means). Some people may argue that stocking programs act differently, since they can directly increase the number of fish in the population. However, besides adding fish which anglers can catch, stocked fish can influence the natural mortality of wild fish by increasing competition, through the coincident introduction of disease or potentially through genetic effects. More importantly, however stocking programs can act to increase fishing pressure (often the program goal) which will affect the total mortality rate of both the stocked and wild population.

Using the model to predict the effect of various management actions means assessing the effects on mortality. The general approach for a number of hypothetical management actions is described below.

- Habitat rehabilitation projects affect population size and structure by changing habitat quality for one or several life stages which, in turn, leads to a reduction in the natural mortality rates affecting those life stages. Habitat rehabilitation projects that target habitat types which are not limiting production will have little or no effect on population size. The challenge is to provide a rational basis for quantifying the change in mortality rate selected. Habitat suitability index (HSI) models provide some basis for this decision.
- Habitat creation and/or range extension projects can lead to increases in fish populations by increasing the carrying capacity of the resource, providing that some adjacent habitats necessary for subsequent life stages are not also limiting. For example, the creation of new spawning habitat may have little or no effect if adjacent nursery habitats are at capacity. To use the model to predict the effect of habitat creation/range extension projects, one must assess the proportional change in mortality resulting from the "effective" increase in habitat on the limiting life stage. HSI models offer one means of assessing this change.

Table 19:

A simplified model of a fish population for use in estimating effects of proposed projects.

Row	Column ▶	(1)	(2)	(3)	(4)	(5)	(6)
▼	Life Stage	Natural Mortality Rate	Fishing Mortality Rate	Total Mortality Rate	Survival Rate	Population Size (number)	How Calculated
A)	Eggs	0.995	0	0.995	0.005	100,000,000	Estimated # of female spawners x eggs / female [T5 x U5]
B)	Fry	0.60	0	0.60	0.40	500,000	egg survival x # of eggs [A5x A4]
C)	Juveniles	0.55	0	0.55	0.45	200,000	fry survival x # of fry [B4xB5]
D)	Age 1	0.50	0	0.50	0.50	90,000	juvenile survival x # of juveniles [C4 x C5]
E)	Age 2	0.50	0	0.50	0.50	45,000	age1 survival x # of age1 fish [D4 x D5]
F)	Age 3	0.50	0.40	0.74	0.26	22,500	age2 survival x # of age2 fish [E4 x E5]
G)	Age 4	0.50	0.40	0.74	0.26	5,814	age3 survival x # of age3 fish [F4 x F5]

Additional Input Parameters

S)	Total Spawners				28,314		Total number of fish capable of spawning.
R)	Sex Ratio				0.5		Sex ratio (expressed as the proportion female).
T)	Female Spawners				14,157		Total spawners x sex ratio
U)	Eggs / Female				7,064		Estimated from average weight (or length) of spawning females.

Key1) Values in the (formulas) in column (6), for example A1 or E5, refer to the row and column of a cell in the table. The two shaded cells in the corners of the upper portion of the table correspond to A1 and G5.

2) Values shown in italics are estimated for input to the model to estimate model outputs.

- Evaluation of the population effects of stream side incubation and/or rearing projects can be assessed in the model by artificially "injecting" a fixed number of individuals of the appropriate life stage into the model at the appropriate intervals, over and above the number of individuals of that life stage that are naturally produced. Standard mortality rates are then applied.
- The effects of changes in regulations are handled in the above model simply by the adjusting the fishing mortality rate by the appropriate amount over the appropriate age classes. The challenge comes in predicting angler response to changes in regulations which ultimately determine the effective fishing mortality rate.
- The model can also be used to predict the effects of a management action which promotes the utilization of an alternative species (A) as a means of reducing fishing pressure on species (B). The effect on species (B) can be predicted simply by adjusting the fishing mortality rate to reflect a reduced level of fishing mortality. Again, the challenge is providing a rational basis for quantifying the expected reduction in fishing mortality. The effects of the new fishery targeting alternative species A also needs to be assessed using the model to ascertain the risk of overexploitation.
- The effects of put and take fishing can be evaluated using the model and a combination of the approaches used to assess (a) the population effects of streamside rearing (or incubation), and (b) the effects of the use of alternative species as a means of reducing fishing pressure on a target species. The principal challenge is in assessing the impacts of angler response to a real or perceived increase in the abundance of fish. As mentioned earlier, an increase in the fishing mortality rate on the wild stocks can result.

Guiding Questions for Assessing Resource Benefits

Determining the resource benefit that may arise from a proposed initiative essentially means answering a series of basic questions about the resource condition and the likely effect of the project. The key questions are:

- *What is limiting stock productivity?* For example, is habitat availability or quality a significant limiting factor or is exploitation the primary limiting factor?
- If habitat is found (not merely assumed) to be limiting, then three questions be answered: 1) *What life stage is it that is limited?*; 2) *What is the nature of the habitat limitation?* (e.g. is it the quality of the substrate, the flow gradient, low oxygen conditions, temperature, or some other condition?); and, 3) *Does the proposed project address the limitation?*
- *Will the proposed project lead to a change in the future use of the resource (i.e. the number of angler days)?* If so, then *How much of a change is likely to occur?* It is important to note the emphasis here is on future resource use since actions that would not necessarily increase resource use, but would sustain populations and hence use could result in corresponding future benefits.

- *What is the likely future effect of the predicted change in resource use on the future condition of the resource?* If there is a potential for the project to increase use (mortality) beyond a sustainable level, and the project will yield desirable economic benefit, then the final question to be considered is:

What alternative approach (or additional actions) could lead to the desired economic benefit while at the same time ensuring that the resource (and hence future benefits) can be sustained?

This list of questions (and indeed all of this section) can be viewed simply as an accounting of the steps necessary to justify a project. In the long run this view is likely to be unproductive since the real value in completing a benefit-cost analysis stems from not simply to providing a rationale *to reject* well intentioned proposals, but from directing effort toward those actions which are likely to yield real future benefits. In this regard, the last question in the above list is fundamental due to its emphasis on developing beneficial project proposals. Consequently, the above list sets out a (thinking) process for project development.

Predicting Effects of Proposed Management Actions on Fish Populations

- 1) Develop a "model" (see Figure 10, Table 19) of the estimated population dynamics before the proposed action is taken (i.e. the current situation). Doing a rigorous job of this requires substantial effort, however a reasonable approximation for many proposed actions may be developed by starting with average estimates as reported in the scientific literature. Specialists at DFO, DNRE, the Atlantic Reference Centre, or local fisheries consultants should be able to provide reasonable values for the particular species in question. Often a range of values can be found and judgement can be used to select a reasonable value within the range (e.g. higher mortality rates for depleted stocks).
- 2) Experiment with the various mortality estimates provided to the model, until the model provides a reasonable picture of the current population (e.g. lots of 3 year old fish, but hardly any 4).
- 3) Estimate the change, if any, that the proposed action will have on the annual **natural mortality rate (n)**. This mortality represents the fraction of the population which would die naturally in any year, independent of any fishing effects. This needs to be estimated for each age group which is considered separately in the model that the proposed action may affect¹¹. The calculation illustrated below for three year old fish is one way to do this.

The calculation can be made for any age class (n) in the population as necessary. The information needed is an estimate of the abundance of the age class for which the estimate is being made (usually determined from population sampling), an estimate of the abundance of the next older age class (n+1) and the number of fish (age_n) caught (usually estimated with creel survey data). The estimates used can be of either the actual numbers

¹¹ Note that it is not necessary to calculate new mortality rates (either *natural* or harvest mortality) for life stages (or ages) which will not be affected by the proposed action.

of fish (absolute abundance) or of their relative abundance¹² (e.g. four year olds are only 40% as abundant as three year olds, i.e. $N_{age4} \approx 0.4 \times N_{age3}$; about 30% of age 3 fish are caught by anglers $C_{age3} \approx 0.3 \times N_{age3}$). The same calculation will be necessary for any age (life stage) which is subject to both *natural* and *fishing* mortality and for which the proposed action will result in a change in either mortality rate.

$$s_3 = \frac{N_{age4} + C_{age3}}{N_{age3}}, \text{ and}$$

$$n_3 = 1 - s_3$$

where,

N_{age4} = the number of 4 year old fish,

N_{age3} = the number of 3 year old fish,

s_3 = the annual "natural" survival rate of 3 year old fish,

n_3 = the annual "natural" mortality rate of 3 year old fish and

C_{age3} = the number of 3 year old fish harvested.

(7)

- 4) Estimate the change in the fishing effort (angler days) and the consequent change in harvest mortality rate (m) that may result from the action. In some ways this is the most difficult part of the analysis since the change in fishing effort (angler days) will depend on the behaviour of anglers in response to the action. Although the response of anglers to changes in management practices or fish abundance is understood in broad generality (e.g. fishing tends to decline when abundance is low) the detailed response is poorly understood and until more specific studies are available the intuition of experienced anglers may be a reasonable source for estimating these effects. In this regard, it may be easier to think about this aspect of the analysis in terms of relative changes in activity (i.e. with the project vs without the project). For example, suppose we estimate that a proposed project will increase both fishing pressure (E - measured in angler days) and harvest (C - number of fish) by ten percent¹³. The post-project effort and harvest can then be predicted from estimates of the pre-project effort and catch from

$$E_{\text{with action}} = 1.1 \times E_{\text{without action}}, \text{ and}$$

$$C_{\text{age}(n), \text{with action}} = 1.1 \times C_{\text{age}(n), \text{without action}} \quad (8)$$

The corresponding incremental benefit (to be used in the calculation of economic benefit, for this example could be calculated from either

¹² The numbers used must be consistent, either all absolute or all relative estimates.

¹³ It is not necessarily the case that the change in both effort (E) and harvest (C) will be the same. It is possible effort to increase but for the harvest rate to decrease, for example if the majority of anglers were to switch to conservation (catch and release) fishing.

$$\begin{aligned}\Delta E &= E_{\text{with action}} - E_{\text{without action}} \text{ or} \\ \Delta E &= 0.1 \times E_{\text{without action}}\end{aligned}\quad (9)$$

The same value for the expected incremental change in fishing effort must be used in estimating both resource effects and net economic benefits (see Section 5.2.3.2, Table 20).

- 5) Once the appropriate estimates of changes in *natural* and *fishing* mortality rates have been made they must be combined to provide an estimate of the **total mortality rate** for an age (or life stage) according to the following calculation¹⁴

$$M = e^{-(\log_e(n) + \log_e(m))},$$

where,

$$\begin{aligned}n &= \text{the predicted natural mortality rate,} \\ m &= \text{the predicted fishing mortality rate,} \\ e &= \text{the base of the natural logarithms} = 2.718..., \text{ and} \\ \log_e(x) &= \text{the natural logarithm of } x.\end{aligned}\quad (10)$$

The final calculation needed is to use the **total mortality rate** to calculate the corresponding survival rates ($S_{age} = 1 - M_{age}$). Which can then be used to replace those used in the spreadsheet model of the current population to assess whether the predicted changes will result in a sustainable outcome, or whether alternative (or additional) actions will be needed.

To check model calculations, it may be useful to estimate the harvest, that would result from the predicted changes in mortality rates and subsequent population abundance. As noted earlier, when there are multiple sources of mortality, the totality rate is not simply the sum of independently estimated mortalities. It is however, relatively easy to estimate the catch for any age (or combined set of ages), as the proportion of the total mortality attributable to fishing, i.e.

$$\begin{aligned}C_{agen} &= \left(\begin{array}{c} \text{Total \# of fish}_{agen} \text{ that die} \\ \text{from either natural or fishing mortality} \end{array} \right) \times \left(\frac{m}{(m+n)} \right) \\ &= N_{agen} \times M \times \left(\frac{m}{(m+n)} \right)\end{aligned}\quad (11)$$

A General Template for Estimating Resource Benefits

As discussed above, the simple model of fish population dynamics described in this section can be used to simulate a wide variety of project effects. The basic approach requires

¹⁴ The functions e and $\log_e(x)$ are readily available on inexpensive hand held calculators and in standard micro-computer spreadsheet packages.

careful thought about how a proposed action will affect *natural* and/or *fishing mortality*. The simplest approach is first to estimate how mortality may change in the short term and then to re-consider changes in mortality which may occur with time (e.g. fishing mortality may increase at first, but then decline). To use the basic structure to simulate change over time can be done simply by using the initial, or model generated, estimates of abundance in one year multiplied by the appropriate total mortality rate to estimate the number of fish in next older age group in the following year. Similarly, the size and character of the spawning population in the previous year is used to calculate the number of eggs for the next year.

Figure 11 illustrates three scenarios generated using the model described in this section. The base scenario represents the behaviour of the population shown in Figure 10 and Table 19, which is in equilibrium with the various mortality factors (including harvest)¹⁵.

The three scenarios illustrated in Figure 11, all reflect variations of a single proposed action; stream side incubation and release. Each scenario assumes that 10,000 eggs will be incubated and that they will enjoy an extremely high survival rate of 80 percent (only 20 % mortality). This was simulated, simply by adding 8,000 fry to the natural population. In Scenario 1, this was done for each year of the 10 year simulation years. This scenario also assumed no change in the rate of fishing mortality. Scenario 2 simulates exactly the same annual addition of fry, but also includes a hypothesis that harvest rate increases by 10 percent. This might correspond to a situation where the action was taken and lots of positive publicity convinced anglers that fishing was getting better, thereby attracting additional effort to the population. This is one type of situation in which lack of analysis of the effect on the fish population could lead to erroneous expectation of long term economic benefit. Scenario 3, is a variation of scenario 2 in which it was assumed that the stock enhancement action was continued for only the first 5 years while increased fishing harvest continued on.

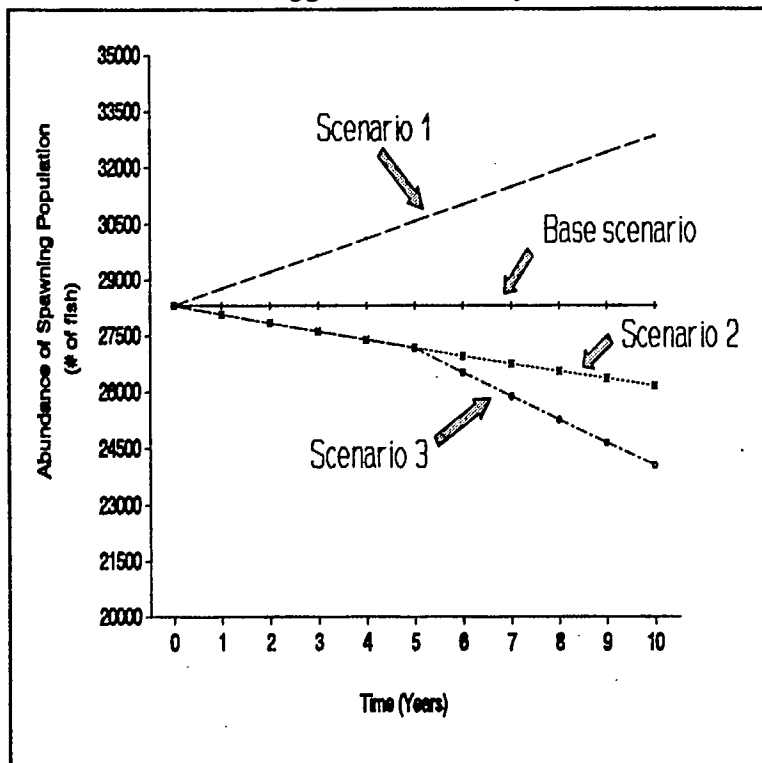


Figure 11: Model based projections of alternative development scenarios.

The model presented here can be reasonably criticized for its lack of reality, due to its extreme simplicity. All of the scenarios presented assumed constant rates of mortality/survival

¹⁵ In reality, things are almost always more complex, and even "stable" sustainable populations will vary somewhat from year to year.

over the duration of the analysis. In reality they are likely to change with time. This does not mean that the model is flawed, simply that it must be used carefully to produce a reasonable analysis. The model presented does not include any density dependent effects, a significant short coming, since natural mortality rates may fall as a population declines and conversely increase with increasing population abundance. This type of effect would cause the rising line of Scenario 1 and the falling lines of Scenarios 2 and 3 in Figure 11 to bend (level off) at some higher or lower abundance. It could take quite a long time, however, for this to occur and for the purpose of initial project screening these more complicated effects have not been included. In addition, as the abundance of a population increases or decreases, changes in competition often lead to changes in the growth rate and size of fish. They may mature earlier, or females of a given age may have more eggs due to their larger size and these effects are not included in the highly simplified model described above. The model also ignores species interactions.

Alternative Models

During the past few years increasing use has been made of much more sophisticated models to help people think about the potential consequences of proposed actions. Many of these models are documented in the fisheries literature, and will be known to specialists at DFO, DNRE, the Atlantic Reference Centre and in Universities. Many of these people will have used or perhaps been involved in the development of such models. Whenever a more sophisticated model can be found, its use should be seriously considered. One critically important caveat however must be kept in mind; no model should be used for prediction (including the simplistic one presented above) until it has first been validated by attempting to use it to simulate current conditions. In addition, for some types of projects, very simple models of potential effect may provide useful information with very little effort. For example, during one of the Strategic Planning Workshops, one sub-group quickly worked through an estimation of the effect of a proposed hypothetical project to create additional spawning habitat for atlantic salmon. By using standard DFO guidelines for egg density (# of eggs / m²) and simply multiplying by the mortality likely to occur at each subsequent life stage. Although this was also a very simplistic analysis it was sufficient to get a sense of the potential benefit of the hypothetical project.

5.2.3.2 Prediction of Socio-Economic Benefits

Benefits are classified as Direct and Indirect. Direct benefits refer to the anglers' willingness to pay for the fishing experience over and above any expenditures made for travel to a fishing site, accommodation, fishing gear, etc. Direct benefits are estimated by multiplying the approximate number of angler days by the Average Willingness to Pay (WTP) for New Brunswick, taken from the 1990 Survey of Anglers undertaken by Fisheries and Oceans Canada.

Separate WTP values are used for anglers who are New Brunswick residents and for non-resident anglers. To calculate direct benefits, applicants should estimate the number of angler days of *additional fishing effort* that will occur with this project but would not occur without it. Estimation of the number of additional angler days that might result from a project can be complicated and is discussed elsewhere in this report.

Using Table 20, below, as a template, direct benefits can be determined by placing the estimated number of *additional* angler days expected to result from a project in Row 1 and Row 4 for resident and non-resident anglers, respectively, then calculating the products as shown in lines 3 and 6, and summing these values over all years.

Table 20:							
Template for Estimating Direct and Indirect Benefits							
	Year 1	Year 2	Year 3	Yr 4 ... Yr 7	Year 8	Year 9	Year 10
	19	19	19		19	19	19
Direct Benefits							
1. Resident Angler Days							
2. WTP	\$18.35	\$18.35	\$18.35		\$18.35	\$18.35	\$18.35
3. Resident Benefit (1x2)							
4. Non-Res angler days							
5. WTP	\$47.23	\$47.23	\$47.23		\$47.23	\$47.23	\$47.23
6. Non-Res Benefit (4x5)							
Indirect benefits							
7. Non-res. angler days							
8. Net GDP per angler day	\$49.30	\$49.30	\$49.30		\$49.30	\$49.30	\$49.30
9. Indirect Benefit (7x8)							

Indirect benefits refer to the additional Gross Domestic Product created in New Brunswick as a result of expenditures made by non-resident anglers. Based on the 1990 sport fishing survey, the net increment to GDP per angler day is estimated at \$49.30 (net of the opportunity cost of labour). Using the table above as a template, the indirect benefits can be calculated by multiplying the number of *additional non-resident angler days* expected to result from a project (line 7, same as line 4) by the net GDP per angler day, and then summing the values over all years.

5.2.3.3 Costs

Estimation of the total costs associated with a project is an essential step in benefit cost analysis. Several kinds of costs need to be considered. These are discussed below and illustrated in the following table. The purpose of this form is to assemble the information necessary to conduct a benefit cost analysis.

Start-up Costs

These are the costs of bringing the project to the operation stage. They are sometimes referred to as capital costs or investment costs and include costs for materials, equipment and labour. They typically occur in the first one or two years of the project. Using Table 21, below, as a guide, start-up costs should be entered in lines 1 through 5 in the boxes corresponding to the year in which they occur. These costs should then be totalled for each year separately, and for all years combined (line 6).

Operating Costs

These are the costs of operating the project each year of its operating life. As with start-up costs, operating costs can include materials, equipment and labour. These costs should be entered in lines 7 through 11 in the boxes corresponding to the year in which they occur, and should then be totalled for each year separately, and for all years combined (line 12).

Materials and Equipment

The estimated costs for these items should be placed in the year in which they occur, net of GST and PST. That is, for benefit cost purposes, the cost of materials and equipment before the GST and PST is required. Costs for materials and equipment during the start-up phase (lines 1 and 2) should be clearly differentiated from materials and equipment costs during the operational phase (lines 7 and 8).

Labour Costs

Labour costs should be estimated as the number of hours of labour time multiplied by the wage rate as shown in Table 22. Labour costs associated with the start-up phase and operational phase should be entered in lines 3 and 9, respectively, in Table 21.

Table 21:

Template for Benefit Cost Analysis

	Yr 1	Yr 2	Yr 3	Yr 4 ... Yr 7	Yr 8	Yr 9	Yr 10
Start-up Costs	19	19	19	19	19	19	19
1. Materials							
2. Equipment							
3. Labour							
4. Other							
5. Other							
6. Total Start up (1-5)							
Operating Costs							
7. Materials							
8. Equipment							
9. Labour							
10. Other							
11. Other							
12. Total operating costs (7-11)							
13. Total Costs (6+12)							
Direct Benefits (\$)							
14. Resident anglers							
15. Non-res anglers							
Indirect Benefits							
16. Non-res anglers							
17. Total Benefit (13+14+15)							
Net Benefit (\$) (17-13)							

Table 22:

Template for Estimating Labour Costs

	Year 1	Year 2	Year 3	Yr 4 ... Yr 7	Year 8	Year 9	Yr 10
1. Labour Hours							
2. Wage Rate (\$/hr)							
3. Labour Cost (1x2)							
Adjustment (x0.7)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
4. Adjusted Labour costs (3x0.7)							

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Appendices

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APPENDIX A₁:**Angler Groups Contacted During the Initial Public Consultation**

Albert Co/Moncton Fish & Game
 Bass Anglers
 Big Salmon River, Hammond, Kennebecacis
 East Grand Lake C.L.I.C.
 Gestion du Salmon de la Riviere Restigouche et ses Tributaire (GSRT), Kedgwick
 Grand Digue Fish & Game Club
 Kent County Gun Club
 Minto Fish & Game Association
 Moncton Archery & Bowhunters Association
 N.B. Dept. of Natural Resources & Energy - Biologists & Technicians
 Nepisiquit Salmon Association / Chaleur Hunters Association
 Northumberland Salmon Protection Association
 Northwest Salmon Association
 Peticodiac Sportsmen's Club
 Richibouctou Village Gun Club
 Sackville Rod & Gun Club
 Salmon River Fish & Game Association, Chipman
 Scoodic Fish & Game Association
 Shepody Fish & Game Association
 St. John River Salmon Association - Central Branch
 St. Croix Salmon Association
 St. Antoine Gun Club
 Sussex Fish & Game Association
 Tobique Salmon Protection Association
 Woodstock Fish & Game Association

APPENDIX A₂:

**Native Groups Contacted During the Initial Public Consultation
 and/or Present at Workshops, or Both.**

Consultation

Big Cove First Nation
 Burnt Church First Nation
 Mawiw Council of First Nations
 Oromocto First Nation
 Red Bank First Nation
 St. Basil First Nation
 St. John River Federation of Native Fisheries
 St. Mary's First Nation
 Tobique First Nation
 Woodstock First Nation

Workshop

Eel Ground First Nation
 Eel River Bar First Nation
 Indian Island First Nation
 Maliseet Fishery Management Federation
 Mawiw Council of First Nations
 Red Bank First Nations
 St. Mary's First Nation
 Tobique First Nation

APPENDIX B:**Request for Information from Unorganized Anglers****Strategic Planning for New Brunswick's Recreational Fisheries****Where Should We Be Going?**

The New Brunswick Department of Natural Resources and Energy in co-operation with Fisheries and Oceans Canada are conducting a joint project to develop a plan for the future management of New Brunswick's Recreational fisheries. When completed this plan will serve to guide recreational fisheries management in the province and will provide a framework for improved co-operation among these agencies and the angling public.

The New Brunswick Wildlife Federation and the Atlantic Salmon Council of New Brunswick are working with the two resource management agencies to provide public input into the planning process. To do this we are meeting with organized angling groups throughout the province. The first phase of this consultation is taking place now and will be completed in the next few weeks. In these initial meetings we are asking anglers to tell us about their aspirations for the fisheries resource, their views on current resource management problems and what actions they think are needed to improve the recreational fishery in their area. Meetings are also being held with native groups within the Province. Later meetings will provide an opportunity to comment on the draft plan.

The purpose of this article is to provide other anglers or concerned citizens who may not belong to an organized angler group with an opportunity to give us your views on these issues. If you wish to provide input to this planning process we ask that you take some time to reflect on the present state of the fisheries resource and then to send us your views by responding to the following brief questionnaire.

-
- 1) What should the future recreational fishery in New Brunswick be like? (What species of fish and what sort of fishing experience do you seek?)
 - 2) In your view, are there problems with the current state of the recreational fishery in New Brunswick? If so, what are they?
 - 3) What actions do you think are needed to improve and protect the quality of fishing in New Brunswick? If appropriate, please indicate the location (e.g. lakes, rivers) your comments apply to.
 - 4) What principles should guide recreational fisheries management in New Brunswick?
 - 5) What license fees should be charged for the privilege of fishing? Would you be willing to pay increased fees for an improved fishery?
 - 6) What role and responsibilities should the angling public have in managing our recreational fisheries resources?
 - 7) Do you have other concerns about New Brunswick's recreational fisheries? If so, what are they?

If you wish to respond, please mail your response by January xx,
1992, to the New Brunswick Wildlife Federation.

APPENDIX C:

Participants at the Strategy Development Workshop

30 January, 1-2 February, 1993

Name	Affiliation
Bill Beamish	University of Guelph/LGL Ltd.
Alex Bielak	Fisheries and Oceans Canada - Gulf Region
Danny Bird	Atlantic Salmon Federation
Arnold Boer	N.B. Department of Natural Resources & Energy - Fredericton
Tim Cameron	Fisheries and Oceans Canada - Scotia-Fundy Region
Bob Carroll	N.B. Wildlife Federation
Mike Chadwick	Fisheries and Oceans Canada - Gulf Region
A.O. Cormier	Fisheries and Oceans Canada - Gulf Region
Peter Cronin	N.B. Department of Natural Resources & Energy - Kingsclear
Kevin Davidson	Fisheries and Oceans Canada - Gulf Region
Jack Davis	Fisheries and Oceans Canada - Scotia-Fundy
Bernard Dubee	N.B. Department of Natural Resources & Energy, Newcastle
David Dunn	Fisheries and Oceans Canada - Gulf Region
Sharon Ford	Fisheries and Oceans Canada - Gulf Region
Dan Fowler	N.B. Wildlife Federation
Lorne Greig	ESSA Environmental & Social Systems Analysts Ltd.
Bill Hooper	N.B. Department of Natural Resources & Energy, Fredericton
Brian Keating	Fisheries and Oceans Canada - Scotia-Fundy Region
Ed LeBlanc	N.B. Department of Natural Resources & Energy, Edmundston
John Legault	Fisheries and Oceans Canada - Gulf Region
Kevin Loftus	LGL Ltd.
Ron Loudon	Fisheries and Oceans Canada - Tracadie
Alan Madden	N.B. Department of Natural Resources & Energy, Campbellton
Don Meisner	ESSA Environmental & Social Systems Analysts Ltd.
Wes Myers	N.B. Salmon Council
Gordon Paul	Maliseet Fishery Management Federation
Sandra Paul	Mawiw Council
Tom Pettigrew	N.B. Department of Natural Resources & Energy, Hampton
Tom Pinford	Gardner Pinford Consulting Economists Ltd.
John Ritter	Fisheries and Oceans Canada - Scotia-Fundy Region
Hank Scarth	Fisheries and Oceans Canada - Scotia-Fundy Region
Janet Smith	Fisheries and Oceans Canada - Gulf Region
Jim Ward	Eel Ground First Nation
Fred Wheaton	N.B. Wildlife Federation/J. Heber Brown Ltd.
Stephen Wood	N.B. Department of Natural Resources & Energy, Fredericton
Iain Young	ESSA Environmental & Social Systems Analysts Ltd.

APPENDIX D:**Participants at the Strategy Implementation Workshop Part 1**

23-24 March 1993

Name	Affiliation
Chief Wendell Barlow	Indian Island First Nation
Bill Beamish	University of Guelph/LGL Ltd.
Edwin A. Bernard	Tobique First Nation
Alex Bielak	Fisheries and Oceans Canada - Gulf Region
Danny Bird	Atlantic Salmon Federation
Randy Brooks	St. Mary's First Nation
Tim Cameron	Fisheries and Oceans Canada - Scotia-Fundy Region
Bob Carroll	N.B. Wildlife Federation
Mike Chadwick	Fisheries and Oceans Canada - Gulf Region
Peter Cronin	N.B. Department of Natural Resources & Energy, Kingsclear
Bernard Dubee	N.B. Department of Natural Resources & Energy, Newcastle
David Dunn	Fisheries and Oceans Canada - Gulf Region
Sharon Ford	Fisheries and Oceans Canada - Gulf Region
Dan Fowler	N.B. Wildlife Federation
Victor B. Gionet	Fisheries and Oceans Canada - Gulf Region
Lorne Greig	ESSA Environmental & Social Systems Analysts Ltd.
Bill Hogans	Huntsman Marine Science Centre/LGL Ltd.
Bill Hooper	N.B. Department of Natural Resources & Energy, Fredericton
Patrick LeBilloy	Eel River Bar First Nation
Ed LeBlanc	N.B. Department of Natural Resources & Energy, Edmundston
Gerald Levi	Red Bank First Nation
Kevin Loftus	LGL Ltd.
Ron Loudon	Fisheries and Oceans Canada - Tracadie
Al Madden	N.B. Department of Natural Resources & Energy, Campbellton
Daniel Mazerolle	Indian Island First Nation
Don Meisner	ESSA Environmental & Social Systems Analysts Ltd.
Mike Murphy	Fisheries and Oceans Canada - Gulf Region
Wes Myles	N.B. Salmon Council
Eugene Patles	Eel Ground First Nation
Gordon C. Paul	Maliseet Fishery Management Federation
Hubert L. Paul, Jr.	St. Mary's First Nation
Sandra Paul	Mawiw Council
John Peppar	Fisheries and Oceans Canada - Gulf Region
John Perly	Tobique First Nation
Tom Pettigrew	N.B. Department of Natural Resources & Energy, Hampton
Tom Pinfold	Gardner Pinfold Consulting Economists Ltd.
John Ritter	Fisheries and Oceans Canada - Scotia-Fundy Region
Bev Scott	Huntsman Marine Science Centre/LGL Ltd.
Fred Wheaton	N.B. Wildlife Federation/J. Heber Brown Ltd.
Stephen Wood	N.B. Department of Natural Resources & Energy, Fredericton
Iain Young	ESSA Environmental and Social Systems Analysts Ltd.

APPENDIX E:**Participants at the Strategy Review Workshop - Part 2**

25 March 1993

Name	Affiliation
Tim Cameron	Fisheries and Oceans Canada - Scotia-Fundy Region
Bob Carroll	N.B. Wildlife Federation
Mike Chadwick	Fisheries and Oceans Canada - Gulf Region
Kevin Davidson	Fisheries and Oceans Canada - Gulf Region
David Dunn	Fisheries and Oceans Canada - Gulf Region
Sharon Ford	Fisheries and Oceans Canada - Gulf Region
Victor B. Gionet	Fisheries and Oceans Canada - Gulf Region
Lorne Greig	ESSA Environmental and Social Systems Analysts Ltd.
Bill Hooper	N.B. Department of Natural Resources & Energy, Fredericton
Brian Keating	Fisheries and Oceans Canada - Scotia-Fundy Region
John Loch	Fisheries and Oceans Canada - Gulf Region
Kevin Loftus	LGL Ltd.
Ron Loudon	Fisheries and Oceans Canada - Tracadie
Wes Myles	N.B. Salmon Council
Sandra Paul	Mawiw Council on behalf of the Union of New Brunswick Indians
John Peppar	Fisheries and Oceans Canada - Gulf Region
John Ritter	Fisheries and Oceans Canada - Scotia-Fundy Region
Fred Wheaton	N.B. Wildlife Federation/J. Heber Brown Ltd.

APPENDIX F:

Valuation of Recreational Fisheries: A Maryland Example

By examining a real example of the use of measures of anglers' willingness to pay to fish and the Contingent Value Method to value a fishery (Fidler 1989¹²), the methodology used in the valuation of the New Brunswick fishery is better explained.

Using Contingent Value Method to Determine Economic Value of Fishery

Anglers in Maryland were asked how much they would be willing to pay above current daily trip costs for two scenarios: 1) current fishing conditions, and 2) if twice as many fish were available at the location of their most recent fishing trip. This measure of willingness to pay was designed to determine if increased fish abundance had any value to the angler. The main results of this study are shown in the table below.

The values in the table are in 1987 US dollars. The overall net economic value (consumer surplus) of Maryland fishing, to both the freshwater and saltwater angler, was \$39.53 per day. This means that the average angler would be willing to pay approximately an additional \$40, above their current daily trip cost of \$36.53, to fish in Maryland waters, given current fishing conditions. Combining the net economic value of \$40 and the current daily trip costs of \$37 results in a gross economic value of \$77 per day.

Examining the economic value on a species basis found that net willingness to pay for freshwater smallmouth bass fishing was \$35.66 above current trip costs and largemouth bass was \$38.72 above current trip costs. For saltwater angling, the economic value was somewhat higher than that for freshwater angling, with anglers willing to pay an additional \$41.57 over current daily trip costs.

Chesapeake Bay angling is predominantly striped bass angling, and it showed a remarkably higher valuation of willingness to pay than the other bass fisheries in Maryland, including saltwater largemouth bass. Anglers were willing to pay an additional \$45.55 above their current trip costs of \$36.91 per day to fish striped bass in Chesapeake Bay.

Multiplying the total number of fishing days in Maryland in all fisheries by their respective average daily fishing trip expenditures resulted in active anglers spending \$435.2

¹² Paper entitled "An Examination of Maryland Angler Characteristics, Behaviours and Economic Values", prepared by Dr. Anthony Fedler, Department of Recreation, University of Maryland, prepared for Tidal Fisheries Program, Maryland Department of Natural Resources, Annapolis, MD.

million on sport fishing in Maryland in 1987¹³. This value measures the total indirect economic impact of sport fishing in Maryland in 1987. The net economic value (direct economic benefits) of sport fishing in Maryland for all fishing by active anglers during 1987 was calculated by multiplying the net willingness to pay (above trip expenditures) per day to fish in Maryland by the total number of days fished for all fisheries. This net economic value was calculated to be \$294.4 million in 1987.

Table F1: Angler Expenditures and Economic Values for Maryland Freshwater and Saltwater Angling for Selected Area and Species (SMB = smallmouth bass; LMB = largemouth bass)							
Expenses	Freshwater			Saltwater			Statewide
(1987 \$US)	SMB	LMB	Total	LMB	Chesapeake	Total	Total
Transportation	\$10.58	\$10.60	\$12.31	\$10.60	\$15.85	\$18.88	\$16.11
Food & Beverages	22.80	18.33	19.17	16.49	24.46	24.59	23.03
Lodging	16.80	7.64	9.69	2.30	6.84	10.37	11.40
Other(gear,fees)	4.68	4.76	4.98	3.22	8.58	9.94	7.91
Total Trip Expenses	\$54.86	\$41.33	\$46.15	\$32.61	\$55.73	\$63.78	\$58.44
Days fished per trip	1.65	1.73	1.58	1.54	1.51	1.56	1.60
Daily trip expenses	\$33.25	\$23.98	\$29.21	\$21.17	\$36.91	\$40.88	\$36.53
Net willingness to pay per day for current fishing conditions	\$35.66	\$38.72	\$35.37	\$41.57	\$44.55	\$42.57	\$39.53
Net willingness to pay per day for double the availability of fish to catch	\$42.89	\$45.54	\$43.58	\$54.13	\$56.83	\$54.20	\$49.69
Sample size	109	93	590	37	436	750	1405

The final step in measuring the total economic value of the fishery is to combine the daily trip expenditures with the net willingness to pay per day to yield total gross valuation of the

¹³ The high values for the direct and indirect economic benefits of the Maryland fishery is due to the large number of angling days (7.5 million total trips made to Maryland waters). The marginal willingness to pay values do not vary significantly with the marginal willingness to pay value derived from the 1990 N.B. angling survey.

recreational fishery per day. The gross economic value of the sport fishery was valued at \$729.6 million in Maryland for 1987.

Impact of Increasing Fish Stocks

One of the main thrusts of the survey was to determine how much anglers would change their valuation of these same fisheries if fish stocks were increased. In order to measure the marginal willingness to pay for increased fish stocks, anglers were asked the question: "if twice as many fish were available to be caught, how much would your daily trip expenditures have to be before you would not go fishing". Most interesting, is the result that doubling the number of fish available to be caught would result in the statewide value of a day fished in Maryland to increase from \$39.53 to \$49.69 (roughly 25%), as reported by anglers. For freshwater fishing, the value would increase by \$8.21 per day (23%) and by \$11.63 (27%) for saltwater fishing. Not shown in the above table, the study also showed there was no significant difference in the percentage change in the valuation of the fisheries, as a result of doubling the available fish to catch, if these valuations were measured on a per trip basis or per day basis.

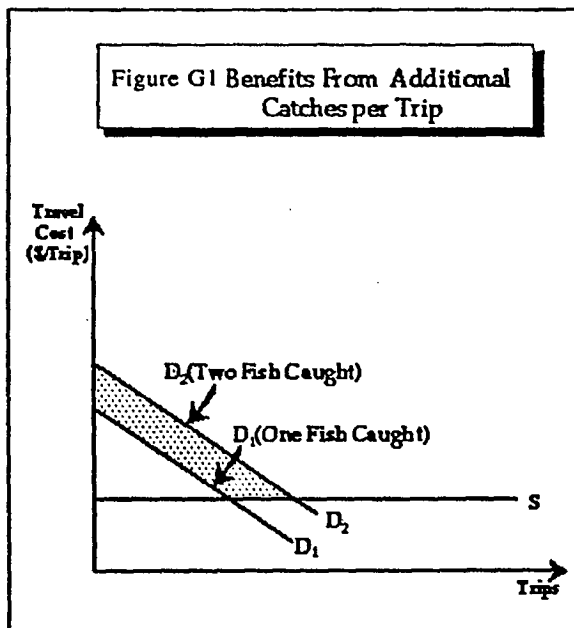
APPENDIX G:

The Trip Cost Approach to Valuing a Recreational Fishery

To determine the demand function for a relatively free-access sport fishing, the implicit or derived price must be used. These implicit prices can be derived through the use of trip costs. Variations in trips taken and cost of trips are used to examine how prices might influence trips.

The consumer of the sport fishing trip is also the producer of the trip, and the estimated demand curve considers both costs and willingness to pay. The supply curve is normally assumed to be the average travel costs, and the area under the demand curve and above the supply curve is used as a measure of net benefits associated with the trip.

The problem remains, however, of how much the benefits arise from catching the fish as compared to other desirable attributes of the fishing trip. One method is to include the catch rate for the species along with cost in estimating the number of trips. By observing how the demand curve shifts as catch rate changes, the researcher can determine how benefits change in response to catch rate changes. The area between the two curves in Figure G1 illustrates the increase in net benefits associated with a catch rate increase.



If recreational fisherman A fishes five times per year and his trip costs are \$5 per trip, and fisherman B fishes two times when his costs are \$12 per trip, from the travel cost approach, it may be concluded, using the elasticity of the demand curve, that a fee of \$7 per trip imposed on fisherman A would reduce his number of fishing trips from five to two. Such a comparison is warranted if A behaves like B when "price" is the same. This would assume both A and B have the same preferences, income, face the same price for substitutes and other demand determinants are the same for each. Of course these factors are not equal in practice and therefore the analysis must suitably account for variations among types of fishermen.

Given this, one can then determine how changes in creel limits or changes in the available catchable fish stocks will change fishermen's net economic benefits from fishing, or how much the catching of each fish is worth. Using this approach, one can also measure the economic impact of an increase in available fish stocks, in terms of how much the additional stocks add to the current valuation of the fishery.

The number of fish caught during a trip is normally unknown prior to the trip. The fisherman must therefore use an expectation of the catch in making the decision of whether or not to go fishing. The measure of net economic benefits incorporates a subjective probability of catch, the accuracy of which depends mostly on the previous experience of the participant. If estimated actual catch is used to shift the demand curve and the individual's expectation of the catch is lower than actual catch the measure of surplus is too low. If, on the other hand, the probability of catching a fish is increased due to increased fish stocks, the net economic value of the fishery to the fisherman is increased, and is reflected by an increased net willingness to pay. As discussed in the next section, the measure of net willingness to pay by Maryland fisherman is increased by roughly 25% for a doubling of the probability of catching a fish.

APPENDIX H:

An Alternative Approach to Estimating the Net Economic Value of the Striped Bass Fishery in New Brunswick

Another approach to estimating the net value of the striped bass fishery in New Brunswick is to multiply the average consumer surplus of an additional striped bass per trip by the estimated number of trips for striped bass times the mean catch rate per trip. This figure would represent the marginal value of trips taken by persons seeking or having caught striped bass. Sports fishermen, however, often seek more than one species and gain satisfaction from boating and the outdoor aesthetics associated with the trips. To attribute the entire value of the trips to striped bass might seriously overstate the recreational benefits associated only with the catching of fish.

To obtain a better estimate of the value generated by the use of the resource, the marginal value of catching an additional striped bass is multiplied by the total number of striped bass caught. Not having a measure of the marginal willingness to pay for an additional striped bass value for New Brunswick it may be possible to use the value specifically calculated for a striped bass fishery which most represents the New Brunswick fishery. Norton, Smith and Strand estimated the marginal willingness to pay for an additional striped bass for four striped bass fishing regions in the Eastern United States (New England, Mid-Atlantic, Chesapeake, South Atlantic), each of which represent different types of fishermen. Table H1 below contains estimates of average daily consumer surplus per striped bass trip by region for each of these regions. The values were adjusted to 1992 Canadian dollars using a consumer price index and the exchange rate.

Table H1	Consumer Surplus	Marginal Willingness to
Region	per Trip	Pay for a Striped Bass per Trip
	(1992 \$ Cdn)	(1992 \$ Cdn)
New England	\$169	\$4.38 (\$24.79)
Mid-Atlantic	\$332	\$14.61
Chesapeake	\$77	\$10.40
South Atlantic	\$226	\$2.63

The New Brunswick striped bass fishery most resembles the mid-Atlantic striped bass fishery. It has both spring and fall fishery components which focus on migratory stocks in nearshore waters, with shore fishing being most prevalent. The Mid-Atlantic value of \$14.61 for striped bass is slightly lower than the weighted average value of the willingness to pay value for resident anglers in New Brunswick of \$18.35 per day. Simply updating the 1980 value from the Norton et. al. study to current Canadian dollars assumes fishing stocks (as well as fishing conditions), have remained the same. It would be expected that depleted stocks in both the mid-Atlantic and in New Brunswick would increase the value from \$14.61 per fish to a higher value. For the sake of comparison, using the conservative figure of \$14.61 and multiplying by 24,042, the number of striped bass caught and retained in 1990 in New Brunswick, resulting net value is \$351,253. This value is

substantially higher than the value obtained by using the weighted average marginal willingness to pay for days fished in New Brunswick of \$45,875.

The large discrepancy between these two values lies not so much in the marginal willingness to pay values, but in the discrepancy between the estimated days fished and the catch data for striped bass. Given a total catch (and retained) figure of 24,042 striped bass in New Brunswick in 1990 and an estimated days fished of 2,500, this gives an average of 10 fish caught and retained per fishing day. This seems to be a high figure for average catch per day, given the sharp decrease in stocks of striped bass. Having verified that the estimate of the number of fishing days was reasonable, it may indicate the catch numbers from the 1990 New Brunswick angling survey are incorrect.

It is interesting to note the rather low estimated net economic value per fish in New England is not consistent with other values from other regions. The reason for this is related to the fact that many sport fishermen in New England sell their catch. Up to 90% of fishermen in certain geographical areas of New England reported selling their catch. The study assumed the net value per fish estimated for New England fishermen of \$4.38 may reflect only the recreation value associated with the fish. This is because the fishermen may discount the potential sales value of their catch when deciding to take a recreational trip. Therefore, the actual net value associated with the recreational catch of striped bass in New England can be estimated as the "Net sport value" plus the actual income from sales. From the survey it was estimated that up to 60% of the fish caught by "recreational" fishermen in New England are sold. The average sales value of the fish was added to the recreation value to give a total net value in New England of \$24.79 per striped bass.

Given the number of recreational sport fishermen who sell their striped bass catches in New Brunswick perhaps it is also necessary to include an estimate of the sales revenue in the valuation of the net value of the striped bass in New Brunswick.

APPENDIX I:

Tournament Case Studies

Woodstock Summer Bass Derby**Case Study****Summary Points:**

- The Woodstock Summer Bass Derby is the largest summer bass tournament in New Brunswick.
- This tournament represents a recent, large-scale, well organized derby which is attracting a steady number of applicants.
- The main spin-off of the bass tournaments in New Brunswick is the educational value of "catch and release" in the bass fishery.

Derby: The Woodstock Summer Bass Tournament
Woodstock, NB

Contact: Mr. Carl Ash
(506) 325-3309
Woodstock, NB

This is the largest tournament in New Brunswick and has been in place for two years. The number of participants registered has averaged around 118 two-person teams (236 persons) over the past two years. Tournament organizers are expecting the same number of teams this year. As with all bass tournaments in New Brunswick, the tournament is organized on a "catch and release" basis. Points are won for the number of live bass brought in per team and deducted for any fish which have died during the process. In this way, teams are penalized for fish caught which are not safely released and replaced in the water at the end of the tournament. It is through this process the tournaments contribute to the educational value of catch and release, both to the participants and to all those involved.

The economic spin-off effects to the community vary from tournament to tournament. Expenditures are higher for nonresident participants who require accommodation in the area.

The Woodstock tournament has averaged a 25 percent participation rate from Maine and a 75 percent participation rate from Nova Scotia and New Brunswick. Nonresident participants usually arrive 2 days prior to the tournament to familiarize themselves with the head pond and to find the best fishing spots.

The basic expenditures for a local person are as follows:

\$125	registration fee
\$60-\$150	gas for outboard motor
\$50	tackle replacement
\$50	meals
\$325	Total basic expenditures (bottom end)

If 50 teams (100 persons) are local participants, this translates into \$32,500 direct expenditures by local participants to attend this tournament. Additional expenditures for those outside the local area are:

\$150	Accommodation per person (two nights)
\$150	Additional two nights for those who arrive early
\$150	Meals for three days of tournaments
\$75	Other entertainment expenditures
\$60	Meals for additional day (if practice fish)

This averages a total of \$585 expenditures for nonresident participants who don't arrive early to practice fish and \$910 in total expenditures for out-of-town participants who do arrive early to practice fish. If approximately 35 teams (70 persons) are from out-of-town in an average year and require accommodation, the total direct expenditure for these participants is roughly \$40,950.

*Woodstock Summer Bass Derby**Case Study*

This amounts to overall direct expenditures of approximately \$73,450 from all participants in the tournament. (This excludes expenditures of onlookers and families or friends of participants).

As a result of this expenditure, additional secondary expenditures create substantial spin-off effects. One participant from New Hampshire claims he spends \$1,000 US each year to attend this particular tournament.

Nonresident fishermen spend a minimum of two nights in local accommodation. Usually this amount is more like 4 nights since they arrive at the tournament site two days prior to the event in order to "practice fish" in the area. The tournament is held in late summer and the fishermen bring their families to the tournament. This means additional direct expenditures for the tournament. Feedback from local organizers indicate that the economic spin-offs for the local community are substantial. Motels along the 60 mile head pond are always booked, in advance, for the weekend of the tournament. The tournament is held on the long weekend in September in conjunction with other family events. There are organized tours of the local region and usually family members of the participants spend substantial amounts of money in the area.

The Woodstock Summer Bass Tournament has sponsors who provide prizes for the tournament. Not only is an abundance of bass a selling feature for this tournament, but the high calibre of the prizes attract people as well. Prizes range from an outboard motor to tackle and gear.

*Johnson Evinrude Summer Bass Derby**Case Study***Summary Points:**

- The Johnson Evenrude Summer Bass Derby is the largest summer bass tournament in New Brunswick.
- This tournament represents a recent large-scale, well-organized derby which is attracting a steady number of applicants.
- The main spin-off of the bass tournaments in New Brunswick is the educational value of catch and release in the bass fishery.

Derby: The Johnson Evinrude Summer Bass Tournament
Mactaquac, NB

Contact: Mr. Greg Davidson
(506) 459-8657
Fredericton, NB

This is the second largest tournament in NB and has been in place for eight years. The number of participants registered has averaged around 75-100 two-person teams (150-200 persons) in the past three years. Tournament organizers are expecting 85-100 two-person teams this year. As with all bass tournaments in New Brunswick, the whole tournament is organized on a catch and release basis. Points are won for live bass brought in per team and deducted for any fish which have died in the process. In this way teams are penalized for fish caught which are not safely released to be replaced in the water at the end of the tournament. It is through this process the tournaments contribute to the educational value of catch and release both to the participants and to all those involved with the tournament.

The economic spin-off effects to the community vary from tournament to tournament. Expenditures are higher for those nonresident participants who require accommodation in the area. Using this tournament as an example, out of 80 teams, an average of 50 are considered local, and 30-40 teams are usually from Maine, NS, and NB (areas outside the Fredericton area). Nonresident participants usually arrive 2 days prior to the tournament to "practice fish" in the head pond waters.

The basic expenditures for a local person are as follows:

\$125	registration fee
\$60-150	gas for outboard motor
\$50	tackle replacement
\$50	meals
\$325	total local basic expenditures (bottom end)

The Johnson Evenrude Summer Bass Tournament has sponsors who provide prizes for the tournament. Not only is an abundance of bass a selling point for this tournament, but the high calibre of the prizes attract people as well. Prizes range from an outboard motor to cash to tackle and gear. One outboard motor dealer in Fredericton pointed out that the bass fisherman was "created" as a result of the bass tournaments.

This tournament has served as a means of disseminating information on catching and releasing bass and has provided the impetus to create the local bass fisherman. What this means in economic terms, is the anglers who have grown to love bass fishing are now fishing for bass in the region between tournaments. They are buying equipment and gear throughout the summer season. Local sales of outboard motors and fishing gear in the Fredericton area have blossomed and a large part of this is due to the New Brunswick summer bass tournaments.

Harvey Lake Summer Bass Derby**Case Study****Summary Points:**

- The Harvey Lake Summer Bass Derby is one of the first summer bass tournaments in New Brunswick.
- This tournament was originally organized by the community to raise funds for a new rink facility, and since then has continued to provide funds to the community and still attracts a steady number of applicants.
- This tournament provides invaluable information on the catch and release program in New Brunswick.

Derby: The Harvey Lake Summer Bass
Tournament
Harvey Lake, NB
Contact: Mr. Ken Weeks
(506) 784-2866
Fredericton, NB

This is one of the first tournaments in NB and has been in place for eight years. The number of participants registered has averaged around 75 two-person teams (150 persons) in the past three years. Tournament organizers are expecting 80 two-person teams this year. As with all bass tournaments in New Brunswick, the tournament is organized on a catch and release basis. Points are won for live bass brought in per team and deducted for any fish which have died in the process. In this way, teams are penalized for fish caught which are not safely released to be replaced in the water at the end of the tournament. Through this process, the tournaments promote the educational value of catch and release, both to the participants and to all those involved with the tournament.

This tournament differs from the Mactaquac tournament in that it is just a one day event, usually the third Saturday in July. This one day tournament represents the majority of tournaments in New Brunswick. Most bass tournaments in New Brunswick are single day events, raising funds for the community, and they are usually held on the local fair grounds, sometimes in conjunction with another event.

The Harvey Lake bass tournament has averaged around 75 teams over the past three years. There are usually 3 or 4 teams from Nova Scotia, 10 or 12 teams

from Maine and the remaining 65 teams are from southern New Brunswick. There is no overnight accommodation needed for those who are travelling from points in southern New Brunswick. Those travelling from Nova Scotia and Maine, however, do need overnight accommodation. These travelling anglers may not necessarily stay overnight in Harvey, but would most likely stay elsewhere in New Brunswick. Nonresident participants may arrive in Harvey 2 days prior to the tournament to "practice fish" in the lake. In this case, additional accommodation and meals would mean additional direct expenditures to the local economy.

If 75 teams (150 persons) participate, this translates into \$48,750 direct expenditures to attend the tournament. Expenditures for out-of-town participants averaged \$585 (excluding those who arrive a day or two early to "practice fish"), and \$910 per day for visiting participants who arrive early to practice fishing in the lake. If approximately 10 teams (20 persons) require accommodation in an average year, the total direct expenditures for nonresident participants is roughly \$18,200.

This amounts to total direct expenditures of approximately \$60 thousand from all of the participants in the tournament, excluding expenditures of on-lookers and families or friends of participants.

The Harvey Lake Bass Tournament has a limited number of sponsors who provide prizes for the tournament. Most of the prizes are cash prizes from the registration fees. The tournament is held on the community fair grounds. The local canteen also takes in approximately \$1,000 during the event.

APPENDIX J:

Fraser Freehold Incorporated Case Study

*Fraser Freehold Strategic Fisheries Management Plan**Case Study***Summary Points:**

- The goal of the fisheries program at Fraser Inc. is to create more and better fishing.
- Four Fraser freehold lakes are leased to an outfitter who has put restrictions on angler numbers and quotas which has markedly improved fish populations in these lakes.
- Eventually 8-10 more lakes will become trophy speckled trout fisheries as a result of a pay for use fee structure and a reservation system.

The management system which has been implemented at Long, Island, Square and Mud lakes, (Fraser Freehold lakes which are leased to an outfitter), is an excellent example of a fisheries restoration accomplishment over a short period of time. The outfitter has placed restrictions on angler numbers and quotas on fish take, and as a result, Long and Island Lakes are the best sport fishing lakes in New Brunswick. The New Brunswick records for speckled trout, lake trout and land locked salmon were all set in 1991 at Long Lake. The outfitter is booked the whole summer at Island Lake and well into midsummer for Long Lake and estimated revenues are in the order of \$125,000 annually.

Long and Island Lakes are Blue Ribbon Lakes now. Eventually eight to ten more lakes will become trophy speckled trout fisheries. A pay for use fee structure and a reservation system will be implemented with a similar set up to be initiated for the Highly Managed Lakes. No fee will be charged for the managed lakes.

All revenues will be used to finance future fisheries projects and stocking programs so that the fishery management will be a break even proposition in the future.

Beginning in 1993, high priority trout streams will also become an important component of this management plan. Based on 1992 creel and habitat surveys, streams will be prioritized and certain management techniques will be implemented according to potential. Such things as angler numbers controls, technique restrictions (fly fishing only) and reduced quotas and size limits will be implemented.

Some streams or sections may also have to be closed. It is not planned at the present time to include streams in a "pay for use" system, but this option will be considered in 1994, depending on angler response to the system in place for lakes.

It is expected that the fisheries resource will respond quickly as a result of the activities outlined in the management plan. Reduced angling pressure since the introduction of controlled access in 1988 and reduction in Provincial quotas has improved the population situation noticeably in Fraser lakes and streams.

In 1991, Fraser Inc. held a workshop designed to address common concerns relating to fisheries management on its 340,000 hectares of Freehold lands in northern New Brunswick. As a result of this exercise, surveys were conducted on specified waters in 1992 and a demonstration of habitat was conducted on the Gulquac river system. DNRE's lake and stream survey files were reviewed to identify waters surveyed and management systems recommendations. The importance of an overall fisheries management plan and a course of action was identified. The survey work on the Gulquac river system involved electrofishing work, carried out by Fraser's field crews, the removal of the North Branch logging dam, (allowing the Atlantic salmon the opportunity to colonize an additional 15 km of the stream, an area capable of producing 400 to 500 adult salmon), and arrangements with the Mactaquac fish hatchery to obtain 100,000 fall fingerling salmon to plant in this area. Also in 1991 Fraser Inc. technical staff were assigned to survey the physical, chemical and biological characteristics of 20 Tobique drainage lakes.

Fraser Freehold Stragic Fisheries Management Plan

Case Study

Although the complete surveys were not performed on all lakes, the survey results showed that most lakes had excellent potential, with management, to support far more sport fishing than they did at the time. Especially important are the "Blue Ribbon" brook trout lakes that still have the capacity to produce excellent sustained angling for wild trout with implementation of management measures.

The Fraser Freehold lakes are divided into three categories:

- Blue Ribbon Lakes which will be managed for trophy class fishing, where angler numbers will be controlled and regulations will be: fly fishing only, 2 fish limits, 10"-12" size rules, fertilizing and lake closures when necessary to allow native stocks to rebuild;
- Highly Managed Lakes which will eventually have management measures such as: liming, spawning area improvement, possible fertilization, regulations such as fly and lure only, 5 fish quotas, 8" size limits, and in some cases limits on the number of anglers;
- Managed Lakes which receive some management control such as liming, stocking, regulations such as 5 fish quotas, 8" rules but general Provincial regulations apply and bait fishing will be allowed.

In the spring of 1992 a more detailed review of the fish management plan with DNRE and DFO, NB Wildlife Federation, Madawaska Fish and Game Club and Tobique Salmon Association was carried out at another workshop. Fraser Inc. met with Regional and Provincial DNRE fisheries personnel to review past work on Green and Tobique Watersheds to come up with possible joint ventures. Fraser also met with scientists from DFO to discuss past inventory work, future work load sharing in the electrofishing, stream surveys and ground truthing DFO data. The watershed survey of the Gulquac project was completed, feeder streams were assessed for improvement, channels were cleared, electrofishing continued, stocks were planted, and the installation of satellite rearing tank facilities was investigated. Reconnaissance and surveys, electrofishing and channel clearing were carried out on the Little Tobique, Two Brooks, Mamozekel River,

River Dee and Dan and O'Dell. Reconnaissance and data collection were carried out on all major streams and tributaries for physical and chemical parameters. Also fish populations and temperatures were reassessed as a result of a resurvey of those lakes surveyed in 1991. Hybrid salmon were stocked in Long and Trousers Lake, and brood stock were collected from Neary Lake or Riley Lake for rearing at a private facility. A brochure explaining Fraser Inc.'s program was produced.

The management plan for 1993 will include a continuation of the Gulquac project involving spot clean up, continued electrofishing, stocking of salmon fall fingerlings, and river clean up on the Little Tobique, Mamozekel, O'Dell, and Two Brooks, time permitting. Also population and habitat surveys, detailed mapping, monitoring and creel census of lakes under reservation system and modified policies were continued. Lake and stream management and treatment will be implemented. Lakes will be closed which were identified in 1992 as future Blue Ribbon lakes, where population problems exist or where reclamation and/or stocking has taken place. Several more lakes will be added to the Highly Managed Lakes category. Riley Lake opened as a hook and release lake. Restrictive angling policies will be implemented on major trout streams (fly fishing, size limits, quota reduction). The following will be implemented as required: liming, fertilizing reclamation of lakes, collection of brood stocks for rearing in hatchery, stocking of wild speckled, hiring of a fish warden, installation of satellite rearing tanks, and the development of canoe routes with land use departments.

APPENDIX K:
Crown Reserve Waters

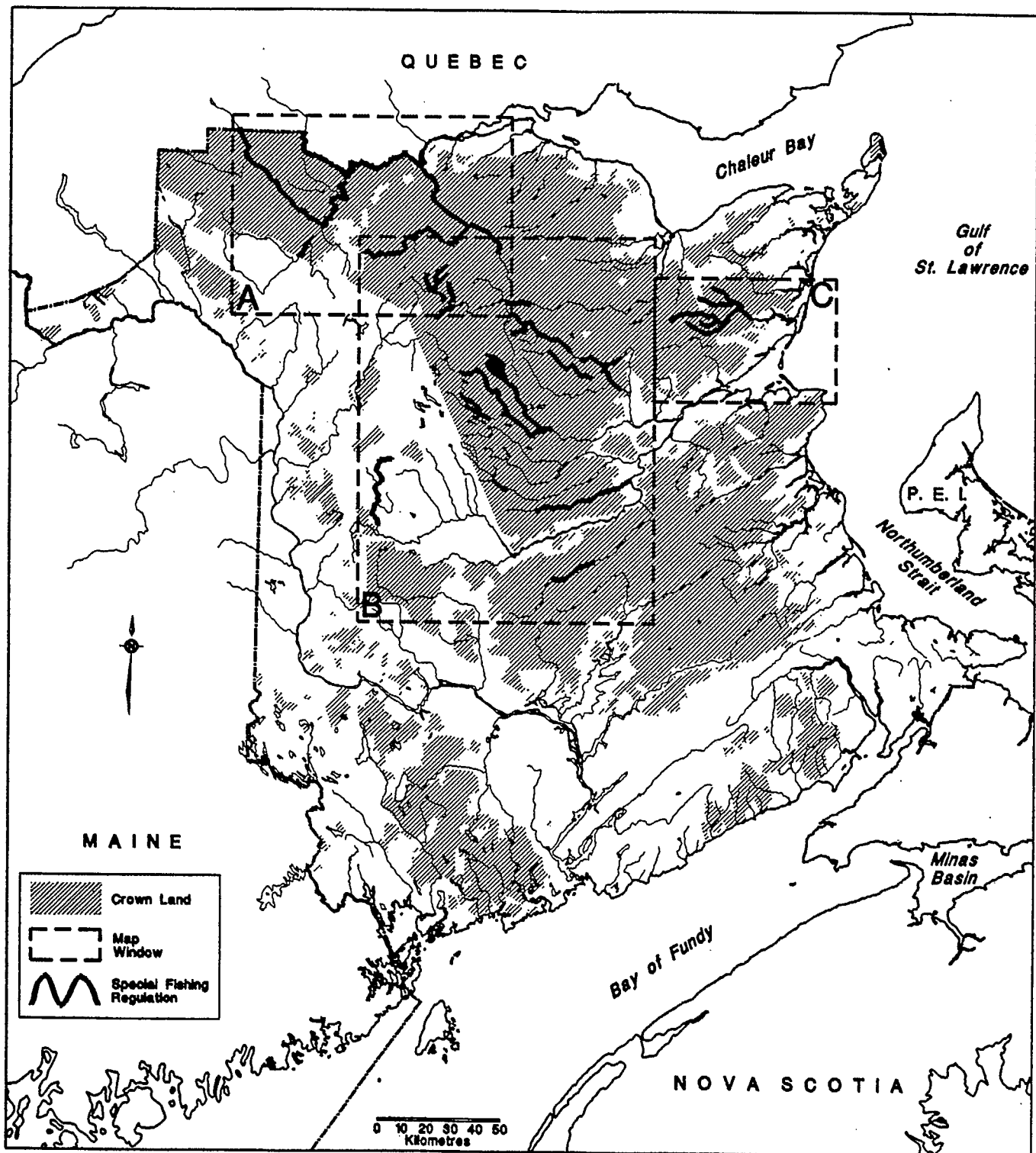


Figure K1. Index map for crown reserve waters maps (Figures K2, K3, K4) in New Brunswick.



Figure K2. Crown reserve waters in area A, Figure K1.

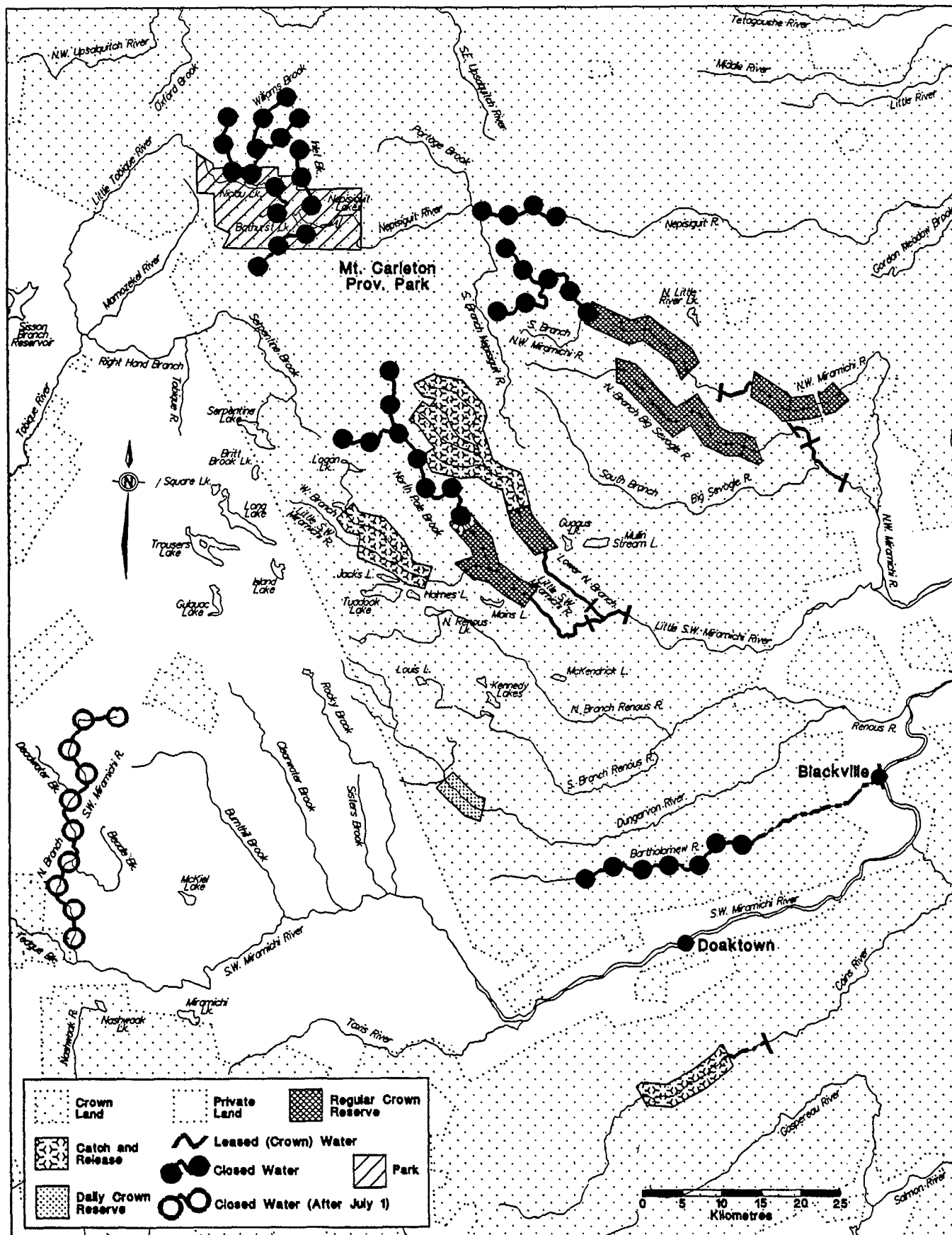


Figure K3. Crown reserve waters in area B, Figure K1.

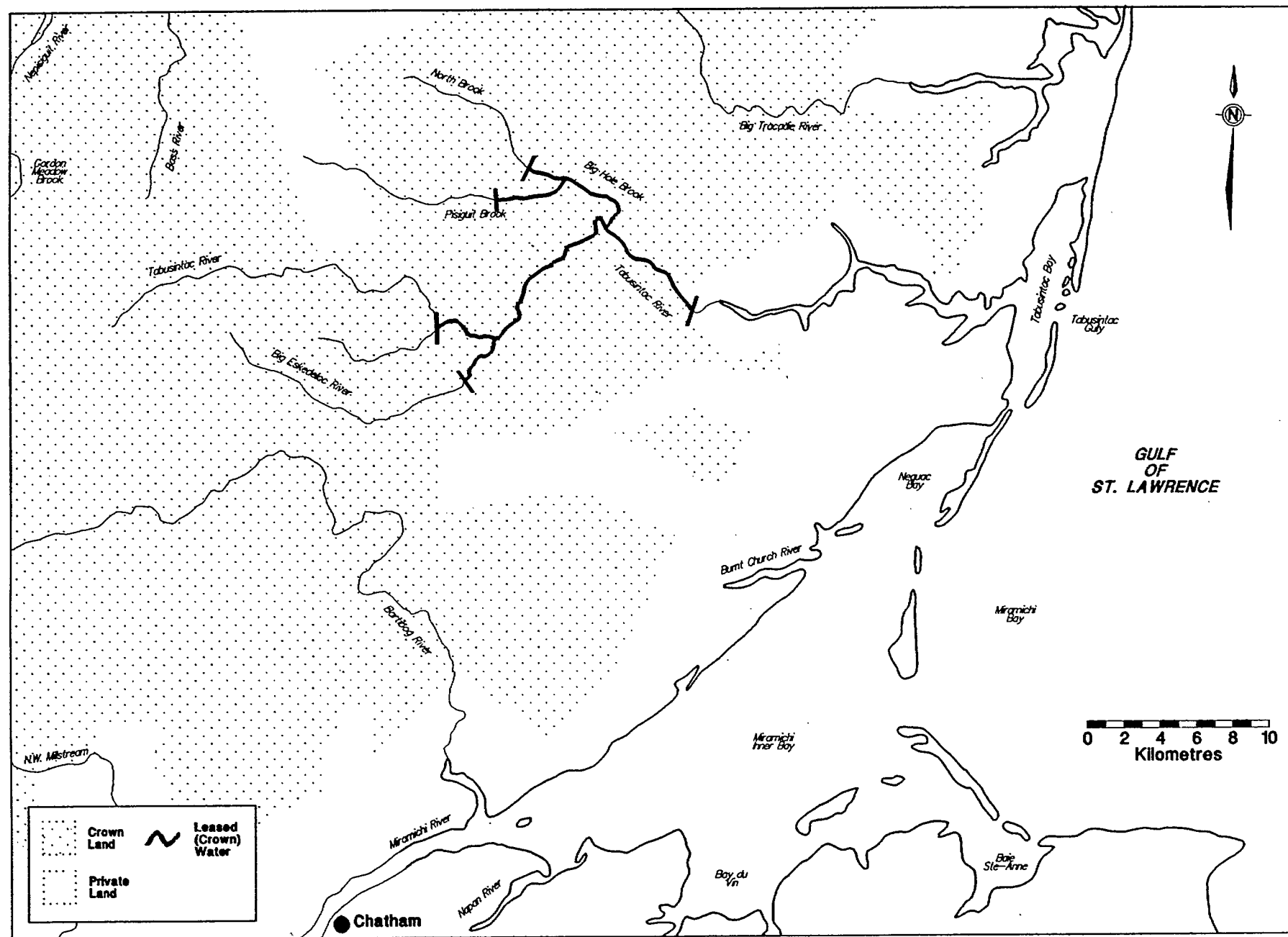


Figure K4. Crown reserve waters in area C, Figure K1.

APPENDIX L:
Watershed Maps

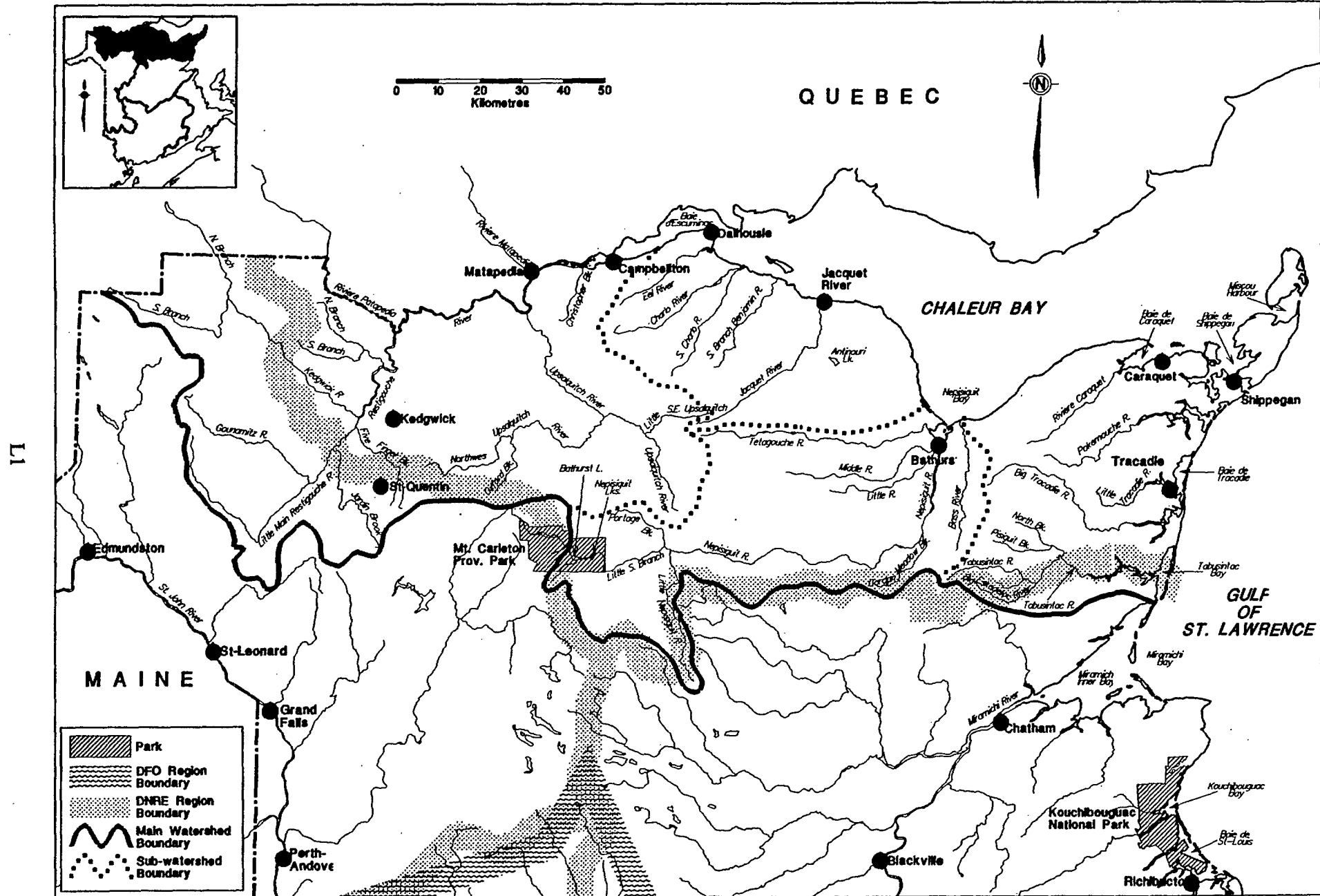


Figure L1. Map showing the Chaleur Drainage with DNRE and DFO administrative boundaries.

L2

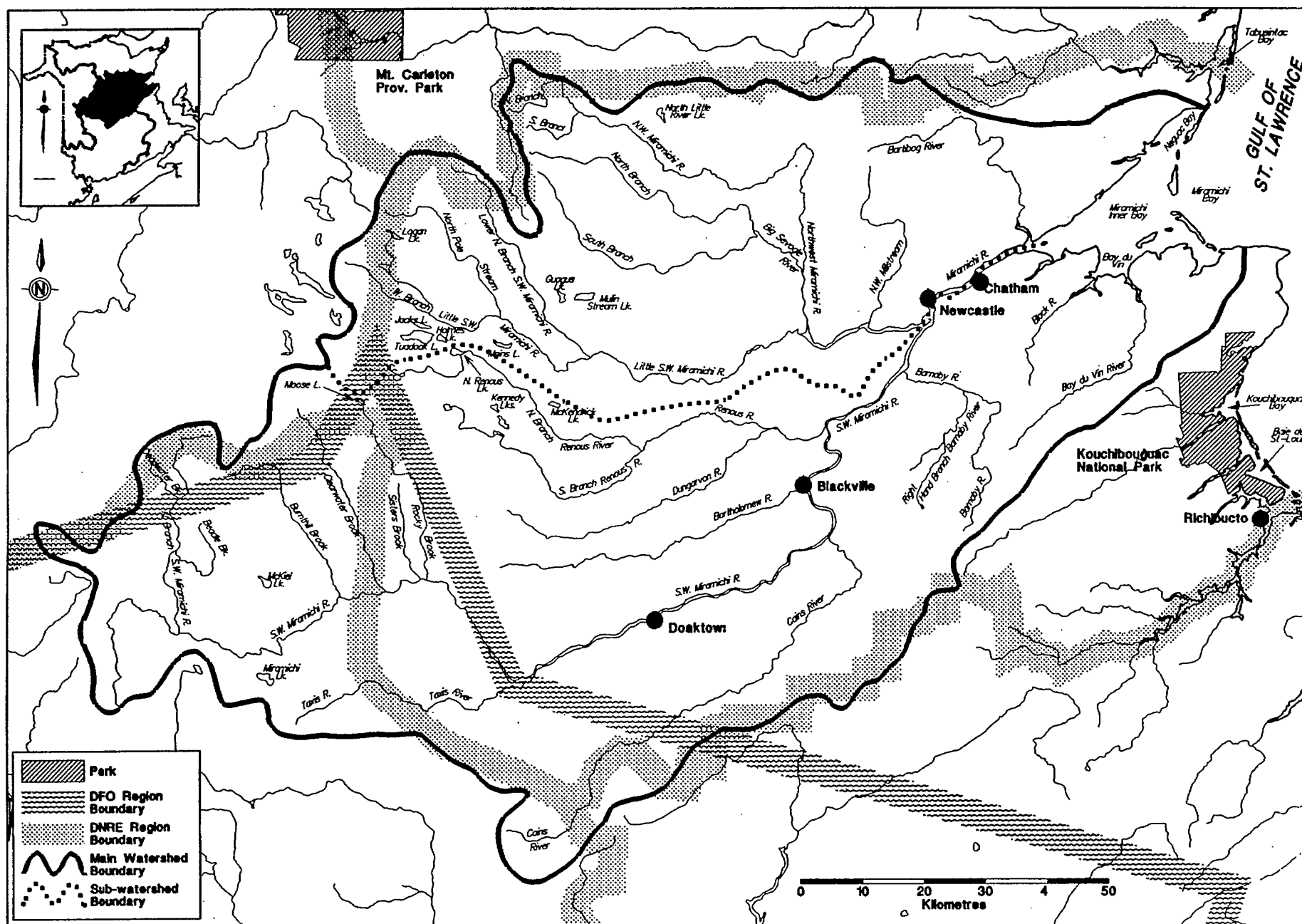


Figure L2. Map showing the Miramichi Drainage with DNRE and DFO administrative boundaries.

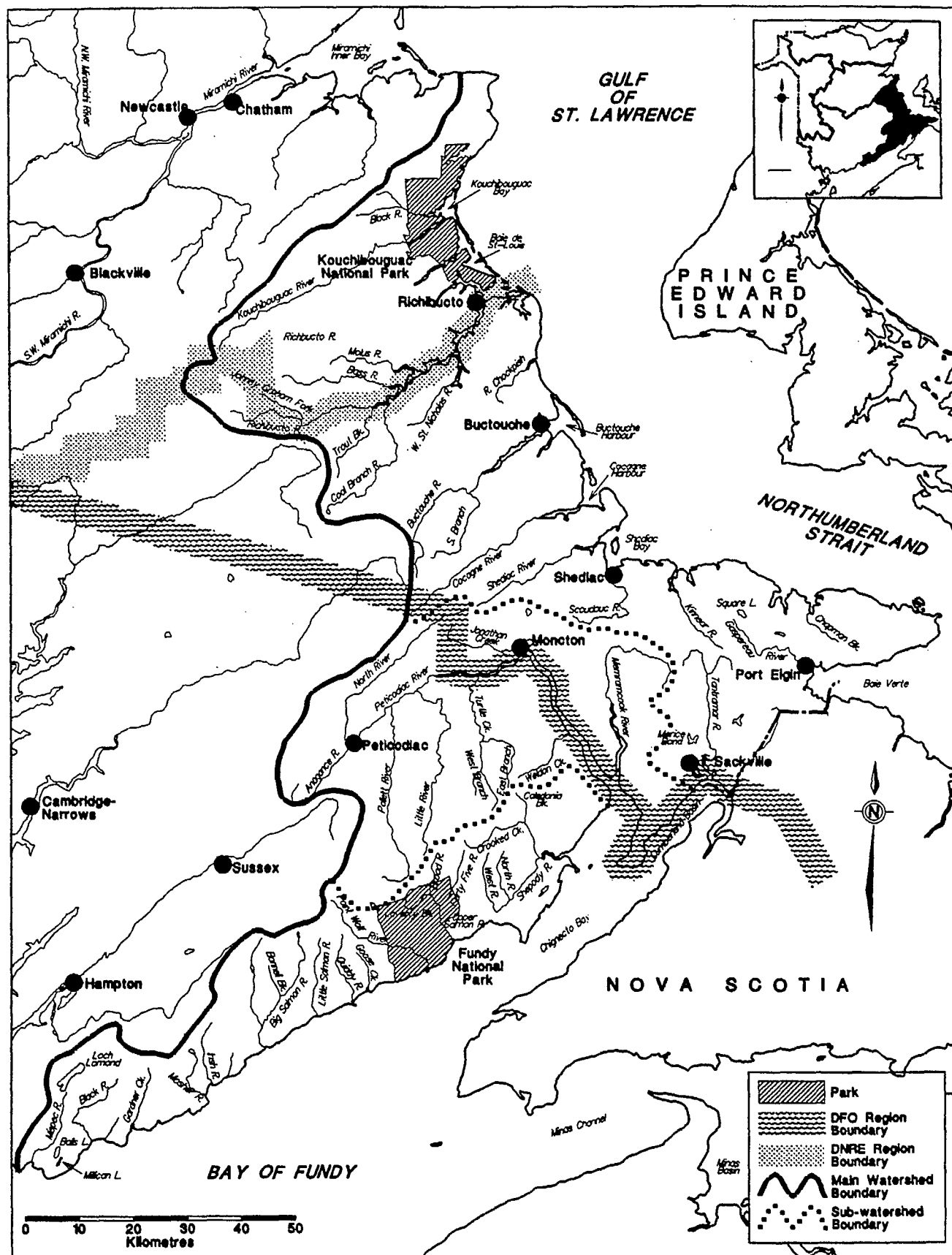


Figure L3. Map showing the South-east Drainage with DNRE and DFO administrative boundaries.

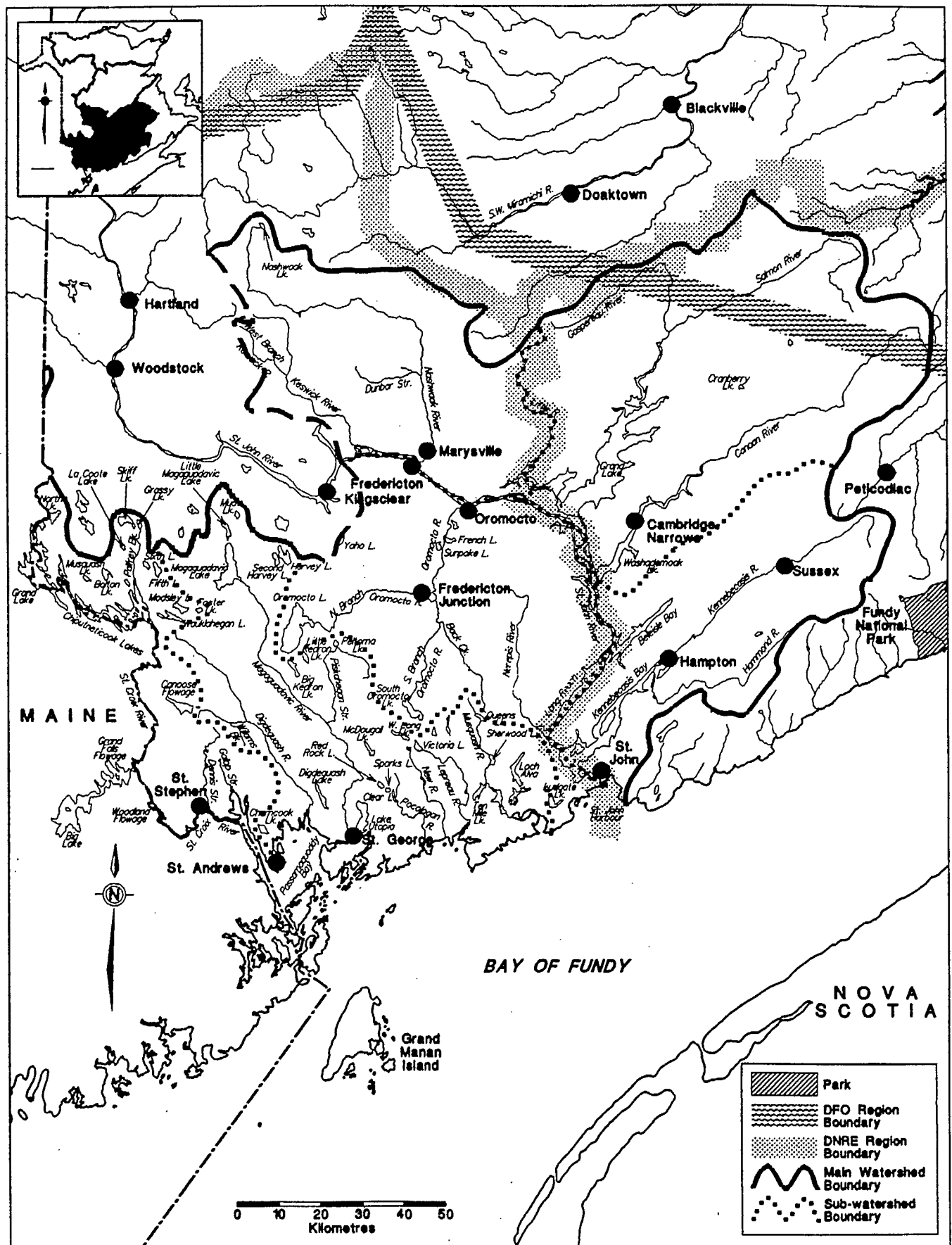


Figure L4. Map showing the Lower St. John (Central) and South-west Drainage with DNRE and DFO administrative boundaries.

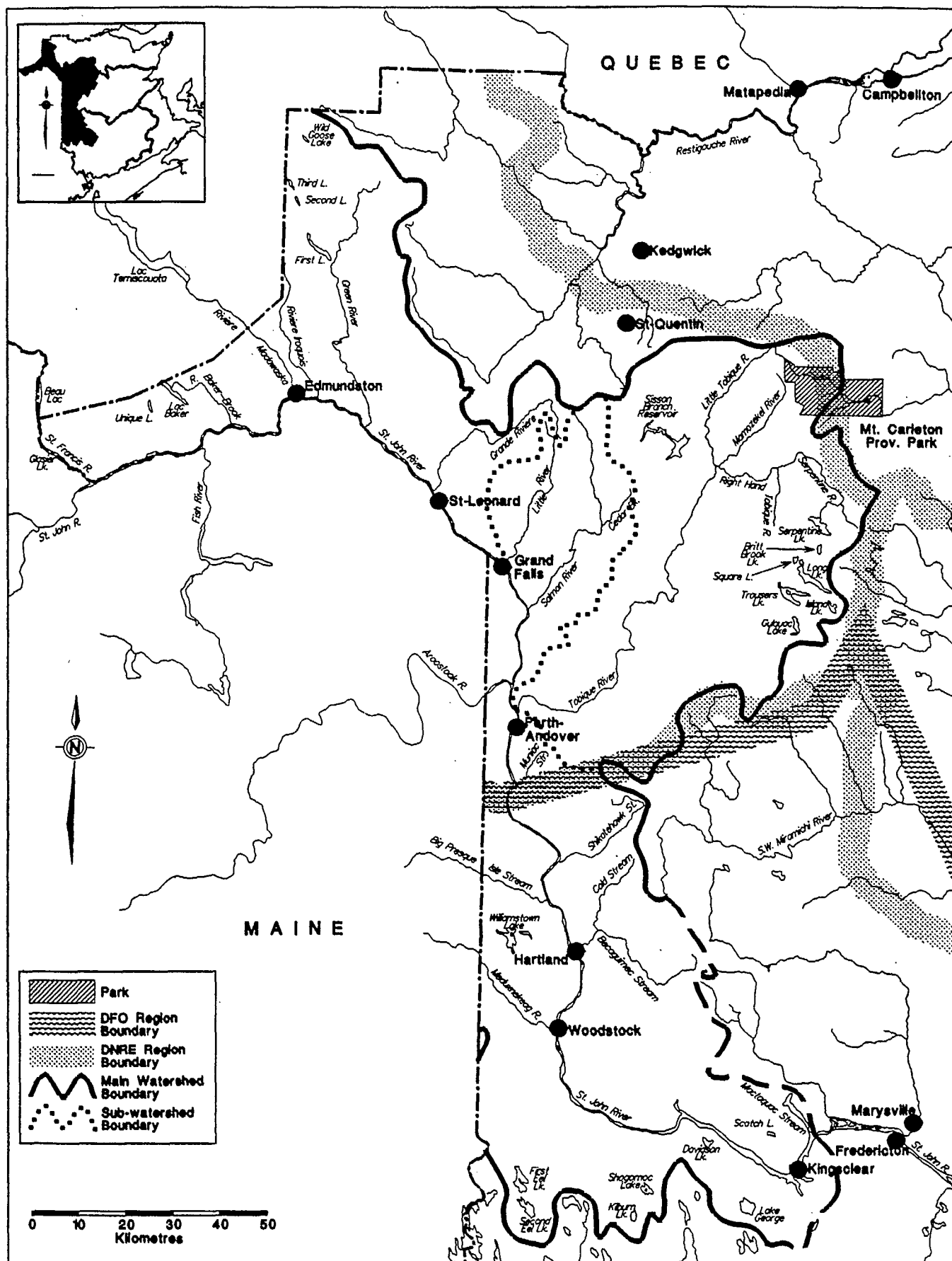


Figure L5. Map showing the Upper St. John Drainage with DNRE and DFO administrative boundaries.

APPENDIX M: COMPENDIUM OF NEW BRUNSWICK SPORTFISH

prepared by

The Atlantic Reference Centre
St. Andrews, N.B.

(¹⁴maps prepared by LGL Limited)

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¹⁴ Initial drafts of the species distribution maps presented in this compendium were initially prepared by personnel from the Atlantic Reference Centre. These maps were subsequently revised based upon comments received by DNRE's regional biologists whose efforts we thank. The "final" maps contained herein were prepared by LGL Limited using a computer-assisted drafting program. Any errors and/or inaccuracies are the responsibility of LGL Limited.

PRIMARY SPORTFISH

Atlantic Salmon

Scientific name: *Salmo salar*

Local vernacular names: salmon, saumon atlantique

More words of praise and description have been written about the Atlantic salmon than any other fish. It is renowned as a gamefish, prized as a foodfish, admired for its beauty of form and persistence in overcoming obstacles to return to its spawning grounds. The salmon is the most important sportfish in New Brunswick. Until the last few years, the salmon was in real danger of extinction in its North American range. Its numbers had been drastically reduced by over-exploitation and destruction of its habitat. The prospect of extinction still exists but has been greatly reduced by aquaculture, which has removed much of the fishing pressure on the wild stocks. However, intensive culture of salmon may create conditions suitable for the spread of contagious diseases which could pose a threat to wild and cultured stocks. An additional threat to stocks may be genetic manipulation which is currently being conducted by research agencies. Such manipulation should be carefully examined and monitored to avoid damage to the gene pool of native stocks. Although avid salmon anglers welcome the concept of hook and release, this practice should also be carefully monitored to ensure that subsequent mortality rates of hooked salmon remain at acceptable levels.

Distribution

The Atlantic salmon ranges from Ungava and Hudson Bay in the north, and south to coastal Connecticut in the United States. In Canada, it occurs along the entire east coast from Ungava Bay to the southern-most limits of the Bay of Fundy. Originally it ranged throughout the St. Lawrence River system including Lake Ontario. The last salmon was taken in Lake Ontario by 1890.

New Brunswick.--Atlantic salmon occurs naturally in all major drainage systems in the province. Some, such as the Miramichi, are among the most famous and productive salmon rivers in the world. Atlantic salmon have been extensively cultured and stocked into several drainages in the province for more than 50 years. These introductions have been so extensive that accurate records are unavailable.

Habitat.--Salmon prefer cool, shallow gravel stream and river beds for spawning and nursery grounds for juveniles (parr). Major construction projects such as dams and bridges have seriously affected juvenile and spawning habitat in some parts of the province. Adults migrate to inshore and offshore marine waters for 1-6 years before returning to their natal rivers to spawn.

Life History Information Relevant to Management

Spawning and early life history.-- Salmon have a strong homing tendency. When returning to freshwater from the sea, most return to the same river they left as smolts. They move into estuaries and then freshwater in spring and summer for early-run fish, and in fall for late-run fish. The approximate time of inbound migration is a characteristic of an individual river. After acclimatization to freshwater in the estuaries, the salmon commence their upstream migration to the area where they themselves were incubated. Thus, destruction of spawning grounds is significant because the population using the bed to spawn in will be destroyed as they will not spawn elsewhere. Constructing

dams, bridges, roads, etc. may cause physical destruction of spawning areas and restrict mature salmon from reaching them. Industrial pollution and the associated changes in pH, water temperature and dissolved oxygen may directly destroy the eggs and larvae.

Hatching, incubation and stream life of the young are similar to that of landlocked salmon (see landlocked salmon below). After 2-3 years in the stream, young salmon reach 12-15 cm in length and move downstream to the estuary and then out to sea. Salmon grow rapidly in the marine environment and may return as "grilse" (2-4kg) after one year at sea or return after 2 or more years as large salmon. Atlantic salmon may spawn several times and portions of some populations spend the winter after spawning in the freshwater of their natal rivers. They return to the sea the following spring as kelts or black salmon.

The most vulnerable time in the life of salmon is during the freshwater phase - the egg-parr-smolt stage and as adults ascending streams to spawn. Formerly important commercial fisheries in the province harvested salmon in the estuaries of natal rivers with traps and gill nets. Angling for returning salmon in freshwater has largely replaced the commercial fishery.

Size and Age.-- Young Atlantic salmon follow much the same pattern as landlocked salmon (see below) attaining 13-15 cm in length after 2-3 years in freshwater. Growth in marine waters is rapid and salmon may reach 4 kg in the first 14 months. Salmon older than 1 year may grow to 6 kg before they return and salmon which have spawned more than once and remained at sea for several years may reach 25-35 kg in weight. Few salmon live beyond 9 years.

Food and Feeding Habits.--The food eaten by young salmon in streams is similar to that of landlocked salmon. When in the sea, salmon eat a variety of organisms, in particular crustaceans such as euphausiids, decapod shrimp and amphipods. Larger salmon also consume fish like herring, sand lance, mackerels and small cod. When they re-enter freshwater, mature salmon cease feeding, although they will take an angler's fly.

Primary Fishing Areas.--The primary fishing areas are in stretches of deep flowing water and pools with minimal current found in many New Brunswick rivers including large rivers like the St. Croix, Saint John, Restigouche and Miramichi, to name only a few. Most dedicated salmon anglers have a favourite river, pool or stretch of water. Several excellent fishing areas are accessible to the general public or allow public access through a lottery. Other areas are under private lease and access is restricted to club members or other individuals.

Regulations.--Anglers are required to release alive all salmon over 63 cm total length, but may keep two grilse (<63 cm) each day with a limit of 8 per angling season. Four fish may be caught and released per day if no grilse are kept. All retained fish must be tagged with special locking tags that are provided with the provincial salmon licence.

Angling Methods.--In Canada, Atlantic salmon can be legally fished only with fly fishing tackle. Fly fishing for salmon is a traditional sport with many unique fly patterns and fishing techniques. Several patterns and methods have been developed for individual rivers and seasons.

Sportfish Characteristics.--The Atlantic salmon is a world renowned sportfish and is often referred to as the "king of gamefish". Fly fishing for salmon is regarded by many as the ultimate

angling experience. The fighting qualities, leaping abilities, endurance and size make the Atlantic salmon one of the most sought-after sportfish in the world.

Foodfish Characteristics.--The salmon is a superb and highly-prized foodfish. The reddish-orange flesh is delicious when baked, steamed, broiled and smoked. Strong market demand for the flesh of salmon has resulted in the rapid expansion of the aquaculture industry in New Brunswick.

Current Economic Utilization.--The production of Atlantic salmon by aquaculture has become an economically significant industry in New Brunswick. The production of cage-cultured salmon in the lower Bay of Fundy rose from a value of \$1.5 million in 1982 to \$95 million in 1991. The value of salmon as a recreational fishery is higher than any other sportfish in the province. The sport fishery continues to support many local economies in all parts of the province; guide and outfitter services, tackle sales and related accommodation and visitor service industries are all important revenue generators.

Population Enhancement Procedures.--Production of wild stocks requires maintaining water quality and cover, and reducing erosion in rivers and streams. Management of adult spawning stocks should be integrated and flexible and account for current trends in abundance. Management on an individual river basis is complicated, but has been shown to be necessary in some regions to maintain and enhance wild stocks. Salmon are very easily cultured and many strains have been developed and stocked in the waters of the province. Recent reductions in commercial fishing effort on New Brunswick stocks may result in a general increase in abundance of Atlantic salmon in areas where stock size had declined.

Cautionary Notes.--Because it is an excellent gamefish, Atlantic salmon have been targeted for study, management and enhancement, while other less popular gamefish species have been neglected. Some of the resources allocated for salmon enhancement could be effectively used on other species. Proper management and enhancement of recreational fisheries for other gamefish species could relieve fishing pressure on some Atlantic salmon stocks.

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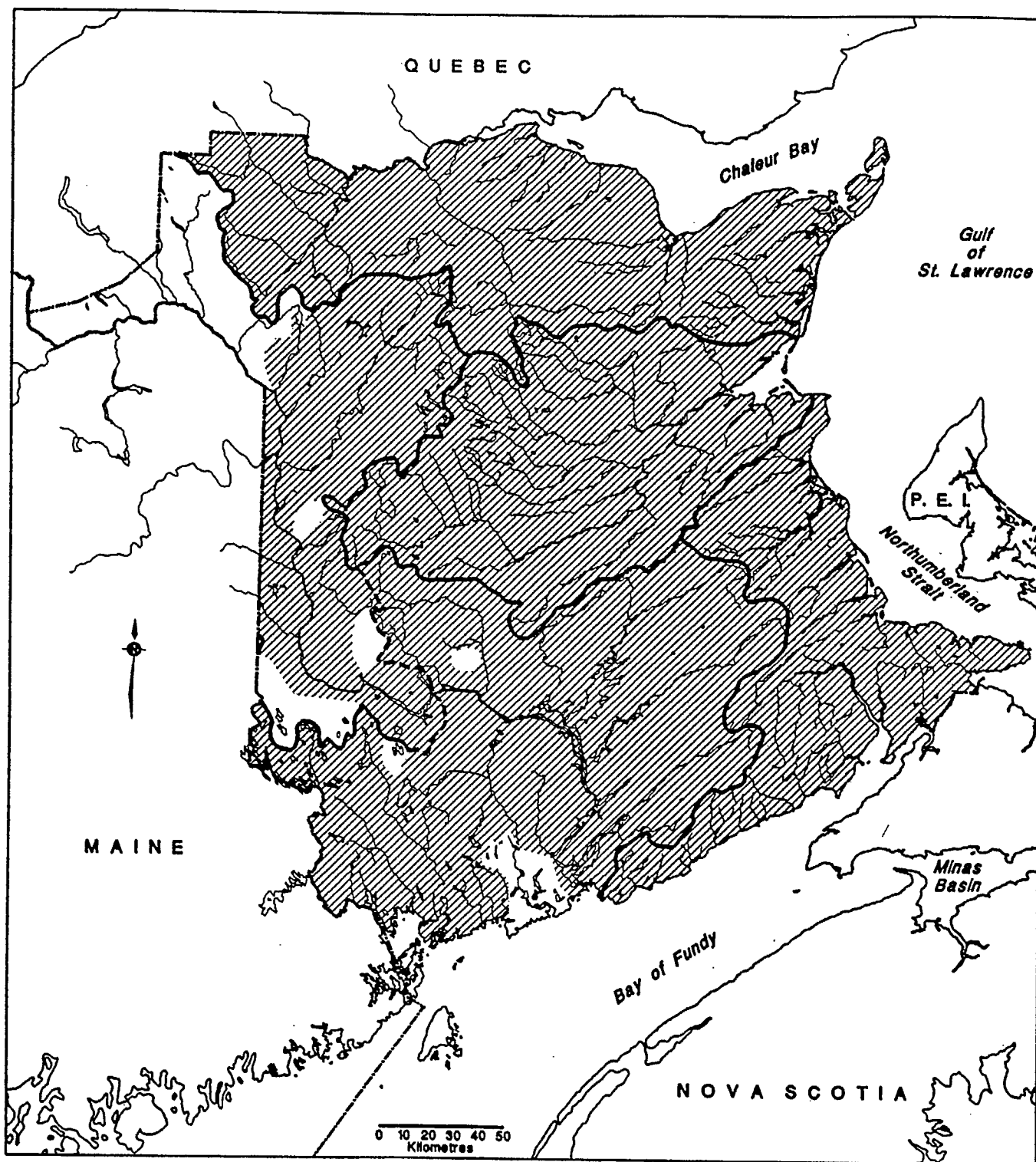


Figure M1. Distribution of Atlantic Salmon in New Brunswick.

Landlocked Atlantic Salmon

Scientific Name: *Salmo salar*

Local vernacular name: landlocked salmon, saumon d'eau douce, ouananiche

Landlocked Atlantic salmon do or did occur in many lakes of eastern Canada (including Lake Ontario before extirpation around 1870). Landlocked salmon are generally smaller and slower growing than sea-run salmon, and their flesh is more pale and less colourful. Externally, landlocked salmon are darker in colour. Although the fish is said to be 'landlocked', implying physical isolation from the sea, many freshwater populations have access to the sea but choose not to go. The reasons why they do not migrate are not known and studies have failed to show any significant morphological or physiological differences between landlocked and anadromous Atlantic salmon. Hence, details of physiological requirements of sea-run salmon apply also to landlocked salmon. In New Brunswick, landlocked Atlantic salmon are sometimes called 'black salmon' but these should not be confused with kelts, which are spent sea-run Atlantic salmon that are also sometimes called 'black' salmon. Kelts are usually larger and rather emaciated compared with landlocked salmon. Many studies on the biology and management of landlocked salmon have been conducted in the state of Maine, where it is a highly prized game fish.

Distribution

Indigenous landlocked Atlantic salmon occurred in many lakes of northeastern North America, especially in eastern Canada and the extreme northeastern U.S., particularly the state of Maine. In Canada, populations occurred in Newfoundland and Labrador, Nova Scotia, New Brunswick, Quebec and even into Ontario (until about 1870).

New Brunswick Watersheds.-- They are found in many parts of the province but particularly in lakes of the following drainages: Central and south west Drainage (St.Croix, Saint John rivers, lakes in Sunbury, Queens, Saint John counties), Upper Saint John River Drainage (Madawaska, Victoria counties), Chaleur Drainage (Restigouche River and lakes in Restigouche and Gloucester counties), Miramichi Drainage (lakes in Northumberland County), and SE Drainage (lakes in Albert County).

Introductions.-- Landlocked salmon have been stocked in many lakes in New Brunswick including lakes to which they were not native. Most of the introductions have been made since the mid-1960s, and stocking has continued to the present day. In the neighbouring state of Maine, stocking of lake Atlantic salmon began as early as 1868 and is done in over 60 lakes.

Habitat and Habits.-- Natural populations of landlocked salmon in New Brunswick occur as adults in cool, oligotrophic lakes that have unpolluted, cool, gravel-bottom tributary streams. They appear to prefer lake outlets.

Life History Information Relevant to Management and Enhancement

Spawning and early life history.--In October and November the sexually mature salmon migrate from the lake up tributary streams to deposit their eggs and sperm over the depressions (redds) created in the gravel by the spawners. The tributary streams are essential for the survival of self-sustaining populations of landlocked salmon. After spawning, the adults may remain in the stream for days or

even weeks before returning to the lake, while in other populations they may return to the lake a few days after spawning. The eggs are buried in gravel at depths of 20 to 30 cm, with depth depending in part on the depth of the gravel over the bottom substrate. Incubation time depends on water temperature, but eggs usually hatch in about 6 months at temperatures of 0 to 4° C. Hatching occurs in about 110 days at a temperature of 3.9° C. After hatching, the young salmon remain in the stream, dispersing along the gravel bottom. The newly hatched salmon, called 'alevins', remain in flowing water until they are about 65 mm long at which time they are called 'parr' and usually grow slowly. When parr reach a length of 12 to 15 cm, they become smolts and move downstream to the lake. This downstream movement does not take place until 2 to 3 years after hatching.

Size and age.--Landlocked Atlantic salmon do not grow as large as sea-run salmon. In New Brunswick, salmon in lakes containing smelt or other forage fishes grow larger than do salmon feeding entirely on insects and other invertebrates. The size of landlocked salmon may vary greatly and depends on the kinds of food that are available; in some lakes, salmon may not exceed 30 to 35 cm in length. In New Brunswick lakes, most landlocked salmon are caught at lengths of 35 to 55 cm and at ages of 3 to 6 years. Average age-at-length relationships for landlocked salmon in the province are as follows: 1 yr - 13 cm; 2 yr - 25 cm; 3 yr - 35 cm; 4 yr - 45 cm; 5 yr - 50 cm; 6 yr - 55 cm; 7 yr - 58 cm. Fish older than 7 years are seldom caught. Landlocked salmon in other parts of their range may attain a larger size. In Lake St. John, Quebec, home of the ouananiche (landlocked Atlantic salmon), the largest fish caught was about 3.2 kg and in Sebago Lake, Maine a fish of 16.1 kg was caught many years ago.

Food and feeding habits.--The importance of rainbow smelt in the diet of landlocked salmon was stressed over 100 years ago by studies carried out in northern New England, particularly Maine. Indigenous populations of landlocked salmon seemed to occur only in lakes having a self-sustaining population of indigenous smelt and, indeed, this also appears to be the situation in Canada. Larval smelt, an excellent source of food for salmon, are hatched at the same time that recently hatched salmon begin seeking food. In lakes where forage fishes are not available, salmon depend on invertebrate foods such as insects, so their growth is slower and the fish are usually smaller.

Current Regulations.-- The catch limit is 2 fish per day with a minimum length of 35 cm, except in certain lakes in Restigouche and Madawaska counties where the minimum length is 50 cm.

Angling Methods.-- The fish are usually caught by dry or wet fly and by spin casting.

Sportfish Characteristics.-- Sleek landlocked Atlantic salmon are a valuable and high-quality game fish. They are strong and vigorous fighters, but landlocked salmon are probably less highly regarded and sought after by some New Brunswick fishermen than are the larger sea-run Atlantic salmon. In neighbouring Maine, the landlocked salmon is considered the state's most important game fish.

Foodfish Characteristics.-- Quality of flesh varies from good to fair to poor, depending on the lake of origin. Some white-fleshed salmon is considered of poor quality for table use.

Current Economic Utilization.-- It is a popular game fish with many enthusiastic followers but it is not fully exploited.

Development Potential.-- A reduction in size limits on lakes with slow-growing salmon populations would make more populations available to anglers.

Population Enhancement Procedures.-- The present population levels probably satisfy angler demand. The numerous shallow ponds in the province offer an opportunity for stocking landlocked Atlantic salmon for put and take angling.

Cautionary Notes.-- Population maintenance depends upon high standards of water quality, particularly in terms of maintaining regular stream flow and pollution controls. Much information on landlocked salmon is available for Maine populations but this information may or may not apply to New Brunswick populations. The landlocked salmon populations of the province require more study than they have received.

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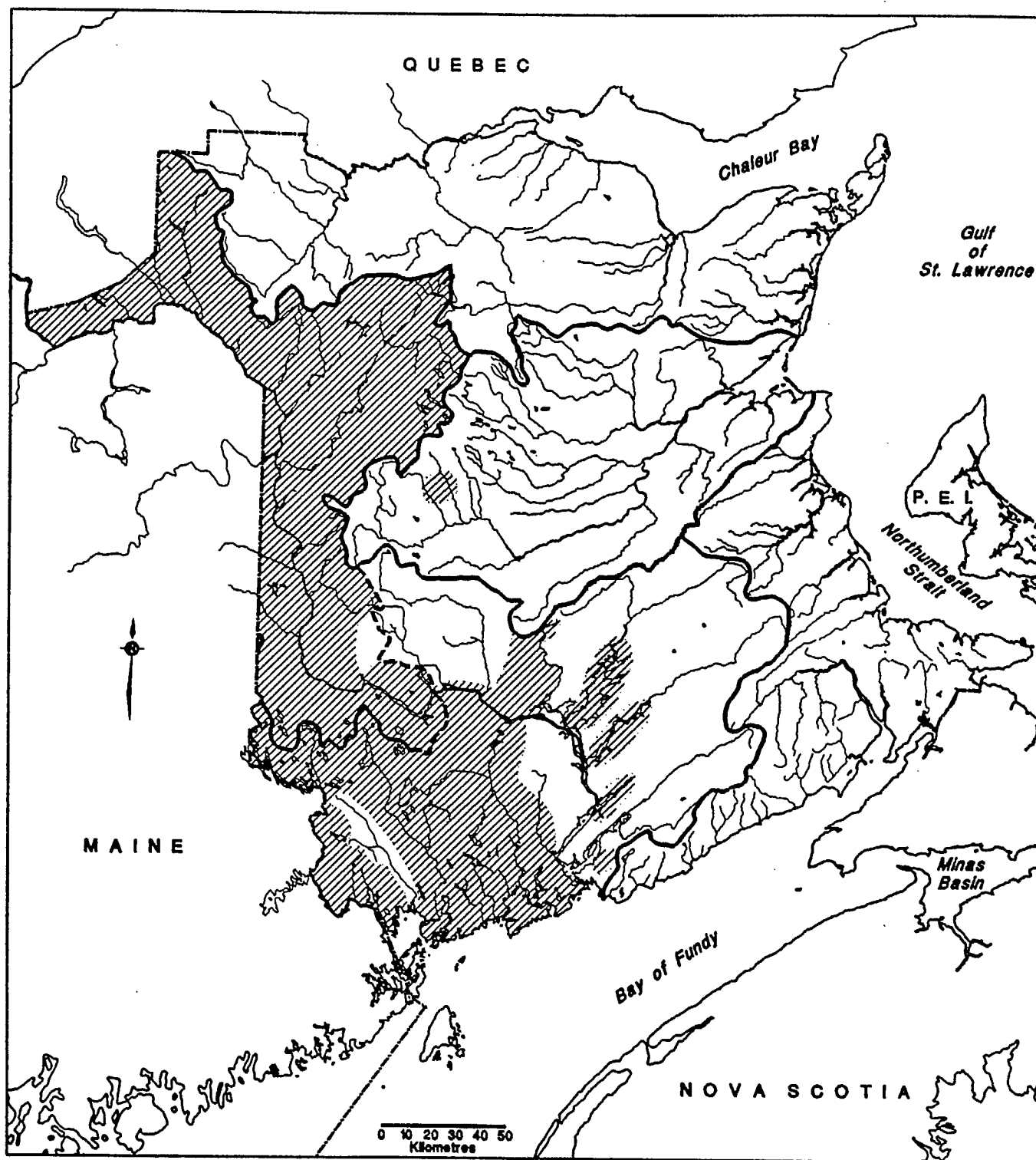


Figure M2. Distribution of landlocked Atlantic Salmon in New Brunswick.

Brook Trout

Scientific name: *Salvelinus fontinalis*

Local vernacular names: speckled trout, mud trout, brook char(r), omble de fontaine, truite mouchetée

Distribution

Brook trout are native to eastern North America, ranging from Hudson Bay to Cape Cod on the Atlantic coast in the east, the Appalachian Mountains and Georgia to the south, and the upper Mississippi and Great Lakes drainages in the west. In Canada, they are found in Newfoundland and Labrador, the Maritimes, Quebec, the Great Lakes drainage of Ontario and north to James and Hudson bays and the North East coast of Manitoba.

New Brunswick Watersheds.-- Brook trout are found in Central and SW Drainage, Upper Saint John River Drainage, Chaleur Drainage, Miramichi Drainage and South East Drainage. They may be the most widely distributed freshwater fish in New Brunswick.

Habitat and Habits.-- Brook trout prefer clear, cool, well-oxygenated streams, rivers, and lakes. In general, fish size is generally related to stream size, with the smallest trout inhabiting small brooks, medium-size individuals in larger streams and ponds, and the largest fish in large ponds and lakes. They feed actively in spring and prefer stream pools and cover, or shady areas or the shallow littoral bottom waters of lakes. If temperatures are less than 20° C through the summer, brook trout remain in streams and rivers. Otherwise, they move downstream to the cooler, deeper waters of lakes or seek oxygen-rich currents. They do not feed very much at this time. In winter, they aggregate and feed in deeper pools of streams or deeper waters of lakes. When temperatures are cold, juveniles are known to hide in rubble. Sea-run brook trout is discussed in the following section.

Life History Information Relevant to Management and Enhancement

Spawning and early life history.--Brook trout spawn between late October and early December, migrating upstream in autumn to spawn in shallow, gravel-bottomed headwaters of streams. Spawning beds are in swift water, in gravel with groundwater seeping up through it, or in the gravelly shallows of lakes where springs are present. Males migrate first to battle for territories; male aggression increases with the arrival of the females. Females dig redds in the gravel, and then cover them with gravel after spawning. Fecundity increases with size: females have approximately 80 eggs at 12.7 cm in length and 5000 eggs at 56 cm. The eggs and young receive no parental care. Incubation time for eggs in gravel is 50 days at 10° C to 100 days at 5° C. Larvae leave the gravel spawning beds when the yolk is absorbed at about 38 mm in length.

Size and Age.--The maximum size of brook trout is 86.4 cm in length and 6.6 kg in weight. Fish larger than 4.5 kg are rare and the average weight is less than 0.5 kg. The minimum recorded size at first maturity is 13.7 cm at a probable age of 2. Most fish mature at an age of 2 to 3 with lengths of 15.2 to 17.8 cm, after which they spawn for 2 or more years. There is no minimum legal angling size. Brook trout seldom live more than 5 years and virtually never more than 8 years.

Water Quality Requirements.--Brook trout prefer clear, well-oxygenated water, seeking flowing, upwelling water when spawning in fall and in summer when temperatures reach 20° C. Spawning

females prefer near-neutral to alkaline pH upwelling water. Eggs and fry are apparently little affected by pH above 4.5.

Food and Feeding Habits.--Brook trout are euryphagous and eat small fishes such as minnows, yellow perch, sticklebacks, banded killifish, sculpins; large aquatic insects; terrestrial insects; and zooplankton. They actively choose the largest individual zooplankton and aquatic insects, especially when co-occurring with white sucker. They are also known to cannibalize brook trout eggs and fingerlings.

Primary Fishing Areas.-- Brook trout are fished in streams, rivers, lakes, and beaver ponds throughout New Brunswick.

Regulations.-- There is a bag limit of 10 brook trout per day in streams and rivers, 5 per day in ponds, lakes, and reservoirs. There is no minimum size limit.

Angling Season.-- The angling season is from April 15 to September 30. The best fishing is often immediately after ice-out in April, and most angling is in May with very little angling from late June to the end of season.

Angling Method in N.B.-- Brook trout are fished with live bait (worm or small fish), spin casting, and artificial fly. They can be angled from shore, casting into 1.5-3.0 m of water, with bait near bottom, or trolled from small boats or canoes, often with live bait and spinners, fishing the littoral zone bottom at 1.5-5.0 m.

Sportfish Characteristics.-- Brook trout are one of the finest and most popular game fishes in eastern Canada and are subject to high angling pressure in New Brunswick. Only small brook trout are generally found in areas of concentrated human populations; in remote areas, with reduced angling pressures, larger fish are taken. A 0.5 kg brook trout is a good catch.

Foodfish Characteristics.-- The brook trout is a fish of delicious flavour. Flesh colour varies and changes with size in non-spawners: white at less than 15 cm in length, pale to orange at 15 - 23 cm, and deep orange at 25 - 35 cm. This colour change is probably associated with habitat and food.

Current Economic Utilization.-- It is illegal to sell wild-caught fish. Brook trout are reared for aquaculture. There are no existing brook trout tournaments, fishing clubs, or directed guide fishery.

Development Potential.-- Brook trout angling could be encouraged in remote waters of New Brunswick, far removed from centers of human concentration. Light angling pressure in any one area is advised to retain large fish in the population (see Cautionary Notes below).

Population Enhancement Procedures.-- In healthy populations, large brook trout are vulnerable to angling and can be overexploited even with light fishing. In such populations, strict enforcement of bag limits and reintroducing reasonable minimum-size limits are recommended. Ice fishing in small lakes with natural populations is not recommended. Brook trout populations are depressed by low productivity habitats, competition from other fishes (e.g. yellow perch, white perch, white sucker, creek chub, chain pickerel, smallmouth bass, American eel), lack of suitable habitat, and overfishing. Artificially fertilizing small lakes in New Brunswick is shown to increase brook trout growth, though

it does not necessarily increase yields. Liming is of questionable value. Removing other fish competitors prior to artificial fertilization or stocking programs is beneficial. Suitable habitat in streams is enhanced by constructing small dams, current deflectors, and cover. Overfishing can be controlled by closing overexploited populations to fishing, enforcing bag limits, and enacting a minimum-size limit.

The infrastructure for a stocking program is well established in New Brunswick and represents a viable option to augment depressed brook trout populations. Suitable waters for stocking are cool, clear and well-oxygenated, and have adequate depths to maintain maximum temperature below 20° C (this could perhaps be achieved through increasing water levels, e.g. raising dam height in a beaver pond). Management techniques that maintain the productivity of the water, provide knowledge and control of potential fish competitors, and close habitats to fishing until the desired population structure has been achieved (followed by controlled fishing) should be encouraged. Controlling bird and mammal predators substantially increases the return of stocked brook trout. Highest yields are achieved when stocking, fertilization, and predator control are carried out simultaneously. In situations where the above procedures are ineffective or undesirable, an alternative is stocking angling-size trout for put-and-take fishery. Historically, the vast majority of such fish are taken during the stocking year; returns in subsequent years are negligible without further stocking. A unique development opportunity would be a put-and-take ice fishery for large brook trout.

Cautionary notes.-- Care must be taken to avoid over-exploiting wild populations. Large individuals are especially vulnerable to overfishing. Brook trout suffer from competition with various fishes (e.g. yellow and white perch, white sucker), so the total fish fauna of a water body must be determined before rehabilitation, in order to make informed decisions. Competition for food and space with age 0 rainbow trout may reduce the summer growth of age 0 brook trout, increasing overwinter mortality, and perhaps eradicating the population. Caution is also advised when stocking "forage" species which may prove competitive. The inadvertent introduction of bait fish (e.g. creek chub, white sucker) into brook trout habitat should be avoided. Water course alteration that reduces cold water habitat downstream is detrimental to brook trout populations. Improperly conducted riparian activities (e.g. road building, clear cutting, farming) that increase the silt load of brook trout habitat are also detrimental.

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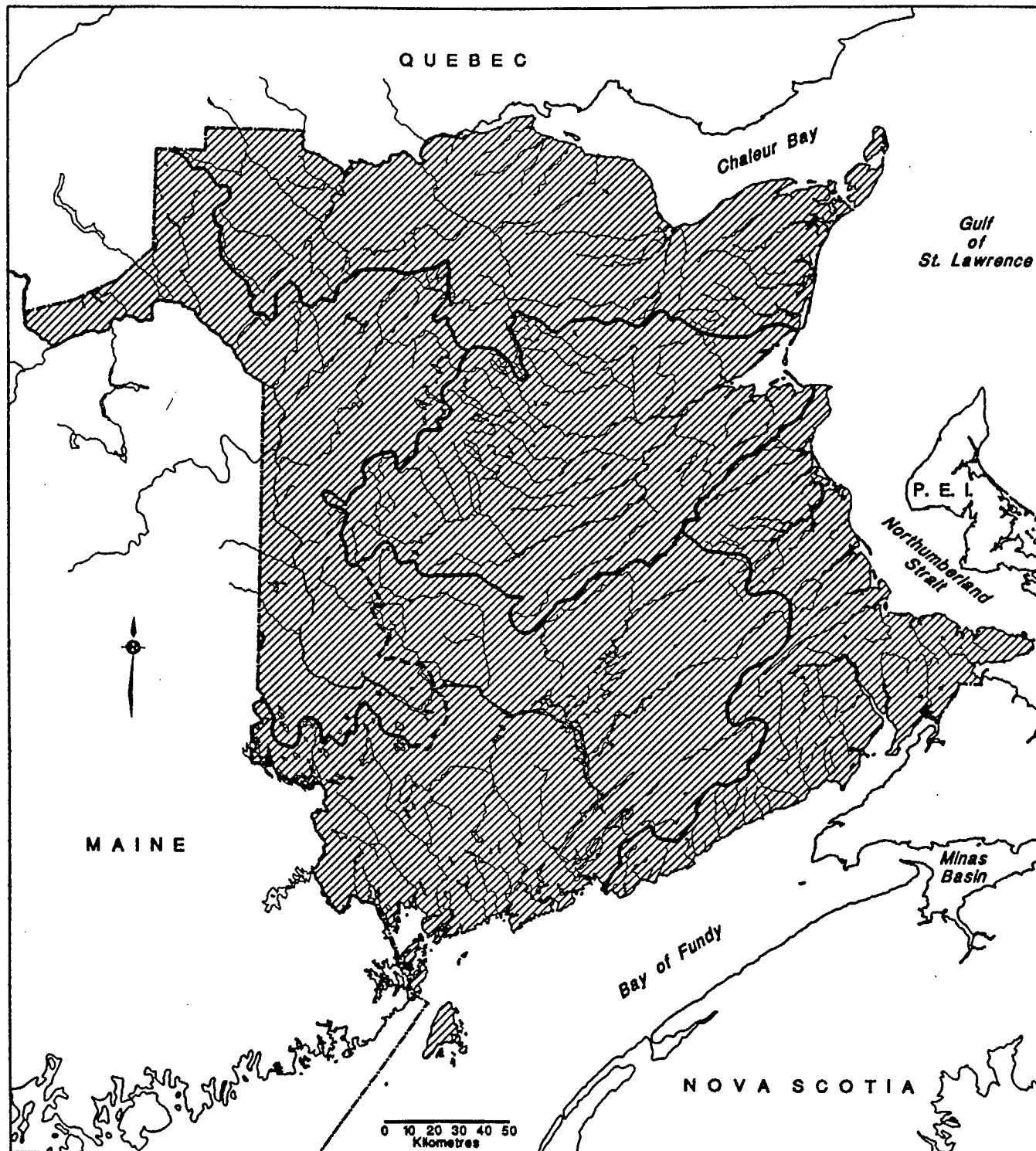


Figure M3. Distribution of Brook Trout in New Brunswick.

Searun Brook Trout

Scientific name: *Salvelinus fontinalis*

Local vernacular names: sea trout, omble de fontaine, truite mouchetée

General Comments

Brook trout in many coastal streams and rivers are anadromous. These fish are of the same taxon as non-anadromous brook trout; populations contain both types of individuals. Anadromous trout of 2-4 years of age move downstream to sea in spring immediately following the freshet peak. Migrations to sea do not exceed distances of 75 km. Up to 1 month may be spent in an estuary before going to sea. Salinity tolerance is best when fish are longer than 15 cm in length. Searun brook trout remain at sea for 2-3 (and occasionally up to 5) months, in shallow, coastal waters near their native stream/river, where they school and feed heavily. In July and August, searun trout return to fresh water, most ascending their natal stream. The silvery appearance of these trout is soon lost after entering fresh water. Brook trout can overwinter at sea, though this is not the norm. More frequent, less directed movements are made between fresh and salt water than these directed seasonal migrations. Searun brook trout grow more quickly than non-anadromous trout, though maximum sizes are about the same. This is likely due to better feeding conditions at sea, where a wide variety of fishes and invertebrates are eaten.

There appears to be little difference between anadromous and non-anadromous brook trout in choice of spawning site, reproductive behaviour, fertility, early ontogeny, or early life history. Searun trout mature relatively later in life, and final gonad ripening occurs after returning to fresh water. Their fecundity, however, is higher than non-anadromous brook trout. Fish normally spawn for 2-3 years.

Searun brook trout form an important recreational fishery, and in coastal waters angling effort can be substantial. Approximately 41 percent of coastal streams in New Brunswick have searun trout in sufficient quantities to provide a sport fishery. They are netted for local consumption in Atlantic Canada, and occasionally are taken in estuarine gaspareau (May and June) and smelt (winter to February) trap nets. Since most natural populations contain only a few thousand fish, their numbers are generally too small for commercial exploitation. Research has shown them to be a poor candidate for marine cage culture.

Population Enhancement Procedures.-- Habitat restoration is suggested where degradation has depleted searun populations; local populations could be used as hatchery stock to supplement existing populations. To improve the survival of reared fish, the fish should be gradually acclimatized to sea water, released during spring when they are naturally migrating to sea, reared in large estuaries (more living space) with proper geomorphology (with mixed as well as stratified water), and in good condition. Growth can be improved by choosing marine sites with abundant food resources. Selective breeding may improve growth.

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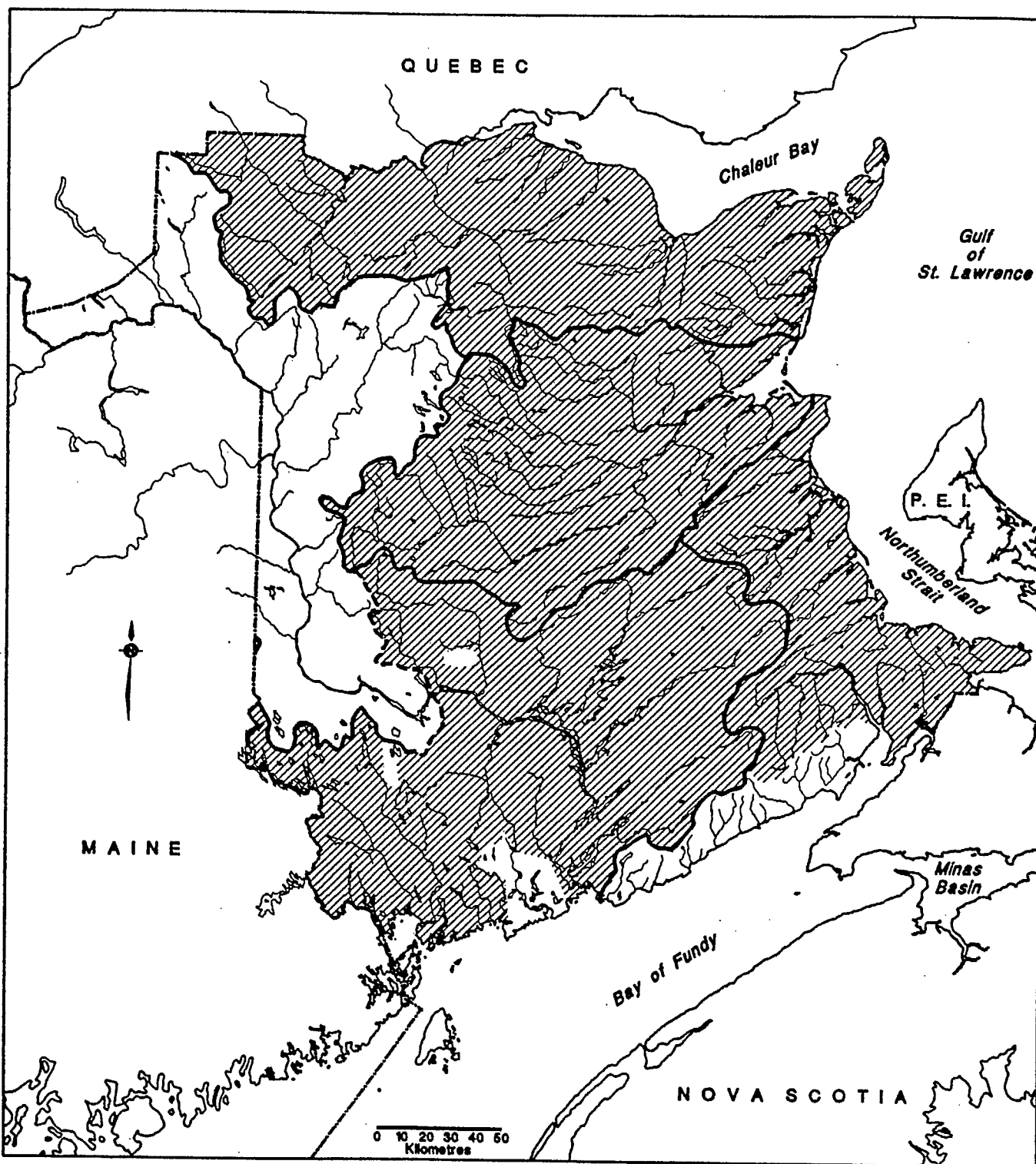


Figure M4. Distribution of searun Brook Trout in New Brunswick.

Lake Trout

Scientific name: *Salvelinus namaycush*

Local vernacular names: togue, touladi

Distribution

Lake trout are native to North America and are widely distributed. They range from Nova Scotia south to New England, and westward in the US to Alaska, Idaho, and Montana. In Canada they occur in southwest Nova Scotia, New Brunswick, much of Quebec, Labrador, Ontario (but not along Hudson and James bays), mostly northern Manitoba, Saskatchewan, Alberta, British Columbia, and they are widely distributed in the Yukon and Northwest Territories.

N.B. Watersheds.-- Lake trout are found in the headwaters of Saint John, St. Croix, and Restigouche rivers, and in some isolated lakes in southwest New Brunswick that are not in Miramichi system. They inhabit the Central and SW Drainage, the Upper Saint John River Drainage, and the Chaleur Drainage.

Introductions.-- Widely introduced to other countries.

Habitat & Habits.-- Lake trout occur in relatively deep lakes with well oxygenated water in southern Canada and in shallow lakes and rivers in northern Canada. They are chiefly a freshwater fish, although they have been reported in coastal waters (their upper salinity tolerance is 11-13 ppt). Depth distribution is seasonal. In early autumn, as waters cool, lake trout leave deep waters for more moderate depths, and then move to rocky shallows for spawning in early October. After spawning, lake trout disperse to various distances and depths where remain for winter. In spring, lake trout can be found in surface waters immediately after ice breakup. With warming, they move to deeper, cooler water, and in summer, they move below the thermocline, (usually 12 - 18m in small lakes), seeking waters of around 10° C. In large lakes, lake trout inhabit deeper water.

Life History Information Relevant to Management and Enhancement

Spawning and early life history.-- Lake trout spawn in autumn, usually in October, on rocky bottoms (boulder, reef, or rubble) at depths less than 12 m and sometimes as shallow as 0.5 m; they rarely spawn in rivers. They spawn at night before midnight, and apparently home to spawning grounds. Fecundity varies with the size of female. Generally, a female produces 880 - 2640 eggs per kg of body weight (this may increase with exploitation as a population regulating mechanism). There is some cleaning of the spawning bed by fanning and brushing; fertilized eggs fall into the crevices between rocks. Lake trout provide no parental care. Eggs usually hatch in March - April to yolk-sac larvae. After 1 month, the young usually seek deeper water.

Size and Age.--The maximum size recorded for lake trout was 126 cm and 46.3 kg; it was estimated that the fish was 20 to 25 years old. Generally, the average size is 1.5 to 2.3 kg. Fish reach first maturity after 6 or 7 years at which they are 35 to 40 cm in length in eastern Canada. They age to their minimum legal catch size in 7-9 years. Maximum longevity is 23 years.

Food and Feeding Habits.--Lake trout are predatory, taking a wide variety of fish. If prey fish are unavailable (such as when they inhabit shallows in summer) or of insufficient quantity, lake trout eat zooplankton and aquatic insects. When this is their only diet, the growth rate is reduced and the fish are smaller in size.

Water quality preferences.-- Lake trout prefer freshwaters that are clear and cold ($\leq 10^{\circ}\text{C}$), and well oxygenated, so they are usually found in deeper waters.

Fishery Management Tactics Currently in Effect.-- There is a creel limit of 5 per day (to a total weight of 3.5 kg in New Brunswick-Maine boundary waters). In boundary waters, there is a minimum size limit of 45 cm.

Primary Fishing Areas.-- Lake trout are found primarily in the larger, deeper lakes in southern and western New Brunswick.

Angling Season.-- The angling season is from April 15 to September 30. Lake trout are fished mainly in spring, and can be taken immediately after ice breakup. They are sometimes fished in summer, and are angled through ice in many parts of Canada.

Angling Method in N.B.-- In spring, lake trout are angled at surface by casting from shore or trolling using natural bait or artificial lures resembling forage fish; or by fly fishing with streamer flies (mimicking forage fish) and dry and wet flies (mimicking aquatic insects). In summer, lake trout are beneath the thermocline, and are trolled with artificial lures, often employing downriggers.

Sportfish Characteristics.-- Lake trout are highly prized as a game fish, giving a good fight. They are one of the larger trouts available for angling in New Brunswick freshwaters.

Foodfish Characteristics.-- Excellent flavour. The flesh is white, pink, orange, or orange-red. It is usually eaten fresh, although it is sometimes smoked.

Current Economic Utilization.-- Lake trout are angled locally, usually by experienced fishermen. There are no lake trout tournaments, clubs, or directed guide fishery. Lake trout eggs fertilized with brook trout sperm produce the fertile hybrid "splake", which is planted in many parts of North America (sparingly in New Brunswick).

Development Potential.-- There is little potential to develop wild populations because of low abundances and susceptibility to overfishing. Intensive stocking of selected non-polluted lakes containing an adequate base of forage fishes may increase lake trout numbers sufficiently to improve angling success.

Population Enhancement Procedures.-- Natural populations may be enhanced by introducing a minimum size limit of at least 40 cm fork length to increase the number of individuals reaching sexual maturity. Lake trout are highly susceptible to habitat degradation, thus protecting their habitat, especially known spawning grounds, is recommended. Lake trout stocking has had only limited success, though certain practices may improve the potential in New Brunswick. Insufficient numbers of spawners of hatchery-origin is a chronic problem in lake trout stocking programs. Thus an appropriate strategy is to concentrate large numbers of stocked fish in a few relatively smaller areas

to allow sufficient fish to reach sexual maturity. The choice of brood stock is important. Hatchery rearing may reduce the physiological or behavioral capability of fish, and their ability to survive. Thus brood stock should be genetically close to the wild population being enhanced. However, use of brood stock from different populations may offer the advantages of "hybrid vigor" and genetic variability, allowing for environmental selection of fit genetic types. Planting eggs or fingerlings on known spawning beds should increase success, encouraging imprinting and subsequent homing. Planted eggs can be protected using artificial turf.

Cautionary notes.-- Lake trout are highly susceptible to habitat degradation and overfishing. Competition with introduced exotic salmonids (e.g. chinook, coho) may impede growth.

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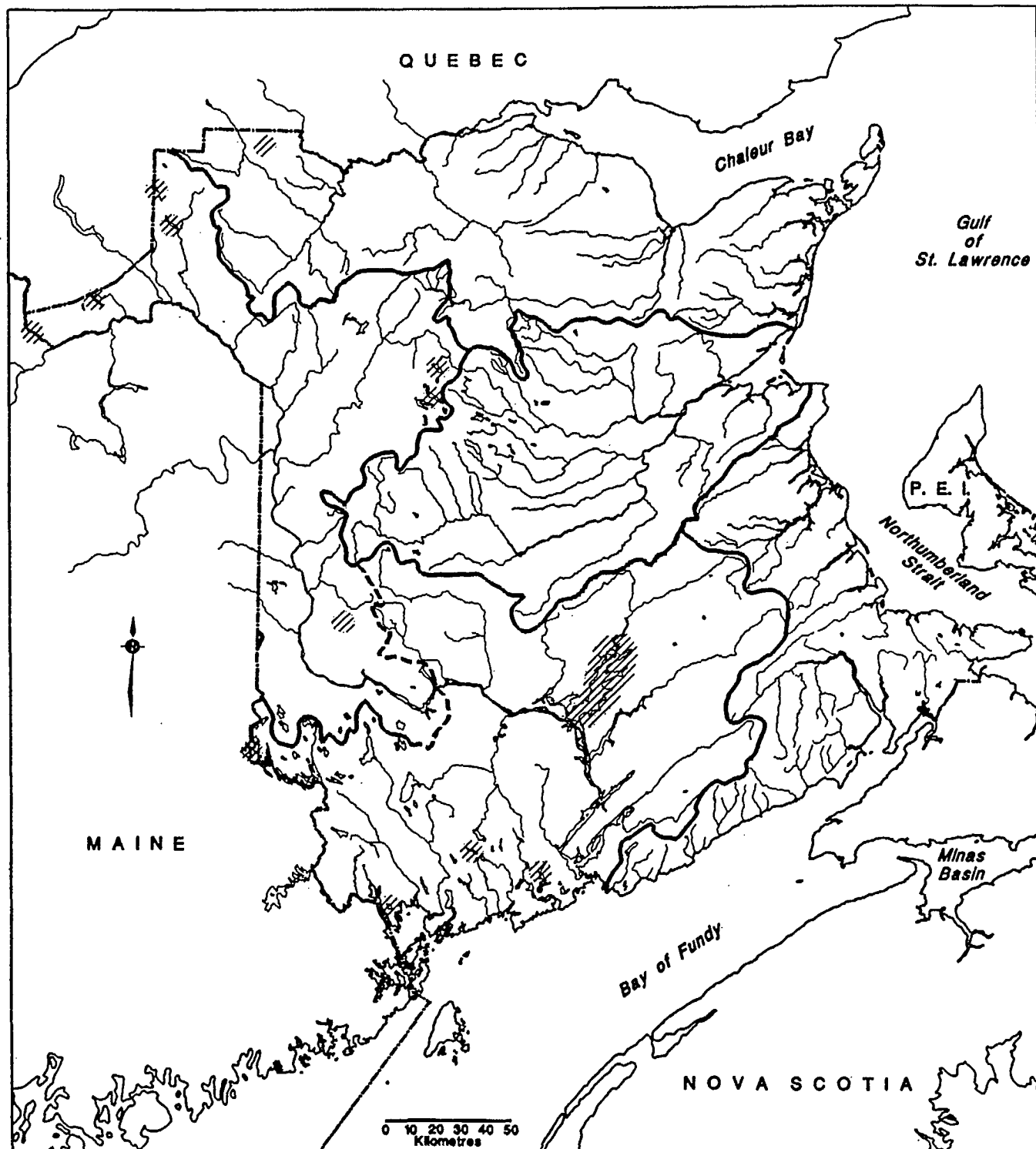


Figure M5. Distribution of Lake Trout in New Brunswick.

Brown Trout

Scientific Name: *Salmo trutta*

Local Vernacular Name(s): trout, German trout

The brown trout is not native to New Brunswick, although both freshwater restricted populations and anadromous strains are found here. Brown trout can be very selective for an individual prey species. For this reason they are often considered to be difficult to catch. In New Brunswick, brown trout have been subject only to minor exploitation. They are locally popular in some areas. Brown trout are less selective in their environmental requirements than brook trout or Atlantic salmon.

Distribution

Native to Europe and Asia, brown trout were introduced into the United States in the late 1800s. They are particularly abundant in the northeast and southwestern regions of the United States, in large rivers and lakes. They are found in all regions of Canada except PEI, the Northwest Territories and Manitoba. Brown trout have been in the Maritime provinces since 1921.

New Brunswick.-- Brown trout are found in only a few rivers and lakes in New Brunswick. They were originally stocked in the Saint John region in several lakes and one river and in the Digdeguash River in the southwest corner of the province. Anadromous strains from these original plantings may have spread to other river and lake systems.

New Brunswick Watersheds.-- Brown trout are present in the Central and Southwestern drainages.

Recent Introductions.--Originally stocked in the Loch Lomond River system in 1921, there have been subsequent plantings in the Digdeguash and Little Rivers and Shadow, Ashburne, Ping Pong and Blindmans Lakes, all (excepting Digdeguash) in Saint John County. Reproducing populations have been established in Loch Lomond and in the Digdeguash and Little Rivers. Some portions of the two river brown trout populations are anadromous.

Habitat.-- Brown trout prefer the pristine waters of lakes, rivers and streams. They are predominately fish of larger streams and rivers and are infrequently found in small brooks. Brown trout are tolerant of flowing waters and may chose to inhabit waters with high current rate if food is available. In New Brunswick, they are found in deep lakes with rock and gravel substrate and in large rivers with similar bottoms. Temperature preference dictates the preferred habitat.

Life History Information Relative To Management

Spawning and early life history.--Brown trout spawn in fall in New Brunswick at water temperatures of 7-9°C. Spawning is usually performed in the shallow, gravel headwater of rivers, but can occur over shallow reefs on the shorelines of lakes. The female forms a shallow depression in the gravel (redd) and deposits eggs which are fertilized by a single male. A 35-40cm female may spawn about 2500-3000 eggs. The eggs are demersal and are about 4-5 mm immediately after fertilization. They hatch in about 70 days.

Size and Age.--Brown trout are large salmonids. The largest recorded in Canadian waters was an anadromous fish from Newfoundland which weighed 15.5 kg. In New Brunswick, lake brown trout may attain weights of 4-5 kg; the average size for lake and river fish is about 0.25-1 kg. General age-length relationships for brown trout are: 1 yr-16 cm; 2 yrs-250 cm; 3 yrs-400 cm; 4 yrs-430 cm; 6 yrs-520 cm.

Food and feeding habits.-- Brown trout are opportunistic carnivores. They frequently feed on aquatic insects; very large brown trout may selectively feed on insects as small as chironomids and mayflies. Large brown trout also feed on large prey items such as forage fish, frogs, crayfish and small rodents. Feeding activity is most intense around dusk and in the early morning.

Water quality requirements.--The optimum water temperature for brown trout is 18-24°C, although they can survive water temperatures as low as -0.7°C. Brown trout are not tolerant of acid water conditions and prefer a pH of greater than 6.5. They are rarely found in waters with turbid environments.

Primary Fishing Areas.--In New Brunswick, the primary fishing areas for brown trout are several lakes and their tributary streams in the Saint John Area. Loch Alva and Loch Lomond are target areas for brown trout fishing. The Digdeguash River in the southwest has an anadromous and freshwater population, both of which are exploited by anglers.

Angling Season.-- Brown trout are caught predominately during the spring and late summer. Mid summer water temperatures are warm and may partially inhibit feeding, especially in shallow river environments.

Current Regulations.-- The brown trout angling season is from April 15 to September 30 annually. There is no minimum or maximum size restriction. The catch limit per day per angler is 10 fish.

Angling Methods.--In spring, brook trout are caught by trolling from boats and casting from shore with artificial lures, (minnow imitations such as the Rapala and spoons are preferred). Fishing with natural bait (live and dead), worms and small baitfish is practised in rivers and lakes. Limited fly fishing for the species in rivers is practised in late spring during insect hatches. Anadromous river populations are fished using all of the above methods.

Sportfish Characteristics.-- Brown trout are very popular game fish throughout their North American range. They are the most popular trout species in the United States. In New Brunswick, they are much less popular than brook trout, but this is probably due to their current limited distribution. They grow larger and fight more intensively than brook trout of similar size. Because of their habit of selective feeding (especially when feeding on aquatic insects), they are generally more difficult to catch than other trout and salmon species. This characteristic has made the brown trout the preferred species of fly fisherman in the United States.

Foodfish Characteristics.-- Brown trout are excellent foodfish and are highly prized wherever they occur. Except in catch and release areas in several large rivers in the United States, brown trout are seldom released by anglers. Their desirability as foodfish has resulted in heavy exploitations of brown trout populations. Most brown trout caught in New Brunswick are retained.

Current Economic Utilization.-- In New Brunswick, brown trout are popular sportfish and are exploited wherever they occur. Their rather limited distribution has dictated that most populations have been exploited only on a local or regional level.

Development Potential.-- The brown trout is very popular as a sport and game fish. It can thrive in a variety of pristine environments. Many waters in New Brunswick which are marginal habitats for brook trout could be successfully colonized by brown trout. Brown trout have been cultured since the mid 1800s, and propagation methods are not complex and are relatively inexpensive. Introductions to waters with suitable habitats are generally successful if sufficient numbers are stocked initially; self-sustaining populations are easily created.

Cautionary Notes.-- Brown trout are large carnivorous fishes that can compete successfully with other gamefishes. They can quickly out-perform brook trout and dominate available habitat. Larger brown trout are known to prey on small brook trout and Atlantic salmon parr. They are not indigenous to New Brunswick. Brown trout are susceptible to several contagious fish diseases such as Infectious Pancreatic Necrosis, Frunculosis and Bacterial Kidney Disease which can cause mortalities of other salmonids.

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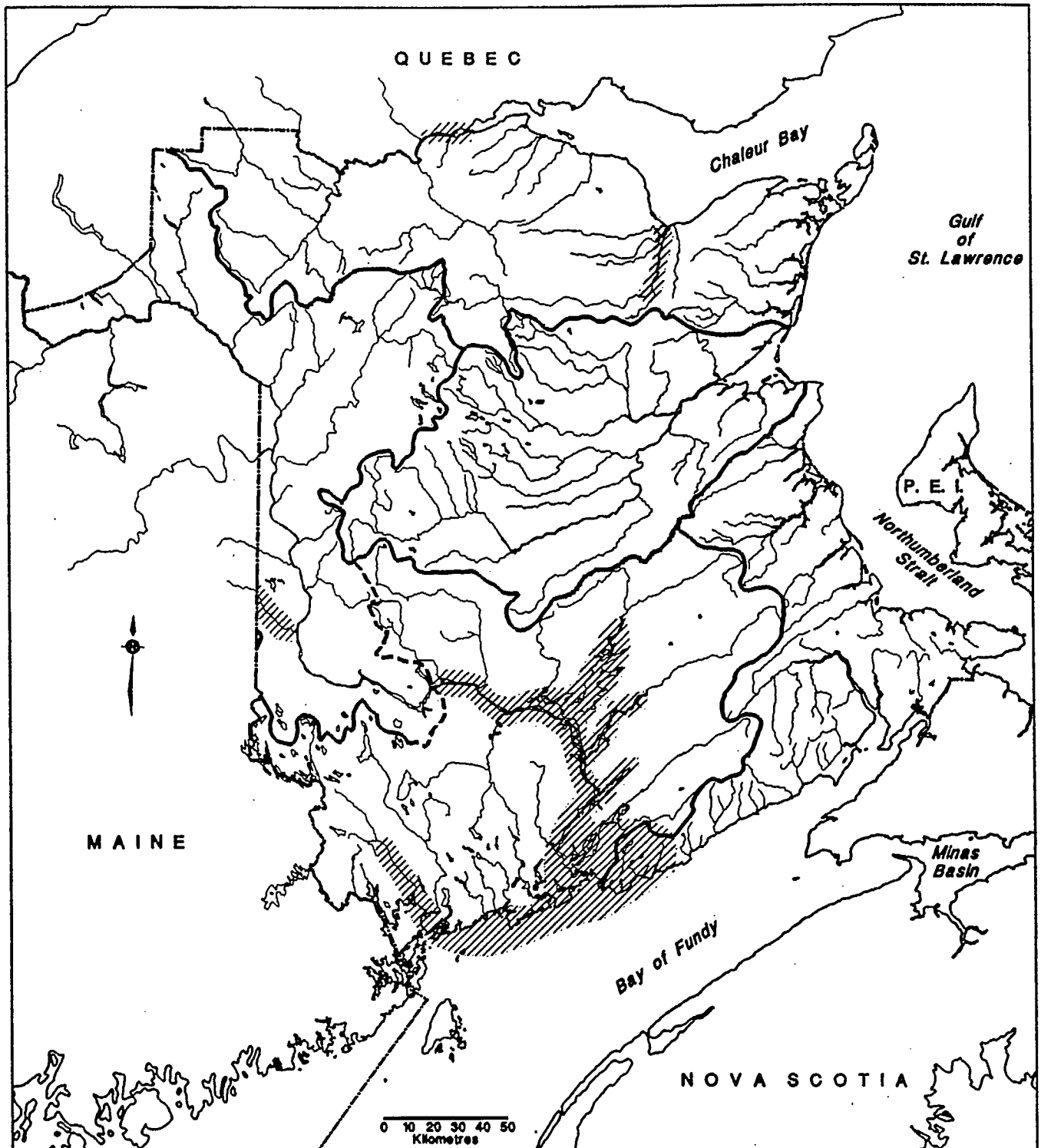


Figure M6. Distribution of Brown Trout in New Brunswick.

Rainbow Trout

Scientific name: *Oncorhynchus mykiss*

Local vernacular names: steelhead trout, truite arc-en-ciel

Distribution

Rainbow trout are native to eastern Pacific Ocean and fresh waters mainly west (and slightly east) of the Rocky Mountains from northwestern Mexico to southern Alaska. Current Canadian distribution is in western Newfoundland, Prince Edward Island, southern portions of the provinces Nova Scotia, New Brunswick, Quebec, and Ontario, central and southern Manitoba and Saskatchewan, all of British Columbia, and the Yukon.

New Brunswick Watersheds.-- Rainbow trout are occasionally found in streams in Albert County; Big Salmon River, Saint John County; Saint John River at Beechwood fishway; Crecy and Chamcook lakes, Charlotte County. There are records of populations in the Central and SW Drainage, Upper Saint John River Drainage, and SE Drainage. Releases have led to resident populations in many New Brunswick counties.

Introductions.-- Rainbow trout were first introduced to New Brunswick in 1899; intentional and unintentional releases (from aquaculture operations) have allowed self-sustaining populations in public waters in many New Brunswick counties to become established.

Habitat & Habits.-- The life history of rainbow trout is extremely variable. Populations can be anadromous (called steelhead trout), river- and stream-resident, or lake-resident. Stream-dwelling populations prefer small to moderately large, shallow rivers with moderate flow and gravel bottoms (pool-riffle type). Steelhead (i.e. anadromous rainbows) in fresh water prefer lower reaches of larger, swift rivers with boulder bottoms, and spawn in higher tributaries of such. Lake-dwelling populations like cool lakes, moderately deep to deep with adequate shallows and vegetation to provide food and gravelly tributary river for spawning. Rainbow trout seek more open-water positions and faster water than brook trout of the same size, and they seldom seek the cover of overhanging banks and branches that are preferred by brook trout. Lake-resident trout have the same pattern of stream spawning as anadromous steelhead trout.

Life History Information Relevant to Management and Enhancement

Spawning and early life history.--Rainbow trout spawn from April to June, with adults homing upstream (or down lake outlets if there are no inlets) in early spring. They do not spawn in the shallows of lakes lacking inlet or outlet streams, preferring the riffle above pools with fine gravel beds. They spawn at temperatures of 10 - 15.5°C. Males are territorial and defend nesting females. The female digs the nest, the fertilized eggs fall into the nest, and the female covers the eggs with gravel. Females make and spawn in several nests. Fecundity ranges from 200-12,749 eggs, with an average of approximately 4000 (800-1000 laid per nest). After spawning, adults migrate back to lake or sea. Eggs hatch in 4-7 weeks to yolk-sac larvae and require 3-7 days to absorb the yolk and become free-swimming. The young of lake forms may move up or downstream to the lake almost immediately or by autumn, or they may spend 1-3 years in stream (attaining lengths of less than 30 cm), after which they move to lakes and remain there until mature. The young of stream forms remain in streams.

Steelhead young remain 1-4 (usually 2) years in streams, and then migrate to sea in spring as 15-20 cm smolts.

Size and Age.-- The growth and size of rainbow trout varies greatly. The maximum size is 122 cm (79 kg); the average is 3.5-4.0 kg. The lake-resident rainbow trout has a maximum weight of 23.6 kg; the average is 2.7-3.6 kg. Newfoundland rainbows reach a maximum weight of at least 3.4 kg. Rainbow trout grow faster than brook trout, maturing at 3-5 years, with males often maturing 1 year earlier than females. Size at first maturity varies from 15-25 cm in small lakes and streams, to 41 cm in steelhead and Great Lakes rainbows. Longevity is 3-4 years in streams and lakes and 6-8 years in the Great Lakes.

Food and Feeding Habits.-- The young eat aquatic insects, benthic crustaceans and some zooplankton; when larger, they shift mainly to fishes. Usually feeding near the bottom, the fish will rise to the surface to take emerging or egg-laying insects.

Water Quality Requirements.-- Rainbow trout prefer waters of temperatures of 21° C or slightly lower (lower lethal temperature in seawater ca -0.7° C). They can tolerate warmer water than brook trout, thriving in lakes with surface waters higher than 21° C if cooler, well-oxygenated water is available.

Fishery Management Tactics Currently in Effect.-- None.

Primary Fishing Areas.-- Rainbow trout can be angled in lakes and streams where intentional and unintentional introductions have occurred.

Angling Season.-- The angling season is from April 15 to September 30. Good angling occurs in May and June; catches are lower in July and August with warming water temperatures.

Angling Method in N.B.-- Rainbow trout are often taken by fly fishing. They are caught with artificial lures by spin casting and trolling, still-fishing with artificial lures activated by stream current, or with natural baits. The fish are wary of anchored boats, so still-fishing from boats reduces success. In lakes, rainbow trout are more difficult to catch than brook trout using similar angling methods.

Sportfish Characteristics.-- Rainbow trout are an excellent sport fish, as they are hard fighting and often leap from water.

Foodfish Characteristics.-- The fish has an excellent flavour, cooked in any way or smoked. Flesh is usually bright red and rich in smaller fish in lakes, pink to white in larger lakes.

Current Economic Utilization.-- Rainbow trout are highly sought in many parts of Canada, though not in New Brunswick where their occurrence is relatively rare. They are angled locally in New Brunswick lakes and streams where they are present.

Development Potential.-- It is relatively easy to establish self-sustaining populations in New Brunswick waters through introductions. Establishing populations in any region would generate local angling and consequent economic benefits. However, stocking of rainbows in New Brunswick waters is not recommended as they reduce the survival of native brook trout. Also, rainbows are more

difficult to catch. They could be considered for stocking in closed lake systems (to prevent spreading) that are devoid of brook trout and have gravelly tributaries for spawning. Planted rainbows grow faster than planted brook trout. Competition from yellow and white perch must be addressed. Fishing in such lakes should be prohibited for several years until rainbow populations established, then regulated to avoid overfishing.

Population Enhancement Procedures.-- Existing New Brunswick populations can be enhanced by protecting their habitats from degradation. Establishing fishing regulations is difficult without knowledge of population structures.

Cautionary notes.-- Rainbow trout are not native to New Brunswick. Several self-sustaining populations have been established here through accidental release from hatchery operations. As rainbow trout are efficient competitors with native brook trout, further accidental releases must be prevented.

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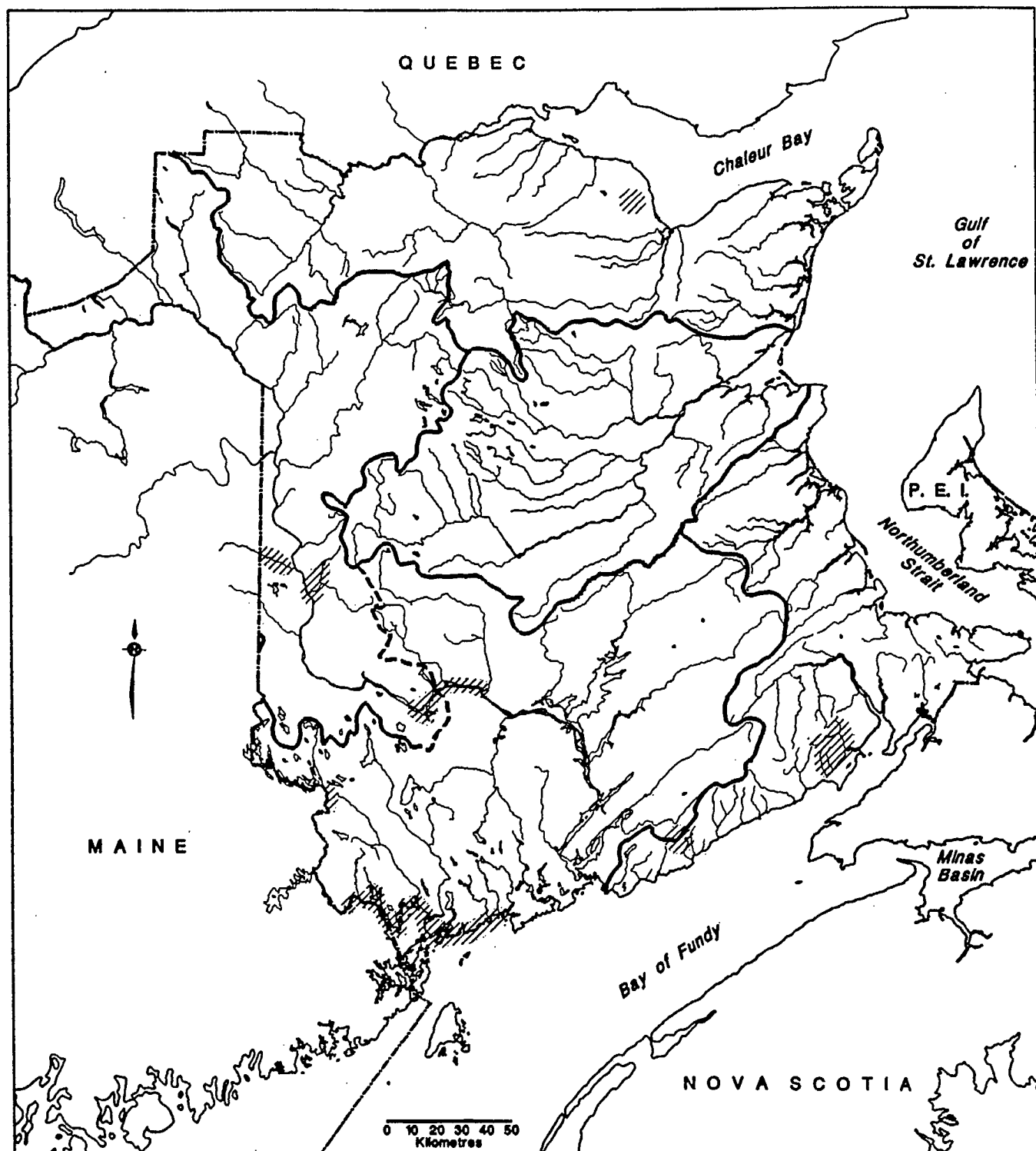


Figure M7. Distribution of Rainbow Trout in New Brunswick.

Arctic Char

Scientific Name: *Salvelinus alpinus*

Local Vernacular Name(s): arctic char, char, omble chevalier

The arctic char is a circumpolar salmonid which may be anadromous or restricted to freshwater. Generally the freshwater populations are confined to the southern part of its range. The char is an excellent game and food fish and is highly prized by native, commercial and recreational fisherman wherever it occurs. Its distribution is restricted to only a few areas in New Brunswick and it is only locally popular.

Distribution

The char is circumpolar in arctic fresh and marine waters and very rarely occurs south of Quebec and the Maritime provinces in North America.

Canada and New Brunswick.-- Arctic char is found throughout the Canadian arctic from Newfoundland west to Alaska. In New Brunswick, they are found only in a few lakes (Portage and Walton) and two rivers (Upsalquitch and Nepisiquit) in the province.

N.B. Watersheds.--The fish are found in the Chaleur Drainage.

Introductions.--Arctic char occur naturally in New Brunswick; no introductions of the species have been recorded in the province.

Habitat and Habitat Preference.-- Anadromous forms are found in lotic rivers and inshore coastal and estuarine areas. Freshwater populations are found in deep lakes where summer temperatures do not average more than 13-16°C. The char is an arctic species which prefers cold water habitats.

Life History Information Relevant to Management

Spawning and early life history.-- Char spawn in fall, in the slow pools of rivers or over shallow reefs in lakes. Water temperature at spawning is 4-6°C. The female digs a shallow depression in the gravel or sand (redd) and the eggs deposited are fertilized by a single male. A 56 cm female may contain about 3500 eggs. Eggs are 4-6 mm in diameter immediately after fertilization. The eggs hatch in March or April having survived the winter in the redd. Larva are about 15-20 mm at hatching. Anadromous char fingerlings from Baffin Island move to the marine environment when 150-200 mm long or 5-7 years of age.

Size and age.-- Arctic char grow very slowly compared to other salmonids. The largest char are 6-8 kg and measure about 80 cm in length. Generally char grow slowest at the northern-most limits of their range and fastest in the southern part. Water temperature defines growth. For landlocked, lake populations in Quebec and New Brunswick, general age-length relationships are: 3 yrs-12 cm; 4 yrs-16 cm; 6 yrs-19 cm; 8 yrs-27 cm; 10 yrs-36 cm; 15 yrs-40 cm. Maturity is determined by geographical region and some females may become mature at as little as 15-20 cm. In New Brunswick, maturity is probably reached at about 25-30 cm for both sexes.

Food and feeding habits.-- Char are opportunistic carnivores and consume whatever is available. Large char are predominately piscivorous if forage fish are available. Lake char consume large quantities of aquatic insects.

Water quality requirements.-- Char prefer water at temperatures of 6-12°C. Temperatures above 12-13°C are lethal to fish from northern populations. New Brunswick and Quebec char can probably tolerate water temperatures of 16°C for short periods. Arctic char, like most other salmonids, are intolerant of acid water conditions (ph <6.5).

Primary Fishing Areas.-- In New Brunswick, arctic char are fished for in only a few small lakes in the province. Anglers fish for char in the Portage lake in spring; Walon lake is privately managed and public fishing is now restricted. Char are occasionally caught in the Upsalquitch and Nepisiquit Rivers by anglers fishing for brook trout and Atlantic salmon. Because arctic char are cold water fishes, they feed most actively in early spring. Fishing for char after the end of May in New Brunswick is seldom productive unless they can be found in the deep, cool water of lakes.

Angling Season.-- Angling season is from April 15 to September 15 annually, with a catch limit of 5 fish per day per angler and no size restriction. Scheduled waters where char occur may be fly fishing only.

Angling Methods.-- Char can be caught on most natural and artificial lures. The traditional New Brunswick spinner and worm combination accounts for many lake char catches in early spring. River char will take a variety of lures, including salmon flies and streamers.

Sportfish Characteristics.-- Char are excellent game fish that bite well and fight hard. Large anadromous char are particularly highly regarded for their fighting ability. Lake char are targeted by anglers wherever they occur.

Foodfish Characteristics.-- Arctic char are one of the most delicious of fishes. Their flesh is pink to deep red and contains few bones. The char is in such demand as a foodfish that the species is now the subject of intensive culture in many areas and few char which are caught by anglers are released.

Current Economic Utilization.-- Char are fished for in only a few localized areas and as such are relatively unexploited. Presently they are popular as sportfish in only two lakes in the province.

Development Potential.-- The arctic char has a limited distribution in New Brunswick and there are probably several other lakes which could be successfully stocked with this species. Char are easily cultured and introductions are generally successful if the habitat is suitable and adequate numbers of fish are stocked. The present limiting factors are its restricted distribution and its rather narrow range of tolerance to water temperatures.

Population Enhancement Procedures.-- Arctic char grow slowly and populations are easily over-exploited. To enhance abundance of char within a population, management strategies should consider age, maturity, fecundity and growth rates. To enhance populations currently in New Brunswick, a management plan which incorporates low catch limits and minimum size should be considered. Stocking to enhance populations has been successfully accomplished in other provinces, and could be utilized in New Brunswick.

Cautionary Notes.-- Char are predacious fishes which will compete with other sportfish species. Large char may also prey on the young of brook trout and Atlantic salmon in lakes and streams where these species co-exist.

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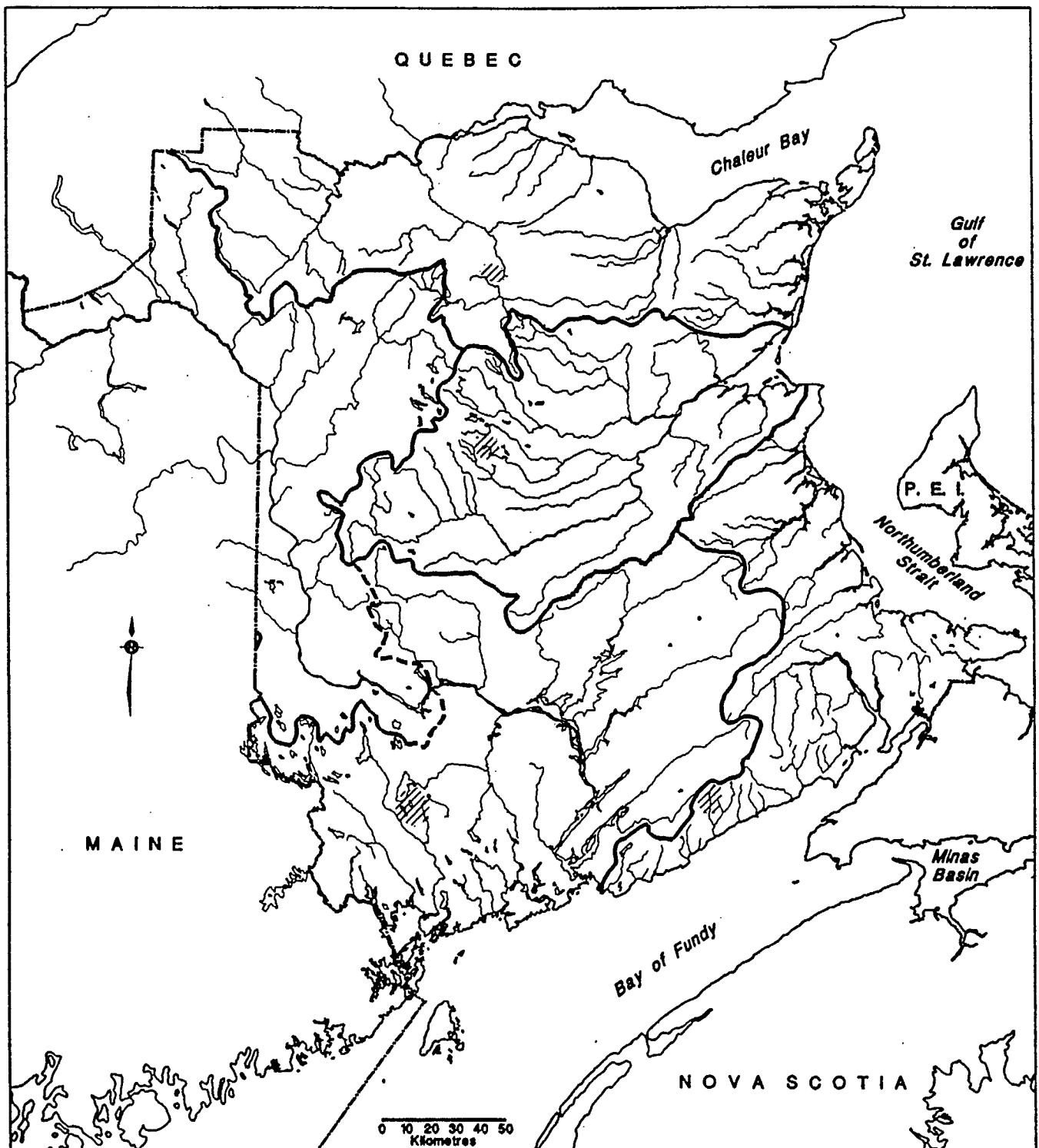


Figure M8. Distribution of Arctic Char in New Brunswick.

Rainbow Smelt

Scientific name: *Osmerus mordax*

Local vernacular names: American smelt, frost fish, perlan arc-en-ciel, perlan du nord

Distribution

Anadromous smelt are present along the Atlantic coast from Labrador to New Jersey. The landlocked form is widely distributed in inland lakes in eastern North America (Labrador, Newfoundland, Nova Scotia, New Brunswick, Quebec, eastern Ontario, Maine, New Hampshire).

N.B. Watersheds.-- Anadromous smelt are present in all major river systems; with the greatest abundance on the Miramichi River and Atlantic coast. The landlocked form is supposedly native in many lakes; several populations have been in Charlotte County.

Introductions.-- Rainbow smelt are commonly stocked with landlocked salmon in New Brunswick as forage fish. They were introduced in the Great Lakes watershed, and their range has extended to all Great Lakes and surrounding states and provinces.

Habitat & Habits.-- Rainbow smelt are a schooling, pelagic fish that can occur in huge numbers. Anadromous smelt inhabit inshore coastal waters, moving into estuaries in large numbers in the fall and remaining there during winter. Landlocked smelt prefer the cool, clear, open midwaters of lakes. Both forms enter rivers and streams only for spring spawning. In lakes and estuaries, populations concentrate in deeper waters during daylight.

Life History Information Relevant to Management and Enhancement

Spawning and early life history.--Rainbow smelt ascend streams in large numbers in early May, spawning in May or June in New Brunswick waters at temperatures of 6 - 7° C. The spawning time in a given stream is nearly the same each year. In the Great Lakes, rainbow smelt spawn on gravel shoals. Adults spawn at night, drifting downstream to lakes or estuaries before daybreak. The spawning peaks for about 1 week, lasting from 3 to 8 weeks. Spent fish move downstream to the cooler, deeper waters of lakes or outer estuaries for summer and autumn (many populations, such as the Lake Erie population, have large post spawning mortality). The fecundity in the Miramichi River ranges from 8500 eggs for a 12.7 cm fish to 69,600 eggs for a 20.9 cm fish. Eggs are adhesive, attaching to bottom gravel and stones, and hatching in 2 - 3 weeks to yolk-sac larvae. Larvae are carried downstream to lakes or lower rivers and estuaries, where they remain until maturity.

Size and Age.--The maximum size of rainbow smelt is 10.2 cm in small inland lakes and 35.6 cm in Lake Ontario and Maritime coastal waters. The average size is 7.6 - 10.2 cm in some inland lakes in Quebec and Maritimes, 15 - 18 cm in Lake Huron and Georgian Bay, and 20 - 25 cm in Lake Ontario, Lake Erie, and east coast anadromous forms. Most smelt in the Miramichi River mature at 2 years at sizes of 13.5 - 14 cm. Females grow faster, larger, and live longer than males. The life span is about 6 years.

Food and Feeding Habits.--Rainbow smelt are carnivorous, taking a wide variety of prey including zooplankton, aquatic insects, and fishes. They appear to ingest proportionally more fishes during winter.

Water quality preferences.--Rainbow smelt prefer clear, cool water (Lake Erie - 7° C, entering 15 -16° C for brief periods).

Fishery Management Tactics Currently in Effect.-- None.

Primary Fishing Areas.-- Rainbow smelt are found primarily in the Gulf of St. Lawrence region of New Brunswick, particularly Miramichi River and estuary.

Angling Season.-- The angling seasons is from April 15 to September 30. Rainbow smelt are angled through ice in winter, and are available during the spring spawning run.

Angling Method in N.B.-- Rainbow smelt readily take baited hooks in winter through ice. Other than during the upstream spawning run, rainbow smelt normally inhabit open water of lakes and are not frequently taken by angling. The anadromous form can be angled from wharves.

Sportfish Characteristics.-- The fish will readily take a baited hook.

Foodfish Characteristics.-- Rainbow smelt are a popular fish with a white flesh and excellent flavour. Their characteristic odor resembles cucumber.

Current Economic Utilization.-- Rainbow smelt are fished commercially and to some extent for recreation in the Gulf of St. Lawrence region of New Brunswick, especially Miramichi River and estuary.

Development Potential.-- The winter ice fishery in estuaries of northern New Brunswick represents the best opportunity for development. Lake-dwelling individuals are of small size and thus of little angling interest.

Other Modes of Capture.-- Rainbow smelt are taken for recreation with seine nets and dipnets during spring spawning run in parts of Atlantic Canada.

Population Enhancement Procedures.-- Protecting spawning grounds and migration routes of anadromous smelt from habitat degradation would enhance existing populations.

Cautionary notes.-- Rainbow smelt are traditionally used as a forage fish for stocked salmonids. Although they are known to improve brook trout growth, some people believe that rainbow smelt depress lake trout populations.

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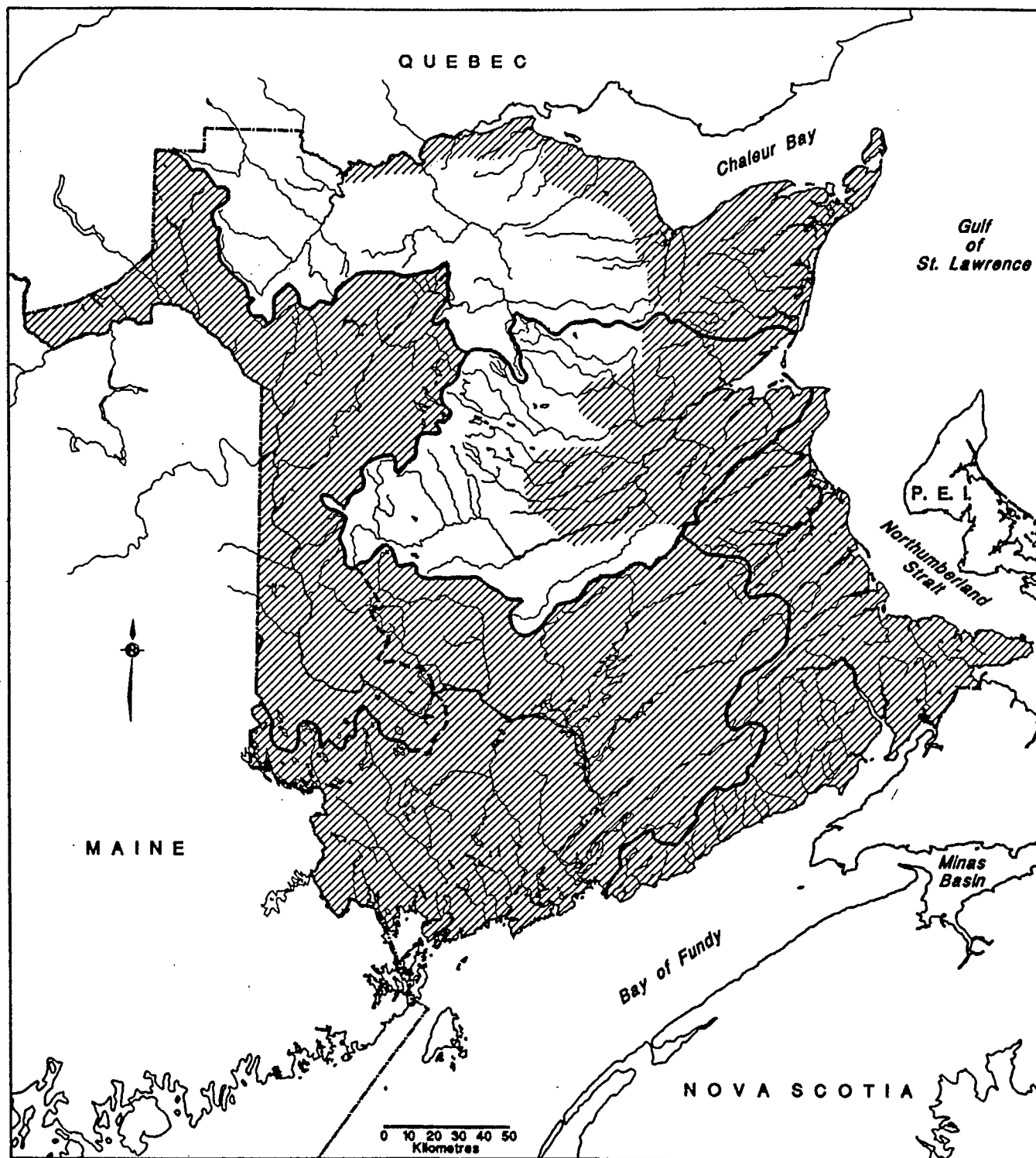


Figure M9. Distribution of Rainbow Smelt in New Brunswick.

Smallmouth Bass

Scientific Name: *Micropterus dolomieu*

Local Vernacular Name(s): smallmouth, bass, black bass

The smallmouth bass is one of the most popular gamefish in North America. Recreational fisheries for smallmouth bass contribute substantially to the economies of several states and provinces. The species has a widespread natural range and has been introduced extensively throughout the world. The smallmouth bass is the subject of competitive and tournament fishing over much of its present range. The species has been intensively cultured for more than 50 years and is the preferred gamefish species for stocking in environments that are marginally suitable for salmonids. Smallmouth bass are the subject of numerous put and take fisheries in the eastern United States and are the third most popular sportfish in New Brunswick after brook trout and Atlantic salmon.

Distribution

The original natural distribution of the smallmouth was in the freshwater habitat of east central North America. It was basically restricted to the Great Lakes, St. Lawrence River and to the Mississippi, Ohio and Tennessee River systems. Since the mid 1800's, its range has grown to include almost all areas of the United States and Canada with suitable habitat. Artificial introductions by man are the main cause of range expansion, and there are few records of extensive natural colonization by the species.

Canada.-- The smallmouth bass is native to the south central regions of Ontario and Quebec. Its present day range, which includes southern Nova Scotia and New Brunswick, and several river and lake systems in the western provinces, is predominately the result of introductions.

New Brunswick.-- The smallmouth bass is found only in the south central parts of the province. It has been introduced and has naturally colonized many lakes and streams associated with the St. Croix River system where it is a dominant fish species. It occurs abundantly in the Saint John River system and many lakes, streams and rivers in the central area of the province from Fredericton south to Saint John and west to St. Stephen contain self-sustaining populations.

New Brunswick Watersheds.-- Small mouth bass are found in the Upper Saint John River drainage and Central and Southwest drainage. As yet, they are unrecorded in the northwest and northeast parts of the province.

Recent Introductions.-- Smallmouth bass are not native to New Brunswick and all present populations are descended from original stockings and natural expansion from the St. Croix River system. In the southwest corner of the province, many lakes and streams have been intentionally stocked by private individuals without authorization from government agencies. The introduction of only a few fish in a lake has frequently resulted in the colonization of all waters connected with it. Much of the smallmouth's provincial range can be attributed to this type of introduction. Each year, smallmouth bass are found in lakes and streams where none were recorded previously, as a result of natural colonization from near-by watersheds or intentional (but unauthorized) introductions. The smallmouth bass appeared in New Brunswick in the late 1870s from Maine waters. Most of the lakes in the southwest corner of the province which presently contain self-sustaining populations were initially stocked with less than 50 individuals.

Habitat and Preferred Habitat.-- The smallmouth bass prefers relatively pristine water with a temperature regime which averages higher than that selected by salmonids found in the province. Smallmouths inhabit a variety of environments but prefer non-turbid lakes, rivers and streams. They are equally tolerant of still and flowing water conditions. In summer, they inhabit shallow, shoreline and pool habitats where food is most abundant. They seek deep river pools and the deepest parts of lakes in which to spend the winter. Smallmouth bass are frequently associated with structure: boulders, rocks, logs and aquatic vegetation in summer.

Life History Information Relevant to Management

Spawning and early life history.-- In New Brunswick, smallmouth bass spawn in late spring, usually from late May to early June. The male builds a shallow depression 0.3 to 2 m in diameter in sand or gravel, usually associated with some underwater structure. The female deposits the eggs in the nest at water temperatures of 16-19°C. A 1 kg female may lay up to 15,000 eggs over the 2 hour spawning period. Immediately after fertilization, the demersal and adhesive eggs measure about 2 mm in diameter. The female leaves the nest site after spawning and the male actively guards the eggs and hatched fry. The eggs hatch in 4-10 days depending on water temperature, and larva are about 5.5 mm in length at hatching. Fry grow rapidly and reach about 60 mm in length by the end of their first fall.

Size and Age.-- Smallmouth bass grow rapidly in warm water lake and river habitats. The largest bass yet recorded, a female 68.6 cm in length and weighing 5.3 kg, was caught in Dale Hollow Reservoir, Kentucky. In New Brunswick the largest smallmouths are generally 28-35 cm in length and 6-9 yrs of age. General age-length relationships are: 1 yr-8 cm; 2 yrs-16 cm; 3 yrs-22 cm; 5 yrs-26 cm. Males reach maturity at age 3-4, females at 4-6 years of age.

Water Quality Requirements.-- Smallmouth bass can tolerate a wide variety of water conditions. They prefer temperatures of 18-28°C. Smallmouth bass are tolerant of acid water but avoid rivers and lakes where the pH is less than about 6. Larvae are particularly sensitive to low oxygen conditions.

Food and Feeding Habits.-- Smallmouth bass consume a wide range of prey species. Prey size increases with bass size, although very large smallmouth bass will feed extensively on hatches of aquatic insects like mayflies and stoneflies. Crayfish and the nymphs of aquatic insects are major components of river smallmouths. Fish are consumed by smallmouth bass in all environments; forage fish such as *Fundulus* and *Rhinichthys* are frequently found in the stomachs of smallmouth bass. Feeding is infrequent at temperatures below about 8°C.

Primary Fishing Areas.-- In New Brunswick, smallmouth bass are intensively fished for throughout their range. Every lake, stream and river which contains smallmouth bass is frequented by anglers at some period during the open season. Waters which are most intensively fished include the St. Croix River, Saint John River (Mactaquac Headpond area), Utopia, Spednic, Skiff, Palfrey, Magaguadavic, Digdeguash and First Eel lakes and the Grand Falls and Canoose Flowage areas. Several other lakes are important in terms of localized fishing effort.

Angling Season.-- Small mouth bass are fished in spring, summer and fall when water temperatures are warmer than about 15°C. Optimal conditions are during the spawning period in May and June, and in early September when fish are actively feeding in preparation for winter.

Current Regulations.-- The angling season is from April 15 to September 30 each year. From April 15 to June 30 there is a catch limit of three fish per day per angler; from July 1 to September 30 there is a catch limit of 7 fish per day per angler. There is a minimum keep size of 30 cm.

Angling Methods.-- The most popular method is fishing with artificial lures using light spinning, spin casting or baitcasting tackle. Fly fishing for smallmouth bass is productive but infrequently practised in New Brunswick, and fishing with natural baits is uncommon. Casting and trolling are the favoured fishing techniques. Typical casting and trolling lures include Rapalas, spoons, spinners, rubber worms and twister tails and crankbaits. Typical flies used include large nymphs, streamer flies, deer hair bugs and cork poppers.

Sportfish Characteristics.-- Smallmouth bass are considered one of the best game fish in North America. Their fighting ability and willingness to take lures is legendary. In waters with low to average fishing pressure, smallmouth bass are abundant and large individuals are frequently caught. Only a few other species of freshwater game fish (largemouth bass and walleye) are as popular and have inspired more tournaments, stockings and angling literature than the smallmouth bass.

Foodfish Characteristics.-- Smallmouth bass have white, flaky flesh which is highly prized. Its foodfish benefits are however usually rated second in importance to its gamefish characteristics. In New Brunswick, most smallmouth bass which are caught are released alive.

Current Economic Utilization.-- Smallmouth bass are used almost exclusively as a gamefish in New Brunswick. There is no legal commercial sale of the species in the province. The majority of fish caught are released for potential re-capture. Sportfishing for smallmouth bass in the province is high-quality and helps support several local economies. The smallmouth is one of several species which are now recognized as providing more economic benefit when alive than when sold commercially for food.

Development Potential.-- The smallmouth bass has a rather limited distribution in New Brunswick at present. Its tolerance to a wide range of environmental conditions indicates that the species could probably prosper in many other areas of the province. It is a prolific species with a low natural mortality rate and the fishing mortality of populations subjected to catch and release is also low. The smallmouth bass is easily cultured and successfully reproducing populations can be established with the introduction of relatively few individuals.

Population Enhancement Procedures.-- Recreational fishing restrictions are the preferred method for maintaining smallmouth bass populations at levels of sustainable yield. Stocking waters where smallmouths are indigenous should be contemplated only when populations are determined to be incapable of reproducing successfully or when fishing effort exceeds production.

Cautionary Notes.-- Smallmouth bass have the capability to compete successfully against other gamefish species. They have been implicated in the decline of brook trout populations in waters to which they were introduced. Smallmouth bass may prey extensively on the young of salmonids. They are very prolific, have low natural mortality rates and may quickly assume the role of dominant fish species when introduced into, or naturally colonizing, new waters.

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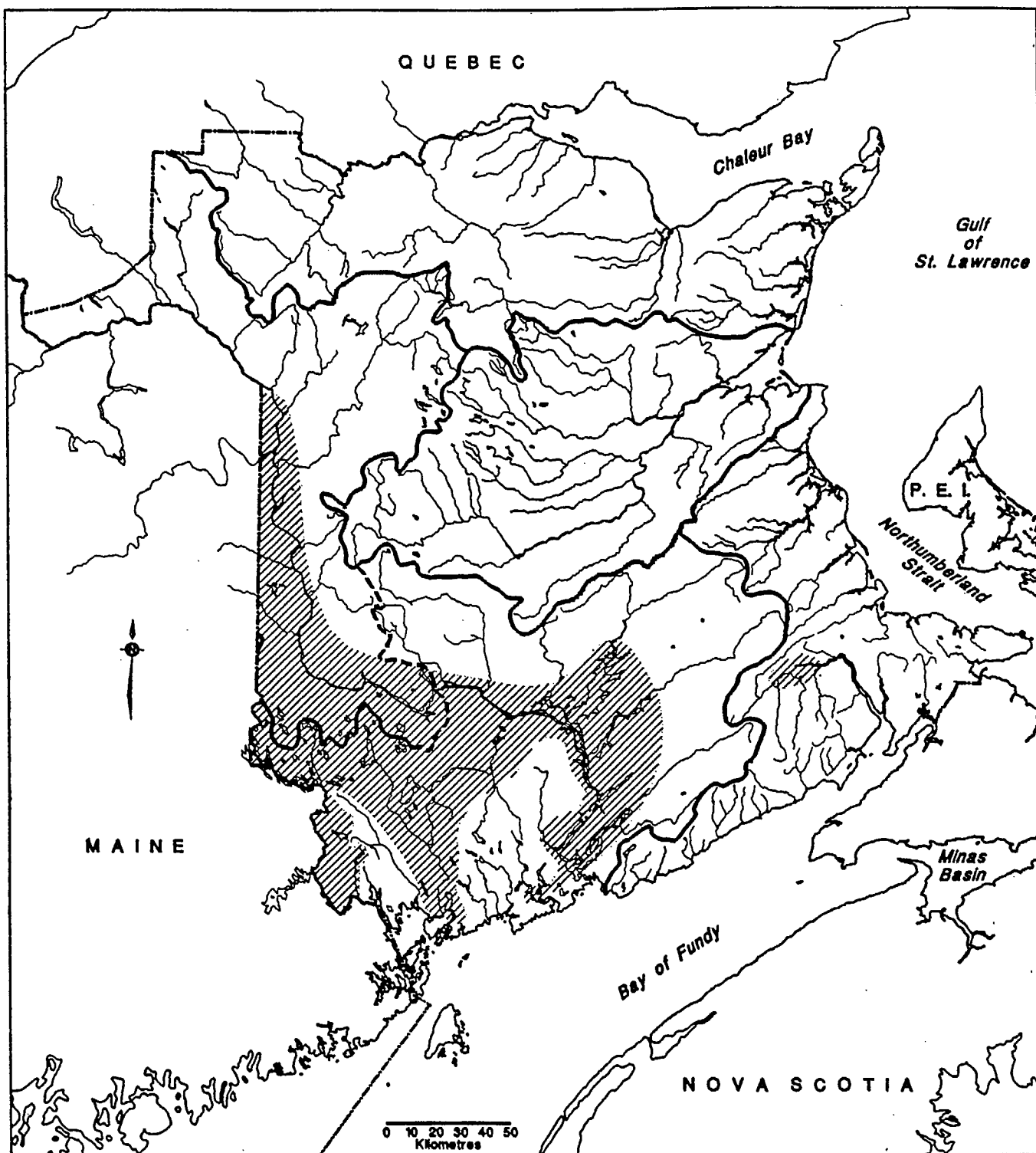


Figure M10. Distribution of Smallmouth Bass in New Brunswick.

American Shad

Scientific Name: *Alosa sapidissima*

Local Vernacular Names: shad, alose savoureuse

The shad is an anadromous species which is one of the most economically important inshore fishes on the east coast of North America. It supports valuable sport and commercial fisheries wherever it occurs. It is rated highly as a game and food fish in the United States. In Canada it is important as a commercial species, but has only recently been exploited by anglers on a limited and local basis.

Distribution

On the east coast of North America, the shad is found from the St. Johns River, Florida in the south, to Newfoundland in the north. It was introduced into rivers on the Pacific coast in 1871; it now ranges from southern California to Alaska.

Canada and New Brunswick.-- The shad occurs on both coasts. Reproducing populations are found throughout the Maritime provinces (except PEI). In New Brunswick, shad can be found in the estuaries of most rivers as they enter freshwater to spawn, and in inshore marine waters during their extensive annual migrations. Shad are thought to spawn in several provincial rivers including the Saint John, Pettitcodiac and Miramichi.

N.B. Watersheds.-- Shad are found in all drainages, but are probably rare or absent in the upper Saint John River Drainage.

Introductions.-- The shad occurs naturally in New Brunswick and has never been introduced in the province.

Habitat and Habitat Preference.-- American shad populations are anadromous, and no landlocked or freshwater restricted strains exist. In summer, shad are found in coastal marine waters and in estuarine areas. In spring, shad ascend freshwater rivers to spawn. Almost all the shad in eastern North America migrate to a turbid estuarine environment in the upper Bay of Fundy region during the summer-fall of each year to feed. Shad winter in deep coastal marine waters.

Life History Information Relevant to Management

Spawning and early life history.-- Shad spawn in the shallow headwater sections of freshwater rivers in late spring; in New Brunswick, this usually occurs in May or June. The water temperature required for spawning ranges from 12-18°C. Spawning occurs in schools and a single female is accompanied by several males. A 45 cm female will spawn approximately 100,000 eggs, but fecundity is dependant on the geographical origin of the fish: southern fish usually contain more eggs at a smaller size. Larva are 9-10 mm at hatching. Fry enter marine waters at 6-8 cm and remain in this environment until maturity and first spawning.

Size and age.-- The largest shad are generally females, reaching a length of about 60 cm and an age of 11-12 years, although age at length is defined by the river of origin. General age-length

relationships for New Brunswick origin shad are: 1 yr-10 cm; 2 yrs-23 cm; 3 yrs-30 cm; 4 yrs-45 cm. Females and males spawn first at age 5 (and rarely at age 4).

Food and feeding habits.-- Shad feed on zooplankton in the form of euphausiids, mysids, copepods and decapod crustaceans while in marine and estuarine waters. In freshwaters, young shad feed on small aquatic insects and cladocerans. Spawning fish eat little or not at all and take lures probably as a result of reflex or stimulation of previous feeding memories by entry into freshwater.

Water quality requirements.-- Shad can survive wide ranges in water temperature. In the marine environment they select, by depth, the thermocline with suitable temperature regime. Temperatures during spawning are relatively consistent in most freshwater rivers where shad spawn. Shad prefer water with a pH of more than 6.5 and newly hatched larva are particularly susceptible to acid pH.

Primary Fishing Areas.-- There are few fishing areas in New Brunswick. Some shad are caught by anglers in the Saint John River below and close to the Mactaquac Dam and in the upper reaches of the Miramichi River. Most shad are caught incidentally by anglers fishing for Atlantic salmon with artificial flies.

Angling Season.-- Shad are primarily caught in May and June when the fish are ascending rivers and streams to spawn. Shad leave the river and return to marine waters after spawning.

Regulations.-- Angling season is the same as that for several other non-regulated species: 15 April to 30 September annually. There are no restrictions on size or catch limit.

Angling Methods.-- In the United States, shad are fished for with small artificial lures and flies. Casting from shore, trolling with a boat and wading are popular methods in rivers. Shad darts, small lead-headed jigs with a feather or hair tail and bead-head shad flies are particularly effective lures. No traditional methods are common for shad angling in New Brunswick, although fly fishing for shad has recently become popular on the Miramichi River.

Sportfish Characteristics.-- Shad are an excellent game fish and are renowned for their fighting ability. They are also a challenging species because, like salmon, they do not feed when migrating upstream in freshwater. Shad angling with the fly rod has a historical basis in the United States where many fly patterns, tackle and techniques have been developed.

Foodfish Characteristics.-- The flesh of shad is excellent no matter how it is prepared. It is especially good when smoked. It is, however, very bony and several methods have been devised to remove the small bones characteristic of fillets taken from shad. In the southern states, the eggs of shad (shad roe) are considered a delicacy when fried or baked.

Current Economic Utilization.-- In New Brunswick, the shad is used predominately as a commercial species. In a few areas (such as the Miramichi region) it has recently been targeted as a gamefish.

Development Potential.-- In the United States, the shad is a popular sportfish which supports many local economies. Fly fishing for shad has become so popular on some rivers in New England that catch and release areas have had to be implemented. Because shad on their spawning runs emulate the

behaviour of Atlantic salmon, they make an acceptable alternate species for angling when salmon are absent or not abundant. Shad are not presently exploited in New Brunswick as a recreational species and most populations could be utilized successfully given an adequate management strategy. The shad is extremely difficult to culture and introductions of the species have not generally been successful (except the initial Pacific stockings). In New Brunswick, the American shad has potential as a sportfish given the current low levels of exploitation.

Population Enhancement Procedures.-- Shad are difficult to culture and introductions usually fail. Populations are best enhanced by fishery restrictions which allow stock size to remain significantly above levels of exploitation.

Cautionary Notes.-- Juvenile shad compete with other anadromous species for food resources in freshwater rivers. They may also compete with other species for spawning areas. However the extent of this competition is probably insignificant given the dissimilar spawning requirements of other anadromous species (like salmon).

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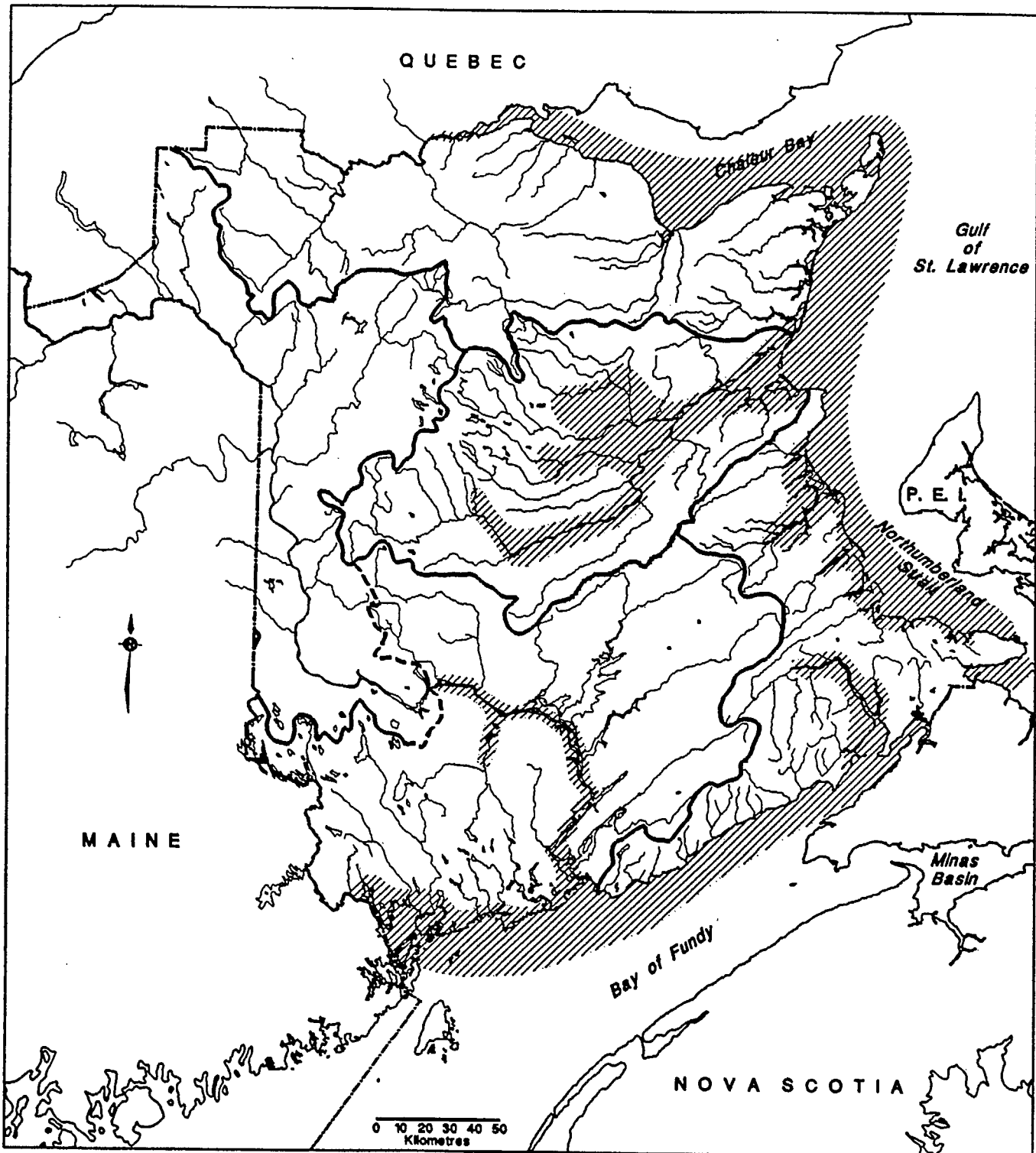


Figure M11. Distribution of American Shad in New Brunswick.

Striped Bass

Scientific Name: *Morone saxatilis*

Local Vernacular Name: Sea Bass, Bar d'Amerique

The striped bass is the most economically important anadromous and freshwater restricted fish on the east coast of North America. It is the most popular coastal and inshore game fish in the United States. Commercial and recreational fishing pressure have reduced the striped bass within its natural range to a remnant of former abundance. Recent restrictions on commercial and recreational fisheries implemented by several mid-Atlantic states have resulted in increased abundance of striped bass. In the Maritime provinces, many striped bass stocks have been decimated by incidental commercial catches and over-exploitation by recreational fisheries. Recently initiated province-wide regulations have restricted recreational and some commercial fishing for striped bass. The benefits of these new restrictions may not be known for several years. The striped bass is one of the top four game fish species in New Brunswick (along with Atlantic salmon, brook trout and smallmouth bass).

Distribution

Striped bass are indigenous to inshore marine waters, estuaries and freshwater rivers of the North American Atlantic coast. Anadromous populations range from the St. Johns River, Florida to the St. Lawrence River in the north. Freshwater lake populations exist in some mid-Atlantic states.

Canada.--Self-sustaining populations of striped bass are widespread in Nova Scotia and New Brunswick. Striped bass occur in the coastal and inshore waters of Prince Edward Island, but are not known to spawn there.

New Brunswick.--Anadromous populations of striped bass are common in rivers that flow into the Bay of Fundy and the Northumberland Strait region in the northeast. Most larger rivers on the coast of the province are inhabited by striped bass and the inshore waters of the coast are inhabited by these same populations during marine migrations. Known spawning rivers for striped bass include the Saint John, Miramichi and Kouchibouguac. Other rivers in the province may also have self-sustaining populations. There are no known freshwater lake populations of striped bass in the province, although the bass species could easily survive in this environment.

N.B. Watersheds.--Striped bass occur in all drainages of the province; although they are probably extremely rare in the Upper Saint John River drainage (above the Mactaquac Dam).

Introductions and Stocking.--Striped bass occur naturally in New Brunswick; no stockings of the species in this province are recorded.

Habitat and Habitat Preference.--Most stocks of striped bass are anadromous and spend the majority of their lives in or near estuaries of rivers. Preferred summer habitats are shallow lagoons and estuaries in the northeast part of the province and the mouths of rivers under tidal influence in the Bay of Fundy region. Spawning and over-wintering takes place in low salinity or in the freshwaters of large rivers. Adults and sub-adults migrate to marine waters in summer and inhabit coastal areas within 3-5km of shore. Young-of-the-year and juveniles are predominately restricted to euryhaline portions of rivers and estuaries.

Life History Information Relative to Management

Spawning and early life history.-- Striped bass spawn in low salinity or freshwater portions of large rivers in spring at water temperatures of 13-18°C (some United States populations that are restricted to lakes spawn in freshwater). In New Brunswick, most striped bass spawn in late May or early June. Spawning generally occurs in schools; one female is accompanied by several males. A 2 kg female may spawn 400,000 eggs. A few hours after being released and fertilized, the eggs measure about 3.5 mm. The eggs are semi-buoyant, non-adhesive and hatch in 3-4 days. The hatched larva is about 5-8 mm. Larva reach fry size (about 20-30 mm) in 1-2 months in the warm water estuaries of rivers in the Northumberland Strait.

Size and age.-- Striped bass reach a large size. The largest ever measured was caught commercially in coastal North Carolina; this weighed 53 kg and was 2 m in length. In New Brunswick, striped bass of 25 kg have been caught frequently in the sport and commercial fisheries. Striped bass in the northeast part of the province are somewhat smaller than Bay of Fundy strains. Age at length relationships for striped bass in New Brunswick are generally: 1 yr-15 cm; 2 yrs-25 cm; 3 yrs-35 cm; 4-6 yrs-40 to 55 cm; 10 yrs-75 cm. The largest fish are usually females. Average size for striped bass caught in the northeast is about 30-45 cm and 1-1.5 kg. In the Saint John River, fish are slightly larger at 55-70 cm. Females mature at age 5; males at age 4.

Food and feeding habits.-- Striped bass are opportunistic carnivores. They will feed actively on whatever prey species is most abundant. Larva and fry feed on zooplankton and small crustaceans (amphipods, copepods and shrimp). Larger striped bass consume invertebrates and fishes in equal proportions. In New Brunswick large bass consume several species of commercially important fishes including gaspareau, river herring, Atlantic herring, smelt and eels. Smaller fish form schools and feed collectively; large fish are often solitary or occur in small aggregations.

Water quality requirements.-- Striped bass prefer and grow optimally in fresh or low salinity (3-8 ppt) waters of 15-25°C. This is why estuarine environments are typical summer habitats. Striped bass can survive temperatures as low as -0.7°C. A pH of greater than 6-6.5 is required for striped bass at all life history stages. Optimal water hardness preferred for most populations is about 50-200 mg/l (CaCO₃). Striped bass are found in both still and fast moving water; still waters with minimal current are probably preferred.

Primary Fishing Areas.-- In New Brunswick, the estuarine portions of major rivers are the best areas for striped bass angling. In the northeast, the tidal lagoon systems of the Richibucto, Kouchibouguac, Miramichi, Tabusintac and Nepisiquit Rivers have annually supported valuable sport fisheries for the species in summer and early fall. The freshwater/marine interface at the mouth of the Saint John River in southern New Brunswick produces large striped bass of 10 to 20 kg. Other river estuaries in the lower Bay of Fundy (Digdeguash, Magaguadavic, St. Croix) have predictable runs of striped bass which are targeted by anglers.

Stocking History.--None; striped bass occur naturally in New Brunswick. There are no records of successful introductions in provincial waters.

Angling Season.-- Striped bass are caught predominately during spring-summer-fall migrations in estuarine and marine waters or during summer-fall in estuaries and rivers. They are not angled by ice fishers in any area.

Current Regulations.--In all areas of New Brunswick, the minimum keep size of angled striped bass is 68 cm, and there is a catch limit of 1 fish per day per angler. Fishing season is from 1 July to 30 October annually. Except for fly fishing only on scheduled Atlantic salmon rivers, there are no other restrictions on recreational fishing.

Angling Methods.--In estuaries and coastal marine waters, fish are caught by: trolling with large minnow and baitfish imitations (Rapalas, plugs, spoons, etc.); bait fishing with live minnows (*Fundulus heteroclitus*); and casting minnow imitations from shore and boat. Fly fishing for striped bass is rarely practised in this province, although it is a popular and economically important fishery in some northeastern states. Live bait fishing with large forage fish such as gaspareau or eels is practised at the mouth of the Saint John River, where very large striped bass are often landed. Other methods, including trolling with hand lines and bait fishing with clams and worms are practised in the northeast part of the province.

Sportfish Characteristics.-- Striped bass have been described frequently as one of the most powerful fish that swim in waters of the Atlantic coast. Individuals of all sizes fight extremely well when hooked and a large striped bass may take more than hour to subdue on light tackle. Striped bass bite readily on most baits and lures, and since those in the smaller sizes often school, several fish may be hooked in rapid succession. Striped bass are pursued actively throughout their range by anglers seeking a fish which fights hard, attains a large size, and is excellent for eating.

Foodfish Characteristics.-- Striped bass have excellent flesh which is white, flakey and delicious. Commercial and recreational fisherman have long sought striped bass for their value as food fish. Only recently has the fighting ability and sporting qualities of the striped bass been recognized in the United States. The striped bass is highly esteemed as a food fish in this province.

Current Economic Utilization.-- In New Brunswick, the striped bass is a valuable food and sport fish. On the northeast coast the striped bass supports a large recreational fishery which is surpassed only by the brook trout in directed fishing effort. More coastal non-fly fishing anglers fish for striped bass than any other provincial species. In the Bay of Fundy region, many anglers fish for striped bass in the mouths of coastal rivers. Many tackle stores stock items for use exclusively for striped bass fishing. In commercial value, the striped bass is an important food fish for many fisherman and sales of this species may comprise a significant portion of an individual's annual income. New restrictions on commercial sale in New Brunswick should decrease effort and enhance abundance of striped bass, particularly in the Northumberland Strait region.

Development Potential.-- The striped bass is so valuable a sport fish within its range that it has been propagated and stocked in nearly every Atlantic state. Stocking and enhancement programs have been initiated for put and take fisheries and to enhance wild populations. Current trends in the mid-Atlantic states include stocking large lakes to support put and take fisheries (which supplement and/or replace largemouth bass programs) and stocking to enhance depleted anadromous populations. In New Brunswick, the striped bass is a prime candidate for stocking and enhancement programs: it is indigenous to the region, is an excellent game and food fish, grows to a large size, adapts well to a

variety of water conditions and is easily cultured. Catch and release angling for stocked freshwater lake populations in the United States is very popular and beneficial to local economies; many large striped bass (5-20 kg) are frequently caught and released in these fisheries. This method may be desirable for inclusion in the management of the species in New Brunswick.

Population Enhancement Procedures.--Fishery harvest restrictions are the best methods for enhancing wild anadromous populations. Striped bass natural mortality is low once the fish has reached juvenile size. Fishing mortality is the predominate factor in declines of striped bass populations. Many Atlantic states have seen substantial increases in the abundance of striped bass after commercial and recreational fishing restrictions were implemented. Populations can and have been successfully enhanced by stocking. Waters in which striped bass are stocked should contain a self-sustaining forage fish and/or invertebrate prey base. Striped bass culture is relatively uncomplicated and economical, and the mortality of cultured fishes is small. Many self-sustaining striped bass fisheries in the United States originated from stocked fish.

Cautionary Notes.-- Striped bass are large predatory fishes which will compete actively with other game fishes. They will also feed actively on other game fish species. Stocking striped bass in freshwater lakes should only be done in waters where other sport fish species are in decline or absent. Striped bass have been recorded as feeding extensively on the young of salmonids.

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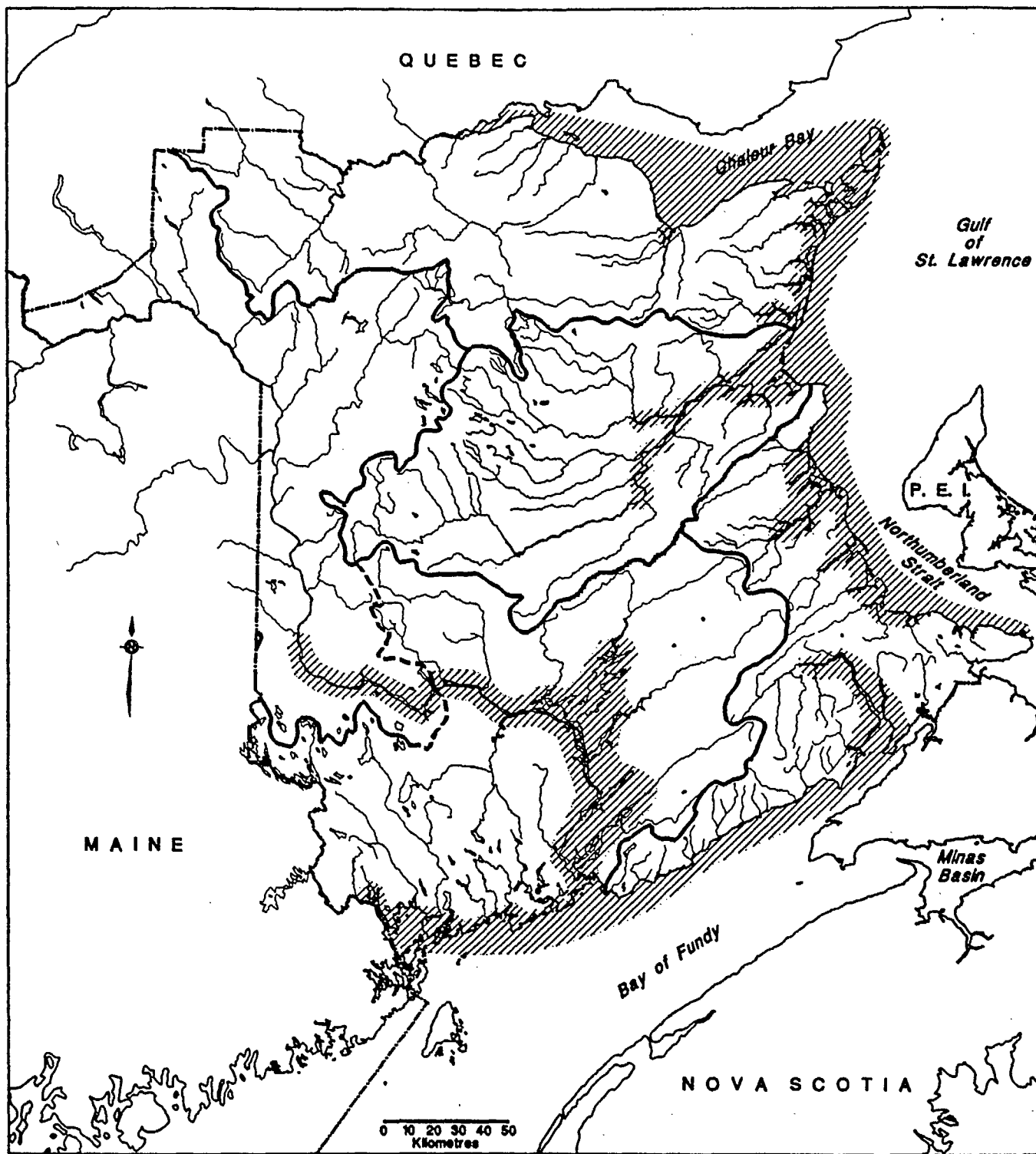


Figure M12. Distribution of Striped Bass in New Brunswick.

White Perch

Scientific name: *Morone americana*

Local vernacular name(s): perch, perche blanche, white bass

The white perch is a popular sport and commercial fish throughout its Atlantic range. Historically, it has been one of the most economically important fishes in the mid-Atlantic states and is particularly important in the Chesapeake Bay region. In New Brunswick it is locally abundant, but not widespread.

Distribution

White perch are found in the coastal and inland waters of eastern North America from the Gulf of St. Lawrence to northern Georgia. They are common to rare in all of the Great Lakes, and are most abundant in the Chesapeake Bay north to the Hudson River, New York. In the anadromous form, the white perch can be found in nearly every freshwater river and estuary within its coastal range; generally within a few miles of the coast in marine waters. In the freshwater form, the white perch is common in lakes, ponds and the upper reaches of rivers throughout its Atlantic range. It is rare in the freshwater of the St. Lawrence River.

Canada.-- White perch are common in Lake Ontario, The Bay of Quinte, lower Niagara River and Lake Erie, and are sparsely distributed in Nova Scotia, Prince Edward Island and New Brunswick. The white perch is an inland, freshwater species in the Maritime provinces where it is restricted to lakes and very rarely found in ponds.

New Brunswick.-- The white perch is not widely distributed in New Brunswick, although it can be locally abundant. No anadromous populations have been reported for the province, although some probably do exist (there are anadromous populations in the Annapolis River, Nova Scotia directly across the Bay of Fundy from the Saint John River where white perch are infrequently caught). All known populations are restricted to freshwater lakes. Only three lakes in the province are known to have self-sustaining populations of white perch. These are Livain Lake in Kouchibouguac National Park (northeastern) and Bolton and Wheaton Lakes in the southwestern part of the province. White perch occur rarely in the Kouchibouguac, St. Croix and Saint John River systems.

New Brunswick Watersheds.-- They are presently restricted to Southwest and Southeast Drainage Systems.

Introductions.-- White perch occurs naturally in New Brunswick, and there are no known selective stockings of this species in the province.

Habitat and Preferred Habitat.--In New Brunswick, the freshwater form of the white perch is found in shallow, weedy lakes with high average summer temperatures (>18°C). The fish prefer still water with little or no current. In rivers, white perch are found in shallow, rock and sand bottom pools and flats in summer, and deep pools in winter. Habitat can and will vary from these examples, since white perch will thrive in a variety of environments. The only limiting environmental parameters are probably water temperature and ph.

Life History and Information relative to management

Spawning and early life history.-- White perch spawn in spring in New Brunswick. In lakes, spawning begins at temperatures of 8-12°C; required temperatures in river headwaters are unknown, but are probably similar. Current is not required for successful spawning. Anadromous populations spawn in freshwater. Typical spawning behaviour involves a single female releasing eggs which are fertilized by several males, although school spawning is known for this species. The eggs are small (approx. 1 mm diameter), are slightly adhesive and are deposited on gravel or rock bottoms. Fecundity of females is roughly 100,000 eggs for a 4 year old female. Eggs hatch in 2-4 days; hatched larva are 2-3 mm long. Yolk sacs sustain the larva for 8-13 days and post-larval transformation occurs at approximately 10 mm.

Size and Age.-- White perch do not reach a large size. The oldest and largest individual from any freshwater habitat recorded so far was collected in New Brunswick at Bolton Lake, measuring 28.5 cm in fork length and estimated to be 18 yrs old (a 17 yr. old fish was caught in a Maine). Anadromous white perch reach greater lengths and age than that characteristic of freshwater populations. In New Brunswick lakes, the majority of white perch are 0* to 10 yrs of age with few living long enough to reach lengths greater than 22 cm and 10 years of age. General length at age relationships are: 6 cm-1 yr; 16 cm-4 yrs; 20 cm-8 yrs. Females first spawn at about age 3 when they are 14 cm in length.

Food and Feeding habits.-- White perch are indiscriminate carnivores and will eat whatever prey species is available. Larva and post-larva feed predominately on zooplankton (cyclopoid copepods and rotifers). Prey size increases with fish size. Juvenile perch (1-3 years old) feed actively on aquatic insect larva and adults (particularly mayflies, stoneflies and caddisflies in lakes). Mature white perch feed frequently on fish including other white perch. White perch have a high reproductive potential and in lakes of limited size, over-population often results. This phenomenon occurs when predation on young perch and natural mortality operates at low levels and available food resources become limited. These factors result in a population composed of large numbers of small, 1-4 yr old fish. "Stunting" of white perch freshwater populations occurs throughout its range.

Water Quality Requirements.-- White perch can tolerate a wide range in water quality. Freshwater forms prefer waters with summer temperatures of 18-26°C for optimal growth. White perch will select water with a hardness of >30 mg/l (CaCO₃). Preference for pH is not known for New Brunswick populations; more southern stocks select a pH of >6. Perch prefer waters of low turbidity.

Primary Fishing Areas.-- White perch are not avidly pursued by anglers anywhere in New Brunswick. Limited fishing effort is directed toward this species wherever they occur. They are most often caught in lakes where they are indigenous by anglers fishing for other species.

Angling Season.-- White perch are most active and feed most intensively in water temperatures of 10-25°C. In New Brunswick, this temperature regime is characteristic in lakes from mid-May through September annually.

Current Regulations.-- There is no size or catch limit for white perch in New Brunswick. Open season is from 15 April to 30 September.

Angling Methods.-- White perch are seldom fished for specifically. Most are caught by anglers in pursuit of brook trout, smallmouth bass and landlocked salmon which co-inhabit the lakes where white perch populations exist. In spring, many white perch are caught on streamer flies trolled for landlocked salmon. Trout anglers using spinners and worms and other natural baits catch many white perch in late April and May. Fly fishing is successful during hatches of mayflies and caddisflies in June.

Sportfish Characteristics.-- White perch are easily caught on a variety of natural baits and lures. Their fighting ability is on par with that of brook trout. They are much less active when hooked than smallmouth bass and landlocked salmon. They do not jump or leap during the fight. In general, white perch caught by angling average only about 15-20 cm in length.

Foodfish Characteristics.-- White perch are excellent to eat, having white, flakey flesh and few bones. Fish from warm summer waters are less desirable than fish caught in spring. Flesh is sometimes infected with larva of the flatworm *Clinostomum marginatum*, making it undesirable.

Current Economic Utilization.--Very little to none in New Brunswick. Consumed locally wherever it occurs. Seldom fished for as a target species.

Development Potential.--White perch grow fast, are easily cultured and adapt well to a wide range of environmental conditions. They may be a good species to introduce into isolated waters of minimal water quality where other more desirable species are in decline.

Population Enhancement Procedures.--Under ideal habitat and environmental regimes, white perch populations grow rapidly and become self-sustaining in a short period. Establishing and enhancing populations is relatively simple: introducing a few dozen mature fish is often all that is required to rebuild or initiate a stock.

Cautionary Notes.-- White perch are extremely prolific and competitive. In terms of competition, white perch will outperform brook trout and most other salmonids in exploitation of available food resources. White perch will feed on the fry of other desirable game fishes. Their propensity to develop stunted populations in waters of limited size is undesirable.

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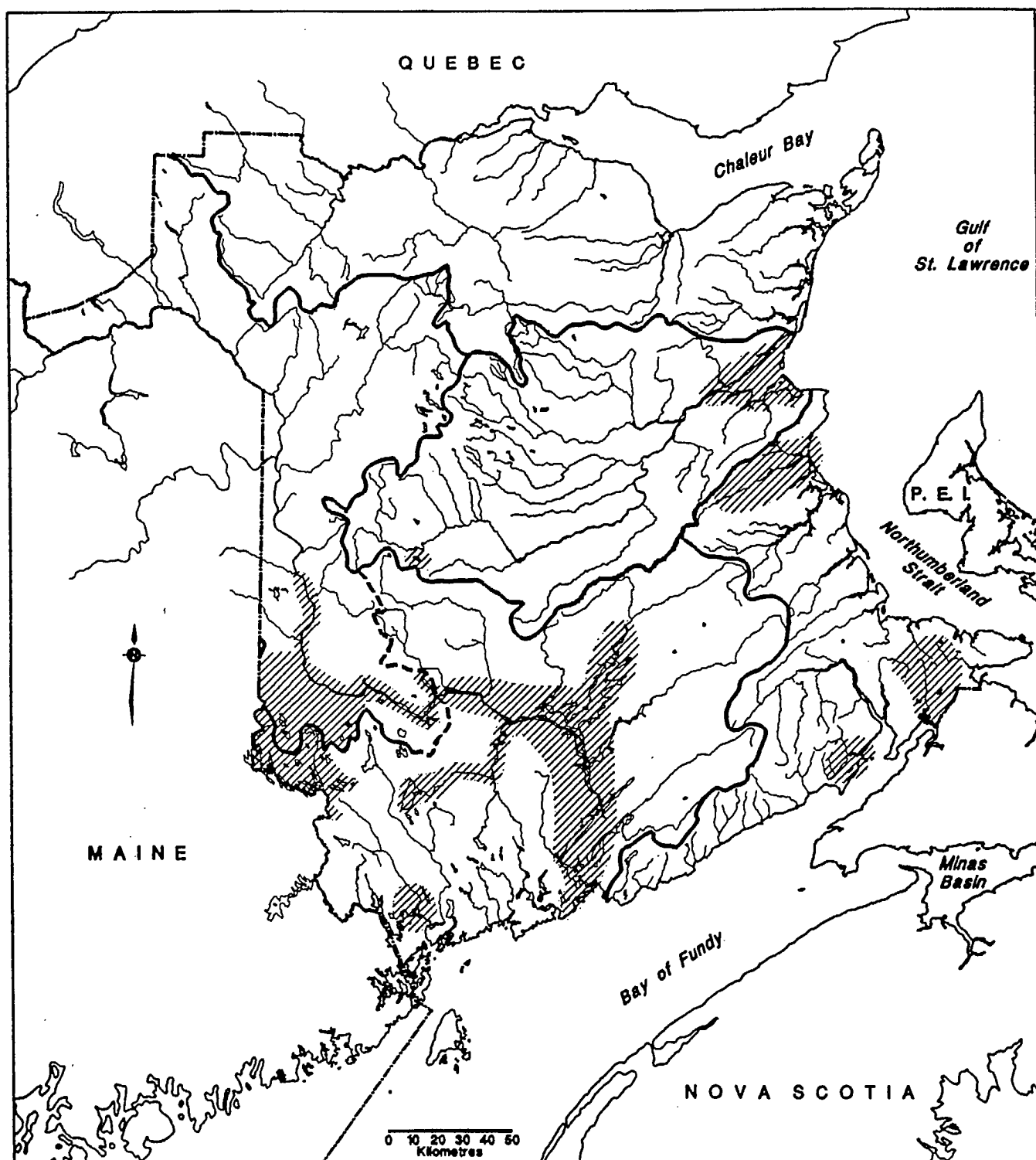


Figure M13. Distribution of White Perch in New Brunswick.

Yellow Perch

Scientific name: *Perca flavescens*

Local vernacular names: perch, lake perch, perchaude

Distribution

Yellow perch are native to North America, and are found from Nova Scotia to Florida, and range westward to Montana, Missouri, and Kansas in the United States. In Canada they are found from Nova Scotia to Alberta and southern British Colombia, and are found adjacent to southern James Bay but not Hudson Bay.

New Brunswick Watersheds.-- Although early writers recorded widespread populations of yellow perch, few positive records exist. They have been recorded in the Central and SW Drainage and Miramichi Drainage, and are probably found in all New Brunswick drainages.

Introductions.-- Many western and southern states.

Habitat & Habits.-- Yellow perch are very adaptable to a wide variety of habitats, from the warm to cooler waters of ponds, to large lakes and quiet rivers. They are occasionally found in brackish water. They are most abundant in the open water of lakes with clear water, moderate vegetation, and mud, sand, or gravel bottoms. Yellow perch prefer shallow water of depths less than 9m and temperatures of about 20° C. In the spring, they are found near shore, but they will move to deeper water if necessary to maintain temperature preference. Yellow perch form small schools that are segregated by size (the young reside in the shallower water nearer shore than adults). They are active and feeding during daylight, principally during the morning and evening, and they rest on the bottom at night. Yellow perch are active and feeding during winter under ice as they feed year round.

Life History Information Relevant to Management and Enhancement

Spawning and early life history.-- Yellow perch spawn in April and May at water temperatures of 7 - 12° C, after migrating to the shallows of lakes or into tributary rivers. Populations living in brackish water enter fresh water to spawn. They seem to consistently return to the same spawning grounds each year. Spawning occurs at night, near vegetation or submerged brush or trees, and occasionally over sand or gravel. Yellow perch do not form nests and do not provide parental care. Fecundity ranges from 2000 - 90,000 eggs, with an average of 23,000. The eggs form a semibuoyant, gelatinous, ribbon-shaped tube 0.6 - 2.0 m long, 5 - 10 cm wide, weighing up to 1.0 kg., adhering to vegetation or substrate. Eggs incubate for 8 - 10 days (27 days at 8.3° C, 51 days at 5.4° C), and hatch to free-living yolk-sac larvae.

Size and Age.-- The maximum weight of yellow perch is 1.9 kg, with an average size of 20-30 cm and a weight of less than 0.5 kg. Males mature at three years and females mature at 4 years, with a size of approximately 10-13 cm. The maximum life span is usually 9 to 10 years.

Food and Feeding Habits.-- Yellow perch prefer to prey aquatic insects, larger zooplankton, and fishes, and are known to eat fish eggs.

Water Quality Requirements.-- Yellow perch are primarily a lake fish, preferring clear water. Turbidity reduces yellow perch numbers. They can withstand low to medium salinities and somewhat lowered oxygen concentrations.

Fishery Management Tactics Currently in Effect.-- none.

Primary Fishing Areas.-- Yellow perch are not a directed angling fishery in New Brunswick, although they are directly sought in other regions. They are most often taken in lakes by anglers fishing for other species.

Angling Season.-- The angling season is from 15 April - 30 September. The fish congregate near the shore in spring, making them available for angling. Since yellow perch feed actively in all seasons, it is possible to fish for yellow perch year round.

Angling Method in New Brunswick.-- Though not sought directly, yellow perch are often taken on streamer flies intended for landlocked salmon in spring; on spinners, worms, and other natural bait intended for trout in late April and May; and by fly fishing intended for smallmouth bass in June. Elsewhere, they are still-fished with minnows, worms, or cut bait.

Sportfish Characteristics.-- Yellow perch are readily available to anglers as they are widely distributed, occupy a wide variety of habitats, school, congregate near shore in spring, and feed (thus takes bait) year round. They may be caught during a spawning run using live minnows as bait (although this is illegal in New Brunswick).

Foodfish Characteristics.-- Yellow perch is a popular eating fish. The flesh is white, flaky, and considered delicious.

Current Economic Utilization.-- It is illegal to barter or sell angled yellow perch. They are consumed locally when caught as a nontarget species.

Development Potential.-- Yellow perch are serious competitors with other, more desirable sport fish (see Cautionary Notes below). Therefore, promoting and developing yellow perch for angling is not recommended in any waters targeted for salmonid or smallmouth bass management, or in nearby waters due to yellow perch's propensity to spread.

Other Modes of Capture.-- N/A

Population Enhancement Procedures.-- Hardy and prolific. Under adequate conditions, a population can quickly grow and become established from natural or artificial introductions of relatively few individuals. Removing adult white suckers will improve yellow perch growth and quality of fishing.

Cautionary notes.-- Yellow perch outcompete stocked salmonids for available food, drastically reducing salmonid growth and survival. Smallmouth bass also face serious competition from yellow perch. Yellow perch have the propensity to develop stunted populations in water bodies of limited size.

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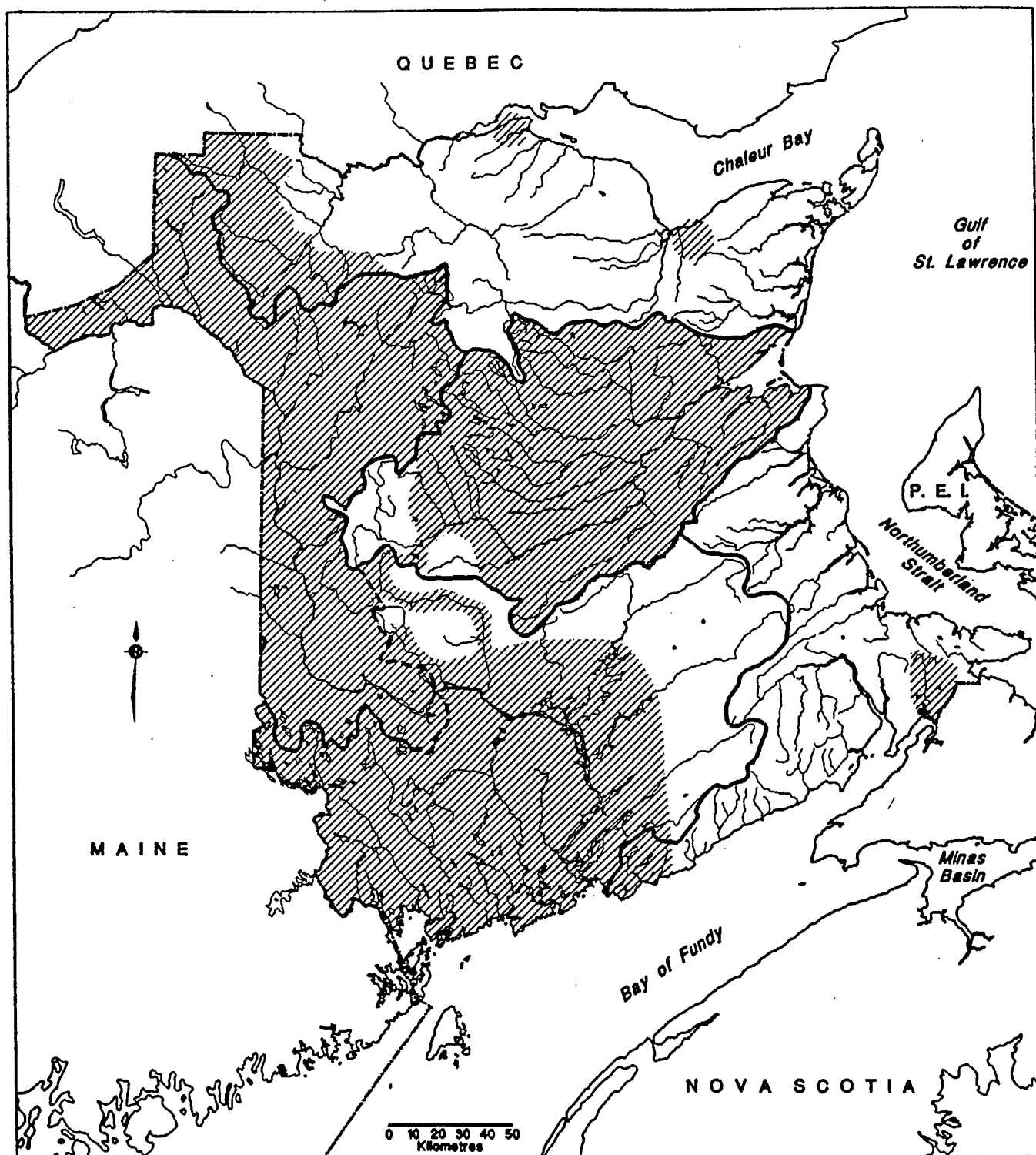


Figure M14. Distribution of Yellow Perch in New Brunswick.

Chain Pickerel

Scientific Name: *Esox niger*

Local Vernacular Name(s): pickerel, little pike

Chain pickerel resemble their larger relatives, Northern Pike and Muskellunge. In New Brunswick, their distribution is restricted to the southwest part of the province and they are rarely pursued by anglers. There is very little information on the biology and recreational fishery potential of chain pickerel in any part of its range. In the eastern United States it is popular as a sportfish wherever it occurs.

Distribution

The chain pickerel is restricted to freshwater and low salinity (<15 ppt) rivers and lakes of eastern North America, from central Florida west to the Mississippi River and north to central New Brunswick and Nova Scotia.

Canada.-- Chain pickerel are found only in New Brunswick, southern Nova Scotia and southeastern Quebec.

New Brunswick.-- Chain pickerel are restricted to the south central and western portions of the province. Basically the species is confined to the St. Croix River and lakes associated with this system and the Saint John River. A few other lakes in southwest New Brunswick not associated with these rivers contain self-sustaining populations of chain pickerel.

N.B. Watersheds.--Central and Southwestern Drainage: Upper Saint John River Drainage.

Introductions.-- Chain pickerel occurs naturally in New Brunswick, and there are no records of selective introductions in the province.

Habitat and Preferred Habitat.-- In spring, summer and early fall, chain pickerel are found in shallow, weedy bays and coves in the backwaters of rivers and along the shores of lakes. They prefer warm shoreline habitats where they orient and associate with structure and cover in the form of logs, rocks, aquatic plants, etc. In winter, chain pickerel move to the bottoms of deep pools in rivers and to deep water areas of lakes. They are often found in the lakes, rivers and streams inhabited by smallmouth bass.

Life History Information Relative to Management

Spawning and early life history.-- In New Brunswick, chain pickerel spawn in early spring in water of 8-12°C, in the southwest part of the province usually in late April to early May. Pickerel are broadcast spawners and the female spreads eggs indiscriminately over a wide variety of substrates. One female lays eggs fertilized by a single or at most two males. The eggs are about 2 mm in diameter, demersal and slightly adhesive. They are often found adhering to vegetation close to shore. A 1 kg female may complete the spawning of up to 40,000 eggs over a two day period. The eggs hatch in about 10 days at 15-18°C. Larva at hatching are approximately 5 mm in length. Active feeding begins at 10-14 mm, after absorption of the yolk sac.

Size and Age.-- Chain pickerel do not reach the size of pike or muskellunge, but are much larger than the closely related grass and redbfin pickerels. The largest pickerel caught in New Brunswick generally range from 1-3 kg and measure 45-65 cm. General age at length for chain pickerel are: 1 yr-1.5 cm; 3 yrs-29 cm; 5 yrs-53 cm; 7 yrs-60 cm. The majority of chain pickerel caught by anglers measure 30-50 cm in length and weigh between 1 and 2.5 kg. The largest and oldest fish are always females.

Food and feeding habits.-- Chain pickerel are opportunistic predators. Prey species size increases with pickerel size. Small pickerel will feed extensively on the larva and adults of aquatic insects and on crayfish. Larger fish are predominately piscivorous. The largest pickerel generally consume a few large forage fish rather than several small ones; amphibians, ducklings and mice are also eaten.

Water Quality Requirements.-- Chain pickerel prefer water temperatures of 18-28°C, a range represented by the summer temperature regime characteristic of most shallow, shoreline habitats in southwestern New Brunswick. In winter, pickerel have survived water temperatures as low as 0.1°C. There is little information on pH and hardness requirements for chain pickerel. They can apparently survive acid water with a pH of 3.8 and can tolerate the salinities of up to 15 ppt that are found in estuarine environments.

Primary Fishing Areas.-- The Saint John and St. Croix River systems contain large numbers of pickerel. The St. Croix in particular has high densities of chain pickerel. Several lakes in the southwest corner of the province are known to contain pickerel in sufficient numbers for quality angling.

Angling Season.-- Chain pickerel can be caught throughout the year and many are taken while ice fishing on some lakes in the southwest region. Pickerel are most active and easily caught during the late spring-early fall period.

Current Regulations.-- In New Brunswick there are no angling restrictions on size, catch limit or fishing methods for chain pickerel. The open season for pickerel fishing is the same as that for smallmouth bass, 15 April to 30 September annually.

Angling Methods.-- In New Brunswick, chain pickerel are caught most frequently by anglers fishing for the more popular smallmouth bass. Any lure which is taken by smallmouth bass can be used successfully for pickerel. Large minnow or frog imitations can be used to catch pickerel. Live and dead baits (especially minnows) are also effective. Fly fishing for pickerel is productive, but seldom practised in New Brunswick. Fishing through the ice with natural baits is effective during the winter.

Sportfish Characteristics.-- Chain pickerel are better sportfish than most anglers realize. Those of larger size (1-2 kg) are strong and fight actively when hooked. Pickerel (like northern pike) are known for their ferocity when attacking a lure. They often jump when hooked. Chain pickerel are best fished for with light spinning and fly fishing tackle. During the summer and early fall pickerel actively take lures and bait and are easily caught.

Foodfish Characteristics.-- The flesh of chain pickerel is white, flakey and excellent. Unfortunately, pickerel flesh contains more bones than most other gamefish. Several cleaning and cooking methods have been created to reduce the amount of bones in the flesh, although no method

has proven entirely successful. Fish from very warm water ($>18^{\circ}\text{C}$) are sometimes less palatable than those caught in colder water.

Current Economic Utilization.-- The chain pickerel is not a target species for anglers in New Brunswick. Almost all that are caught are taken by anglers fishing for smallmouth bass. Most of the pickerel caught in New Brunswick are released. Few anglers in New Brunswick, even in areas where the species is abundant, fish directly for chain pickerel.

Development Potential.-- Chain pickerel are abundant, but not widely distributed. They are good sportfish and have the potential to replace and/or reduce recreational fishing pressure on more highly desirable species, particularly smallmouth bass which share their New Brunswick range. Chain pickerel have the potential for natural expansion into unutilized habitats; their suitability for waters in the northern part of the province is unknown. Many lakes in the southern part of the province which have abundant habitat suitable for pickerel (but not appropriate for salmonids) could be successfully stocked with pickerel.

Population Enhancement Procedures.-- Chain pickerel populations have been historically under-exploited when compared to other gamefish within its range. Chain pickerel have not previously been considered desirable sportfish throughout most of their range, so fishing pressure has been generally low on the species. No enhancement of stocks and/or populations has yet been necessary. Culture techniques for the species have not been specifically developed, although techniques which are known for northern pike and muskellunge could probably be applied to the propagation of chain pickerel.

Cautionary Notes.-- Chain pickerel are prolific and are able to exploit a wide variety of habitats. They will compete successfully against other game fish species, and are known to prey on the young of salmonids.

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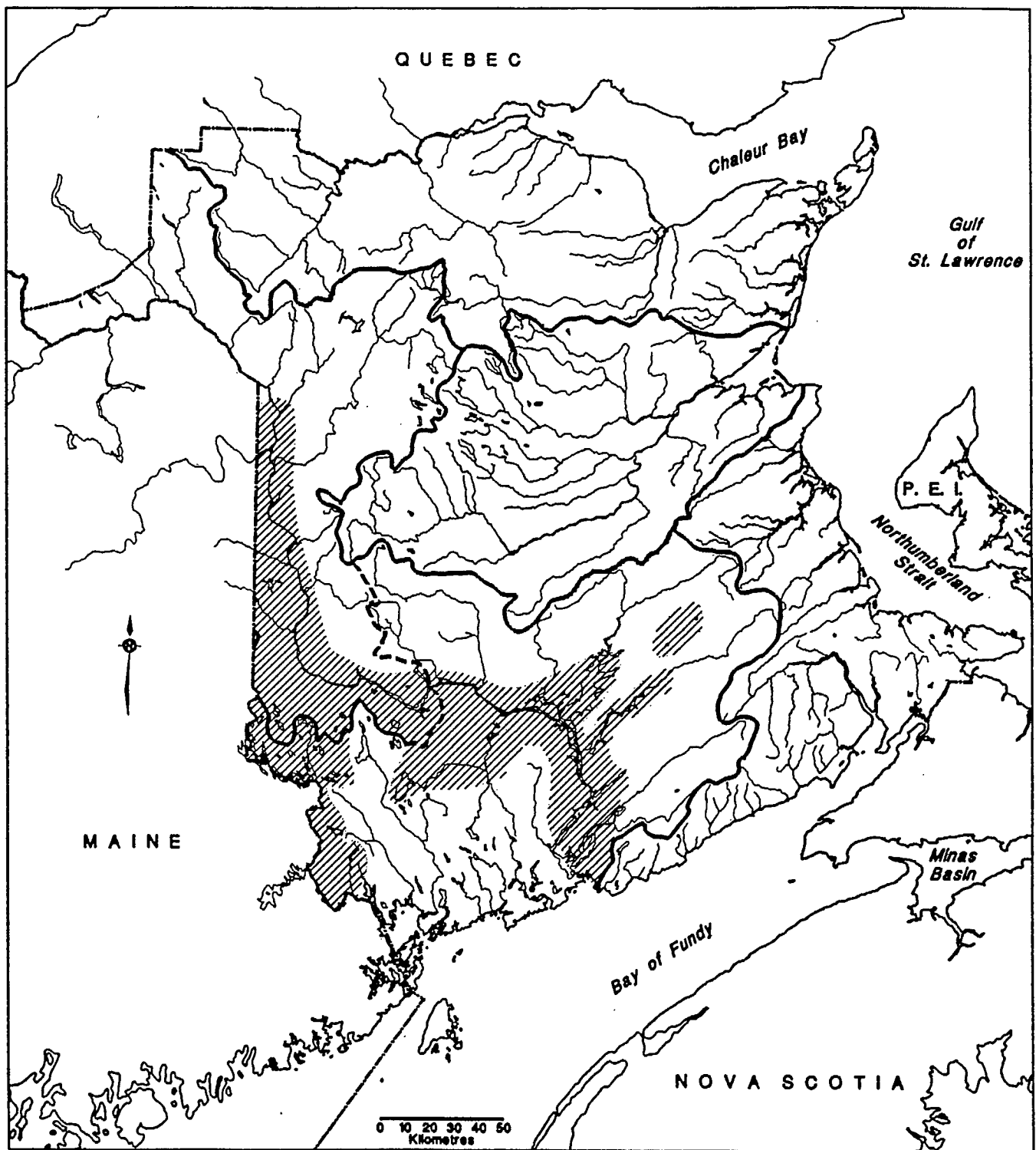


Figure M15. Distribution of Chain Pickerel in New Brunswick.

Tomcod

Scientific Name: *Microgadus tomcod*

Local Vernacular Name(s): tomcod, frostfish, poulamon atlantique

The tomcod is a small gadiform fish which spends the majority of its life in marine and estuarine areas. It is generally available to anglers only when it enters freshwater to spawn. The tomcod is a popular sportfish wherever it occurs and most New Brunswick populations are exploited. Almost all tomcod are caught while ice fishing.

Distribution

The tomcod is found in coastal marine waters from Labrador south to the Chesapeake Bay.

Canada and New Brunswick.-- Tomcod are found in inshore marine and estuarine waters in Atlantic Canada. There are a few landlocked, freshwater populations in Quebec and Newfoundland. In New Brunswick it is found in both the Northumberland Strait and Bay of Fundy regions where many populations ascend rivers and streams to spawn in euryhaline or freshwater.

N.B. Watersheds.-- Tomcod are present in all drainages, but are probably rare in the upper Saint John River drainage.

Introductions.-- Tomcod occur naturally in New Brunswick; no introductions of the species to waters of the province have been recorded.

Habitat.-- In spring, summer and fall, tomcod inhabit the inshore marine and estuarine areas of the province. They are basically fish of littoral and sub-littoral coastal zones. In winter tomcod move into rivers and streams to spawn.

Life History Information Relative to Management

Spawning and early life history.-- Tomcod are unusual in that they spawn in mid-winter, often under the ice. They spawn in fresh or euryhaline water over sand and gravel bottoms. Spawning takes place at temperatures of 1-3°C. In New Brunswick, spawning occurs during late December through January. A 180-200 mm female may spawn up to 7000 eggs. Spawning apparently occurs in schools. The adhesive eggs are 1.5 mm in diameter immediately after fertilization, and hatch after about one month. After hatching, the fry remain in the nursery area until they reach about 50-70 mm when they then migrate to estuaries.

Age and size.-- Tomcod are small fish; the largest tomcod average only about 25 cm and weigh about 500 g. There is little data on the age-length relationships of tomcod. Tomcod caught by anglers in New Brunswick average about 15-20 cm in length.

Food and feeding habits.-- Tomcod consume a wide variety of prey when in marine and estuarine environments, including crustaceans, molluscs, polychaete worms and fish. They apparently continue to eat when on their spawning runs because most are caught during this period by anglers using natural baits.

Water quality requirements.-- There is very little information on the water quality preferences of tomcod. They feed actively in water with temperatures as low as 1-2°C. The larvae and fry of tomcod are known to be sensitive to water with low dissolved oxygen content and chemical pollution.

Primary Fishing Areas.-- Many small rivers and streams in the province contain mid-winter runs of tomcod. Almost all are popular locally for fishing when the runs are at peak abundance.

Angling Season.-- During the spawning run in winter, best in December through February.

Regulations.-- There are currently no regulations on catch limit, minimum size or season for tomcod in the province.

Angling Methods.-- Tomcod are caught while ice fishing, usually with natural bait. Worms, clams and mussels are the most frequently used natural baits. Spinning rods adapted for ice fishing or hand lines are the tackle types used.

Sportfish Characteristics.-- The tomcod are small fish and not known for their fighting ability; they do, however, take natural baits eagerly and large numbers can be landed.

Foodfish Characteristics.-- Tomcod have white flesh which is excellent. The fillets from tomcod have few, if any bones.

Current Economic Utilization.-- Tomcod are utilized wherever they occur in New Brunswick. They form the basis of several winter fisheries when sportfishing for most other fish is not possible. Winter tomcod recreational fisheries are important to the economies of many rural areas. Commercial fishing for tomcod is predominately based on incidental catches in gear set for other species (particularly smelt).

Development Potential.-- So little is known of the biology of tomcod it is difficult to predict if current New Brunswick fisheries for the species could be expanded. Most populations may currently be exploited at or above sustainable levels. Some could sustain more intensive effort. Without knowledge of the basic population dynamics of New Brunswick stocks, it would be unwise to increase pressure on the species in this region. The techniques for culturing tomcod have not been developed anywhere, so stockings and introductions are not currently possible.

Cautionary Notes.-- Our knowledge of tomcod is sparse and nothing is known of their ability to compete with other species or what other effects its increased abundance or introduction to new waters would have on indigenous species.

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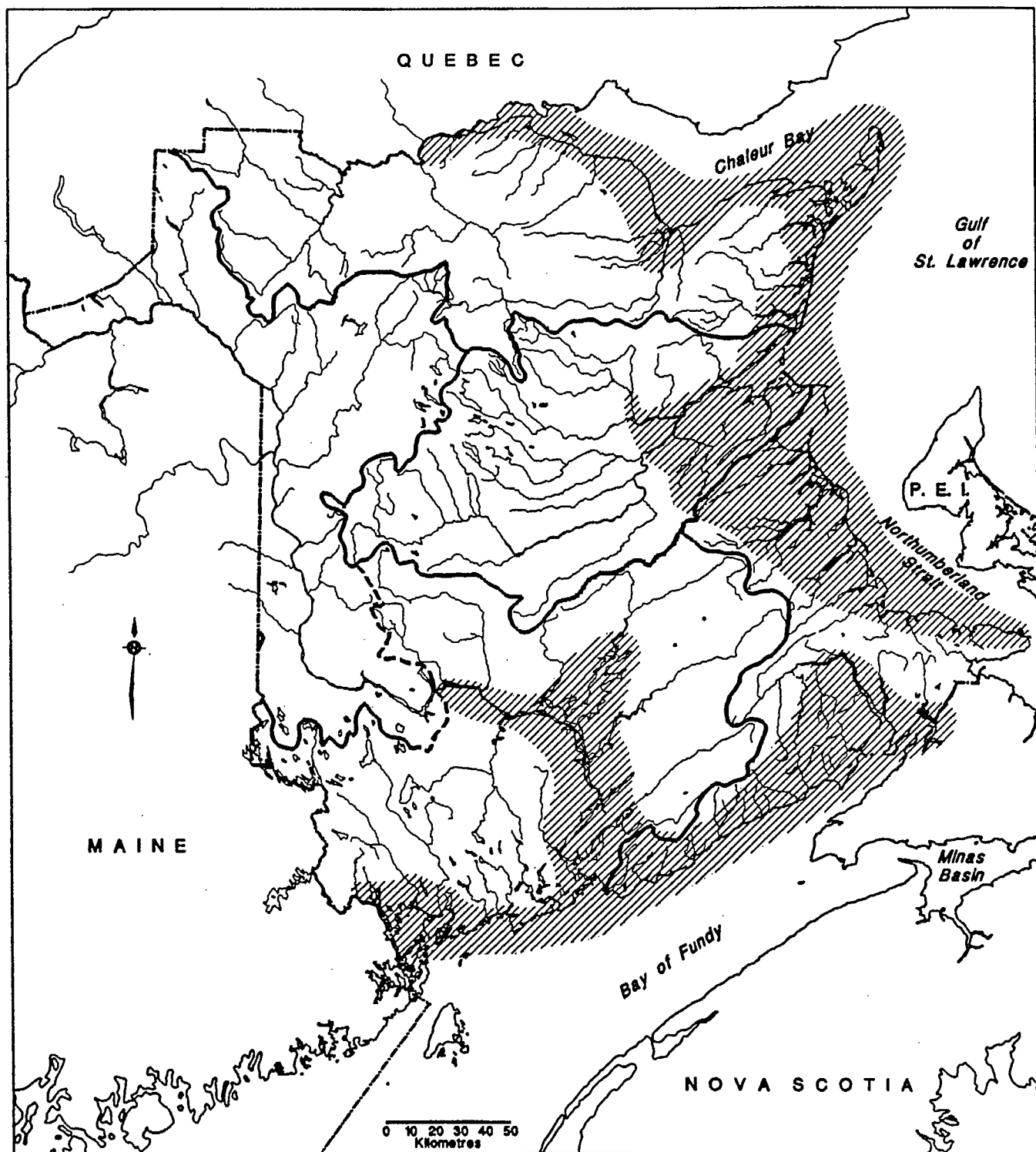


Figure M16. Distribution of Tomcod in New Brunswick.

SPORTFISH OF LIMITED POTENTIAL

Splake

Scientific name: *Salvelinus namaycush* X *Salvelinus fontinalis*

Local vernacular names: wendigo

General Comments

Splake are a fertile hybrid of female lake trout and male brook trout. They have been introduced to many parts of North America, including Quebec and particularly Ontario, including the Great Lakes. Recaptures have been made 5 and 6 yr after planting in those areas. Splake stocking supports a small recreational fishery in New Brunswick. In some life history habits they resemble either lake trout or brook trout, and in other respects their habits are intermediate between the two. Attempts have been made to selectively breed splake with the desirable traits of both parent species, such as the deep swimming habits of lake trout with the early maturing habits of brook trout.

Splake grow more quickly than either parent, to a maximum size of 7.3 kg. They mature on average at 3 years, with a maximum longevity of 9 years. They spawn in autumn, during day and night. Eggs hatch in early spring. From 1 - 4 years, splake eat zooplankton and aquatic and terrestrial insects; after 5 years (38 - 58 cm) they eat chiefly fish. As splake are fertile hybrids with unlimited backcrossing potential, any stocking intentions in New Brunswick waters should be seriously considered to prevent depression or displacement of native brook or lake trout populations.

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Lake Whitefish

Scientific name: *Coregonus clupeaformis*

Local vernacular names: gizzard fish, whitefish, coregone de lac

General Comments

Lake whitefish are widely distributed in North American fresh waters from the Atlantic coast across northern U.S. and Canada to British Columbia, Yukon, and Alaska. They are present in virtually all of Canada except the northernmost islands of the Northwest Territories. They are found in some Nova Scotia lakes, but are more common in New Brunswick. Lake whitefish have been introduced in Newfoundland and elsewhere. They are principally a freshwater fish, with rare brackish and saltwater records (off Blacks Harbour in New Brunswick), and they prefer cool waters. In the Great Lakes, they move from deeper to shallow water in spring, and back to the deeper, cooler hypolimnion in summer. In fall, they return to shallows to spawn. Lake whitefish are generally regarded as schooling fish.

Lake whitefish are benthic feeders, with chief foods being aquatic insects, molluscs, and amphipods; they also take fishes and fish eggs. Lake whitefish reach a maximum size of 19 kg, with an average size of 1 - 2 kg. Their growth is rapid, reaching 1 kg in 4 - 5 years. Maximum longevity is 27 - 28 yr, though they are more likely to live 16 - 17+ years. Lake whitefish spawn in fall, usually in shallow water (< 7.6 m), over hard, stoney (and sometimes sandy) bottom. They may ascend streams to spawn. Eggs are laid randomly, receive no parental care, and hatch in spring. Typical fecundity is about 20,000 eggs per kg body weight. Larvae aggregate along steep shorelines, and the young move to deeper water in summer.

Primary fishing areas would be the lakes of the Saint John, Tobique, Restigouche, and Madawaska river systems. They are taken in spring in some regions, and can be angled in summer, but are more readily caught in fall and in winter through ice. There is an active sport fishery for this species in many areas outside New Brunswick. Whitefish can be angled with small hook baited with salted or fresh minnow. The flesh is white, flaky, and of exceptional flavour. Whitefish are of no economic importance in New Brunswick and have historically had a minute commercial importance here. They are sensitive to habitat degradation and overfishing.

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Muskellunge

Scientific Name: *Esox masquinongy*

Local Vernacular Names: Musky, maskinonge

General Comments

The pike-like muskellunge is one of the largest freshwater fishes found in Canada. It is one of the most sought-after and popular game fishes in North America. The muskellunge is a fish of northeastern and north central North America and has only recently been found in New Brunswick.

Muskellunge live in large lakes or rivers and the larger individuals are solitary and territorial. Muskellunge spawn in the spring of the year at water temperatures of 10-15°C in shallow, marshy areas. No nest is made and the parents do not care for the young. The eggs hatch in about two weeks. Growth is very rapid; generalized growth rate is: 1 yr-30 cm; 3 yrs-58 cm; 5 yrs-80 cm; 8 yrs-95 cm; 12 yrs-110 cm. Anglers capture muskellunge of up to 15-25 kg each year. Maturity is reached in 3 to 5 years and the largest fish are always females. Renowned as voracious predators, muskellunge feed on a variety of food items including fish, waterfowl and mammals. Muskellunge prefer non-turbid, well-oxygenated water with a consistent pH of more than 5.5.

In New Brunswick, muskellunge have only recently appeared in selected areas; there are no regulations on recreational fishing for the species at present. Anglers fish for muskellunge with a variety of natural and artificial baits, with large minnow and small mammal imitations being most frequently used as artificial lures. Live and dead minnows of large size are the best natural baits. Fly fishing with big streamer flies is less productive than spinning or bait casting and is seldom practised.

When hooked, the muskellunge is one of the strongest of freshwater fishes and jumps frequently. It is also a challenging sportfish and many hours of effort may be required to catch a single fish. The flesh of muskellunge is white, flaky and highly-prized by many anglers. The trend in recent years has been to release most muskellunge caught, as so few are generally found in a single lake or river.

In New Brunswick muskellunge are not currently used. Since 1988, muskellunge have only been reported from the Saint John River system. Those individuals (6: 5-81 cm in length) have been caught close to (above and below) the Mactaquac Dam.

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Atlantic Sturgeon

Scientific Name: *Acipenser oxyrinchus*

Local Vernacular Name(s): sturgeon, lake sturgeon, esturgeon noir

General Comments

The Atlantic sturgeon is one of the largest freshwater fishes in Canada and the largest in New Brunswick. An anadromous species, the sturgeon is periodically very common in some of the larger rivers in the province. Individuals of various sizes are infrequently caught in several rivers in the province, both by anglers fishing directly for them, and by anglers fishing for other gamefish species.

In New Brunswick, the sturgeon is found in inshore marine waters in the Bay of Fundy and Northumberland Strait and in the estuaries and freshwater portions of large rivers associated with these systems. The sturgeon spends most of its life in marine waters but mature individuals move into freshwater to spawn in spring. In New Brunswick, sturgeon spawn in May or June; the water temperature required for spawning is 13-18°C. Eggs are laid indiscriminately over a variety of substrates. A large (158 kg) female contained 3.8 million eggs. The eggs hatch in 10-14 days depending on water temperature. The young remain and grow in freshwater for 3-4 years before migrating to the sea.

Sturgeon grow slowly, but reach a very large size. General age-length relationships are: 5 yrs-50 cm; 15 yrs-120 cm; 20 yrs-160 cm; 46 yrs-260 cm; 60 yrs-267 cm. A 60 year old sturgeon may weigh 160 kg. Males and females reach maturity at 20-28 years of age. Sturgeon are bottom feeders which consume a variety of plants, invertebrates and small fishes. Adults cease feeding when on their spawning migrations.

In New Brunswick, the sturgeon is targeted by anglers only in the lower Saint John River area. In Washdemoak Lake, Kennebecasis Bay and in lower portions of the main river, sturgeon are occasionally plentiful enough to make fishing for them productive. A wide range of live and dead baits from small gaspareau to beef liver have been used to catch sturgeon. Tackle must be necessarily heavy to land fish which may average 30-50 kg.

The sturgeon is periodically a valuable commercial species in the province. However its numbers have declined due to over-fishing over much of its range, including New Brunswick. A related species, the much smaller shortnose sturgeon (*Acipenser brevirostrum*) is also anadromous and is frequently found in the same areas as the Atlantic sturgeon. Its numbers have also declined significantly and it

is now considered an endangered species in many areas, including this province. It is easily confused with juvenile Atlantic sturgeon.

The Atlantic sturgeon is a good foodfish and its eggs have frequently been used as caviar. In New Brunswick, the Atlantic sturgeon is presently under-utilized as a sportfish; this may be related to its low levels of abundance.

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Fallfish

Scientific Name: *Semotilus corporalis*

Local Vernacular Name: chub, outitouche

General Comments

The fallfish is a large cyprinid fish which is frequently caught by New Brunswick anglers while fishing for other gamefish species. Although often caught it has not previously been considered a sportfish anywhere within its range. In New Brunswick it occurs in most rivers and several lakes in the southwestern two-thirds of the province from the Miramichi system south.

Fallfish prefer streams and rivers with moderate current flow and large, shallow pools. They are rarely encountered in lakes. They spawn in the spring at water temperatures of 16-18°C. The male builds a nest in the form of a gravel mound. The eggs hatch in 2-4 days and fry can reach a length of 3 cm by the end of their first summer. The largest fallfish are about 40-45cm in length. The average angler-caught specimens in New Brunswick are usually 25-30 cm. Fallfish eat a wide range of prey species, with the nymphs of aquatic insects being frequently consumed; small fish are also eaten. The fallfish requires clear, well-oxygenated water and can survive a ph of 4.5.

Fallfish are frequently caught by anglers seeking brook trout and Atlantic salmon. They will take natural baits (worms and minnows) and are particularly likely to be caught on a trout or salmon fly. Although not attaining a large size, fallfish are game fish, especially on a light fly rod. Larger individuals fight hard for their size, and often leap clear of the surface. Fallfish have white, firm flesh; opinions on its palatability are mixed. In this province, fallfish are generally viewed as a nuisance species by most anglers fishing for other gamefish species.

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Creek Chub

Scientific Name: *Semotilus atromaculatus*

Local Vernacular Name: chub, mulet a cornes

General Comments

The creek chub is one of the most common cyprinids in the eastern United States and Canada. It is found in brooks, streams and rivers. The chub is found throughout New Brunswick, and is often caught by anglers fishing for trout, salmon and bass. It has frequently been used as natural bait for larger species of gamefish. The chub prefers lotic waters with moderate current and large pools. They spawn in spring when water temperatures reach 13°C. Eggs are deposited by the female in a gravel mound nest built by the male, and they hatch in about 3 days. Growth of chub is rapid: up to 9 cm in the first year. The largest chub are males and average about 25-30 cm; females are somewhat smaller. Males reach maturity at age 4, females at age 3. Most chub caught by anglers are 15-20 cm in length. Creek chub are opportunistic predators and consume a wide range of prey species, including aquatic insects, crustaceans (including crayfish) and small fishes. They have been known to eat the eggs of other gamefish. Chub require clear, unpolluted water with a pH of 5.5 or greater.

Creek chub are often caught by anglers fishing for trout, salmon and bass. They readily take a variety of natural and artificial lures and are often caught by fly fisherman. Larger chub fight well on light tackle and jump often when hooked. The flesh of chub is white, firm and flavourful, but contains many small bones. In New Brunswick the creek chub is not presently considered a sportfish; its major role in recreational fishing in the province is when used as live or dead bait for other gamefish species.

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White Sucker

Scientific Name: *Catostomus commersoni*

Local Vernacular Name(s): sucker, catastome noir commun

General Comments

The white sucker is a common cyprinid fish of lakes, rivers and streams in New Brunswick. Essentially a large minnow, the sucker is often incidentally caught by anglers fishing for brook trout and Atlantic salmon.

Suckers are found through-out the province, although they are rare in the northeast region. The white sucker prefers large rivers and streams but can be found in small brooks and the largest lakes.

Spawning can take place in just about any habitat, but most is done over shallow gravel areas with slight current. Spawning occurs at water temperatures of 10-14°C and in rivers and streams there is usually a large run of fish upstream to the spawning area. Two to four males fertilize the eggs of a single female and a 50 cm female may contain up to 140,000 eggs. The eggs are scattered indiscriminately and are slightly adhesive; they hatch in about 14 days. Fry reach about 15-20 mm their first year and grow approximately the same amount each year. Sexual maturity is reached in 3-8 years depending on geographical location.

The largest white suckers are 45-60 cm in length and about 14-16 years old. Angler caught specimens from New Brunswick average much less at 15-30 cm. Suckers consume many types of food; in particular, they consume aquatic insects and freshwater crustaceans such as cladocerans. The evidence for egg predation has been termed inconclusive: a few studies have indicated that suckers eat the eggs of other gamefish species; other extensive investigations have shown that suckers do not consume the eggs of other fish species even when they were abundant.

The sucker can live in a variety of environments; and although it does not require clean, non-turbid environments, it is often found in them.

The white sucker is an important forage fish species for other gamefish. When small the sucker is actively consumed by brook trout, Atlantic salmon parr, smallmouth bass and chain pickerel. It is often used as a live bait by anglers fishing for these species. Large suckers are frequently caught by anglers and provide an intense, if not protracted, struggle. They will take a wide range of natural baits and are often caught on artificial flies.

White sucker flesh is white and palatable, but has an abundance of bones. They are considered very good when smoked and the bones removed. In New Brunswick the sucker is not presently considered as a sportfish and is used only as bait for other species.

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Tiger Trout

Scientific name: *Salmo trutta* X *Salvelinus fontinalis*

Local vernacular names: none

General Comments

The tiger trout is a sterile hybrid of brown trout and brook trout that is generally produced in hatcheries, although it may occur naturally. It has been reared by New Brunswick Department of Natural Resources and Energy at Minto hatchery, and authorized and private introductions have been made in New Brunswick waters. They are a stocky fish with a reputation for aggression, so they may

be undesirable when in sympatry with natural brook trout populations. Tiger trout are opportunistic carnivores, eating a wide variety of food organisms. Their flesh is of excellent flavour, with pink to red colour.

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