Scientific Excellence • Resource Protection & Conservation • Benefits for Canadians
Excellence scientifique • Protection et conservation des ressources • Bénéfices aux Canadiens

Characteristics of Sport Fish Populations in Six Experimentally Fished Salmonid Lakes of Gros Morne National Park, Newfoundland

P.M. Ryan and J.J. Kerekes

Science Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland A1C 5X1

November 1988

Canadian Technical Report of Fisheries and Aquatic Sciences No. 1636

Fisheries and Oceans   Pêches et Océans

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457-714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715-924 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Technical Report of

Fisheries and Aquatic Sciences 1636

November 1988

CHARACTERISTICS OF SPORT FISH POPULATIONS IN SIX EXPERIMENTALLY FISHED SALMONID LAKES OF GROS MORNE NATIONAL PARK, NEWFOUNDLAND

by

P. M. Ryan

Science Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland A1C 5X1

and

J. J. Kerekes

Canadian Wildlife Service
Environment Canada
c/o Biology Department
Dalhousie University
Halifax, Nova Scotia B3H 4J1

Science Branch

Department of Fisheries and Oceans

P.O. Box 5667

St. John's, Newfoundland A1C 5X1

Cat. No. Fs 97-6/1636E ISSN 0706-6457

Correct citation for this publication:

Ryan, P. M., and J. J. Kerekes. 1988. Characteristics of sport fish populations in six experimentally fished salmonid lakes of Gros Morne National Park, Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. 1636: vi + 172 p.

CONTENTS

CONTENTS

Part 2 - Lake-to-Lake Variation in the Relative Abundance, Size Composition, and Growth of Fishes

ABSTRACT

Ryan, P. M., and J. J. Kerekes. 1988. Characteristics of sport fish populations in six experimentally fished salmonid lakes of Gros Morne National Park, Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. 1636: vi + 172 p.

An experimental gillnet fishery was conducted on each of six salmonid lakes in Gros Morne National Park, Newfoundland, over a three- to five-year period from 1975 to 1980. The lakes varied in size (area = 10-104 ha, mean depth = 0.7-14.3 m) and water quality (salinity = 8-69 ppm, pH = 5.2-7.9, total phosphorous = 5.4-10.6 $mg \cdot P \cdot m^{-3}$, chlorophyll a = 0.3-0.9 $mg \cdot m^{-3}$). The relative abundance of fishes, stock characteristics, and their interrelationships with lake descriptors were documented. Brook trout (Salvelinus fontinalis) was the dominant salmonid in all of the lakes and three of the populations were anadromous. Atlantic salmon (Salmo salar) and Arctic charr (Salvelinus alpinus) coexisted with trout in three of the lakes and two of the salmon populations were anadromous. Rainbow smelt (Osmerus mordax) occurred in two lakes and American eel (Anguilla rostrata) were present in four lakes. Average annual salmonid yields ranged from 0.07 to 0.52 $kg \cdot ha^{-1}$ at average annual levels of fishing intensity ranging from 0.33 to 1.52 units of $effort \cdot ha^{-1}$ (15 m fished for 24 h) with 19-89 mm (stretched mesh) gill nets. An examination of variations in the catch rates, size compositions, and growth rates of salmonids in the individual populations did not reveal measurable changes attributable to the experimental fishery in 10 of the 12 populations. Consistent declines in the catch rates with time were suggestive of catches in excess of maximum sustainable levels from two of the Arctic charr populations. An examination of variations in the catch rates, size compositions, and growth rates among the populations indicated three major determinants of variations in those characteristics. The availability of rainbow smelt as forage fish, a greater inherent lake productivity, and the use of ocean habitat by anadromous fishes contributed to a greater salmonid biomass, a larger size of individuals, and a more rapid individual growth rate. Detailed information on the relative abundance and biology of the individual populations is included in the report for the recognition of future changes.

RÉSUMÉ

Ryan, P. M., and J. J. Kerekes. 1988. Characteristics of sport fish populations in six experimentally fished salmonid lakes of Gros Morne National Park, Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. 1636: vi + 172 p.

On a procédé à une pêche expérimentale au filet maillant dans chacun des six lacs à salmonidés du parc national du Gros-Morne (Terre-Neuve) pendant une période de trois à cinq ans, entre 1975 et 1980. De dimensions variées (surface = 10-104 ha, profondeur moyenne = 0,7-14,3 m), ces lacs présentaient aussi des eaux de différente qualité (salinité = 8-69 mg/l, pH = 5,2-7,9, phosphore total = 5,4-10,6 mg · P · m^{-3}, chlorophylle a = 0,3-0,9 mg · m^{-3}). L'expérience a fourni des renseignements sur l'abondance relative du poisson, sur les caractéristiques des stocks et sur les interrelations entre ceux-ci et les conditions propres des lacs. La truite de ruisseau (Salvelinus fontinalis) était l'espèce de salmonidé dominante dans tous les lacs; trois de ces populations de truite étaient anadromes. Le saumon de l'Atlantique (Salmo salar) et l'omble chevalier (Salvelinus alpinus) coexistaient avec la truite dans trois des lacs; deux des populations de saumon étaient anadromes. L'éperlan de lac (Osmerus mordax) était présent dans deux des lacs et l'anguille américaine (Anguilla rostrata) dans quatre d'entre eux. Le rendement annuel moyen des salmonidés variait de 0,07 à 0,52 kg · ha^{-1}, à des niveaux moyens annuels d'intensité de pêche allant de 0,33 à 1,52 unités d'effort · ha^{-1} (15 m exploités durant 24 h) avec des filets maillant de 19-89 mm (maille étirée). Une étude des écarts observés dans les taux de prise, les tailles et les taux de croissance des salmonidés des différentes populations n'a pas révélé de changement appréciable dû à la expérimentale dans 10 des 12 populations. Dans deux populations d'omble chevalier, cependant, une baisse régulière des taux de prise pendant la période considérée semblait indiquer que les prises étaient supérieures au rendement maximal soutenu. Un examen des écarts dans les taux de prise, les tailles des poissons et les taux de croissance des populations révélait trois factuers importants de variation de ces caractéristiques. Il s'est avéré que la disponibilité de l'éperlan de lac comme poisson fourrage, une productivité interne supérieure des eaux et l'utilisation de l'habitat océanique par les poissons anadromes contribuaient à l'obtention d'une plus grande biomasse de salmonidés et de poissons plus gros ainsi qu'à un taux de croissance individuelle plus rapide. Des renseignements détaillés sur l'abondance relative et la biologie des populations sont fournies dans le rapport au fin d'établissement des variations futures.

GENERAL INTRODUCTION

This report describes the characteristics of sport fish populations in six experimentally fished salmonid lakes of Gros Morne National Park, Newfoundland. It is intended that this report will contribute to the understanding of the sport fishery potential of the lakes of Gros Morne National Park and assist in the management of their fisheries. It is also intended that the information contained in this report will assist in the recognition of environmental change in Gros Morne Park, should it occur.

The study was initiated in 1975 by the Canadian Wildlife Service, Atlantic Region, in cooperation with the Warden Service, Gros Morne National Park. It was designed to fulfill one of the requirements of a memorandum of agreement between Parks Canada and the Province of Newfoundland for the establishment of Gros Morne National Park. Specifically, the study was designed to assess the sport fish populations of Gros Morne National Park.

The Canadian Wildlife Service agreed to plan the program, provide continuous technical advice to the Warden Service, and analyze and interpret the data collected. The Warden Service agreed to conduct the necessary sampling and provide the data in an organized manner. Subsequently, the Department of Fisheries and Oceans provided technical advice and assistance with data analyses and interpretation.

With few exceptions (Dadswell 1970; Kerekes 1978; Rombough et al. 1978; Barbour et al. 1979) there has been little information available on the fish populations in the lakes of Gros Morne National Park. There are a number of empirical relationships designed to predict potential fish harvests or biomass (Ryder 1982). However, the applicability of these relationships to the lakes of Atlantic Canada is not well understood. In Atlantic Canada, lakes often exhibit low chlorophyll responses to phosphorous addition (Kerekes 1983), have high levels of turbidity and color (Kerekes 1977; Scruton 1983), and high flushing rates (Kerekes 1973; Kerekes 1975). Such characteristics are known to account for regional variation in the relationship of fish harvest data to individual lake descriptors (Ryder et al. 1974; Ryder 1982). Accordingly, an experimental gillnet fishery was started in Gros Morne National Park to obtain information on relative fish abundance, stock characteristics, and their interrelationships with lake descriptors.

The study was conducted on six lakes during the period 1975 to 1980. Fishing effort was varied from year to year so that some indication of the level of sustainable fish harvests might be obtained. Data on population characteristics were collected. In the following pages of this report, a description of the study lakes including the fish species present is provided prior to a description of materials and methods used in data collection and processing. Subsequently, the report is divided into two sections. The first section describes the analysis of data from the individual lakes for evidence of any changes in the populations resulting from the experimental fishery. The second section is an examination of variations in population characteristics among the study lakes so that factors influencing these variations could be identified.

THE STUDY AREA AND FISH SPECIES

Gros Morne National Park, with an area of 1894 km^2, is in northwestern insular Newfoundland (Fig. 1). Many of its more than 1100 lakes have been described by Kerekes and Schwinghamer (1975a, 1975b, 1975c, 1975d) and Kerekes (1978). The lakes are free from major direct human disturbances. They have a strong maritime influence with atmospheric precipitation providing, for most lakes, the major supply of phosphorous. Sport fish captured in the park are brook trout (*Salvelinus fontinalis*), Atlantic salmon (*Salmo salar*) and Arctic charr (*Salvelinus alpinus*). Other fish species known to be present are American eel (*Anguilla rostrata*), rainbow smelt (*Osmerus mordax*), threespine stickleback (*Gasterosteus aculeatus*), fourspine stickleback (*Apeltes quadracus*), and ninespine stickleback (*Pungitius pungitius*).

The six lakes selected for the present study are all within the boundaries of Gros Morne Park (Fig. 1). As with most Newfoundland lakes, they are referred to locally as ponds. They exhibit considerable variation in elevation, area, depth, and flushing rate (Table 1). The waters are dilute, with salinities less than the world average concentration of about 120 ppm (Wetzel 1975). Water quality parameters are all within the ranges previously reported for waters of Atlantic Canada (Jamieson 1974; Kerekes 1974, 1975, 1983; Scruton 1983; Ryan and Wakeham 1984). Phosphorus and chlorophyll a concentrations are characteristic of pristine, oligotrophic, humic lakes of Atlantic Canada having low available phosphorus (Kerekes 1983). All of the study lakes drain into the Gulf of St. Lawrence.

Brook trout, insular Newfoundland's most widely distributed freshwater fish (Scott and Crossman 1964) is the most widely distributed fish among the study lakes (Table 2). Anadromous brook trout (as determined by their silvered appearance) were identified in Wigwam, Half Moon, and North Narrows ponds. Atlantic salmon were captured in three lakes, two of which contained sea-run individuals (as determined by their size, silvered appearance, and subsequently by their scales). No anadromous Arctic charr were identified although, in two of the three lakes in which charr were captured, sea-run individuals of other species were present. Rainbow smelt were captured in two lakes. Catadromous American eels were captured in all but the two lakes of highest elevation, consistent with previous studies (Kerekes 1978).

Fish communities in the study lakes are not atypical of those elsewhere in Newfoundland. Brook trout, Atlantic salmon, and Arctic charr are frequent cohabitants of river systems in Newfoundland and their varying dominance from place to place has been well documented through lake and river surveys (Scott and Crossman 1964; Johnson 1980; Ryan 1980; Anderson 1985; Hammar and Filipsson 1985). Similarly, the American eel and rainbow smelt are widely distributed in Newfoundland fresh waters (Scott and Crossman 1964; Anderson 1985).

DATA COLLECTION AND PROCESSING

FISH CAPTURE

The six lakes were fished for a two- to six-day period from June to October in each of three to six consecutive years from 1975 to 1980. Gangs of

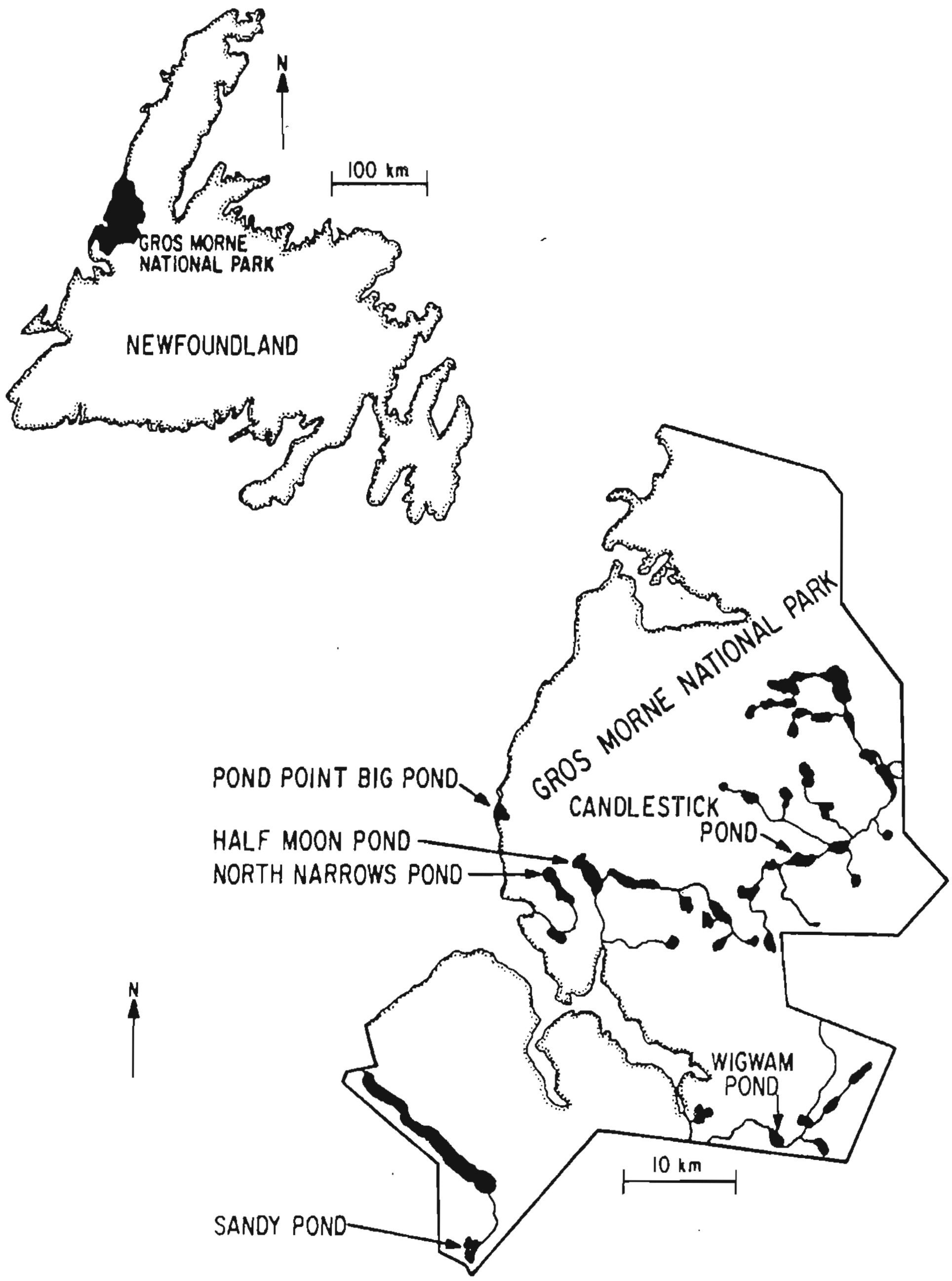

Fig. 1. Locations of the study lakes in their watersheds within Gros Morne National Park, insular Newfoundland.

Table 1. Locations, morphometric features, and water quality characteristics of the study lakes in Gros Morne National Park. Water analyses were done on offshore surface samples drawn in August or September of 1975, 1976, or 1977 and values represent the means from two samples except where indicated. Data from Kerekes and Schwinghamer (1975a, 1975b, 1975c, 1975d) and Kerekes (1978) except where indicated.

	Pond Point Big Pond	Candlestick Pond	Sandy Pond	Wigwam[a] Pond	Half Moon Pond	North Narrows Pond
Latitude	49°40'15"	49°38'00"	49°19'20"	49°24'30"	49°37'40"	49°37'15"
Longitude	57°57'55"	57°34'45"	57°59'00"	57°37'30"	57°52'00"	57°54'05"
Elevation (m)	15	460	455	120	105	90
Catchment basin area (km^2)	0.4	52.4	11.6	67.7	3.7	6.6
Water area (ha)	10.2	92.5	104.0	74.9	32.9	57.5
Maximum depth (m)	1.1	16.0	21.8	34.0	11.0	17.0
Mean depth (m)	0.7	4.5	9.8	14.3	3.0	6.0
Flushing rate ($times \cdot yr^{-1}$)	4.1	8.3	0.7	4.0	2.4	1.2
Morphoedaphic index[b]	73.9	1.8	1.4	1.5	14.4	11.5
Salinity (ppm)[c]	51.7	8.2	13.9	21.9[d]	43.2[a]	68.8[a]
pH	6.8	5.2	6.4	6.8[d]	7.6	7.9
Color (H.U.)	185	53	18	40	43	17
Turbidity (N.T.U.)	2.1	0.5	0.3	0.3	0.6	0.7
Total phosphorus ($mg\ P \cdot m^{-3}$)	10.6	8.0[e]	5.4	6.8[d]	8.2	5.8[d]
Chlorophyll a ($mg \cdot m^{-3}$)	0.8	0.3[e]	0.6	0.3[d]	0.7	0.9[d]

[a]Water analysis of one sample.

[b]Salinity/mean depth.

[c]Salinity estimated from specific conductance (Kerekes 1978).

[d]Based on subsurface (2-12 m) sample.

[e]Data of Rombough et al. (1978).

Table 2. Fish species captured during experimental gillnet fishing in six lakes of Gros Morne National Park, 1975-80. Presence is indicated by +. Lakes in which sea-run individuals have been identified are indicated by o.

Lake name	Brook trout	Atlantic salmon	Arctic charr	Rainbow smelt	American eel
Pond Point Big Pond	+				⊕
Candlestick Pond	+	+	+		
Sandy Pond	+			+	
Wigwam Pond	⊕	⊕	+	+	⊕
Half Moon Pond	⊕	⊕	+		⊕
North Narrows Pond	⊕				⊕

15 and 27 m long monofilament gill nets were set overnight. Stretched mesh sizes were 19, 25, 38, 51, 64, 76, and 89 mm. The mesh size compositions of the gangs of nets and the lengths of individual nets of given mesh sizes varied from time to time and place to place, depending on net damage and the availability of replacement nets.

Fishing effort was varied in each lake from year to year. Units of fishing effort were calculated as the number of 15 m lengths of gill net fished for 24 hours. For comparative purposes, fishing intensity was calculated as the number of units of fishing effort applied per hectare of lake area.

RELATIVE ABUNDANCE AND SIZE DATA

The total number, total weight, and mean weight of undamaged fish caught were, with the exception of eels, documented with separation by species, lake, year, and gillnet mesh size. Weights (g or 0.5 g) were obtained from undamaged individuals or groups of fish. The incidence of fish having tissue loss due to eel predation in total catches or in catches from individual mesh sizes was recorded. The total weight of fish removed from each population each year was calculated from the total number of fish captured and the mean weight of undamaged fish.

Few eels were caught during the present study even though extensive damage had often been inflicted by eels on the gillnetted salmonids (Appendix 1). In commercial fisheries, gill nets are not considered useful for the capture of eels (Eales 1968). During the present study, complete catch records for eels were not obtained and eel catches by gill nets were considered, as were incidences of eel-damaged salmonids, as indicators of the presence of eels (Table 2) rather than indicators of their relative abundance. Information on the incidence of eel damage during the experimental fishery is included in Appendix 1 of this report as potential baseline data for the recognition of long-term change in eel abundance.

Fork or total lengths (mm or cm) of undamaged fish were obtained from each species except eels in each lake. The length measurements were obtained from total undamaged catches or subsamples representative of the length ranges encountered and were typically obtained each year. Total lengths were converted to fork lengths using ratios of fork to total length obtained from Belding (1938), Carlander (1969), and Dempson (1984).

FISH GROWTH DATA

Scale samples were obtained from each species except eels in each lake for the purposes of age determination and comparisons of growth in length. Scales were taken from subsamples of the catches and were typically obtained each year. Scale samples were taken below and posterior to the dorsal fin above the lateral line and stored in individual envelopes containing the corresponding fish length (mm or cm), weight (g or 0.5 g), and other relevant information.

A scale from each fish, regular in shape and appearance, was mounted in water on a glass slide or petri dish, examined, and measured using a Bausch and Lomb microprojector. Magnification was 46 or 139 diameters, depending on the choice of the different scale readers employed in different years. An age was assigned to each fish equal to the number of completed scale annuli according to criteria described by Tesch (1971). Magnified scale images were measured from the focus to the scale edge and to each annulus along the anteriormost radius. Resulting data, together with those obtained at capture, were entered on IBM cards for data processing using the computer program of Nickerson et al. (1980).

With the data separated by species and magnification, the logarithm (base e) of fish length (mm) was regressed upon the logarithm (base e) of magnified scale radius (mm) to obtain an overall body-scale relationship for each species at each magnification used. In the case of brook trout, sufficiently large numbers of fish had been sampled to permit comparisons of back-calculated lengths at age. Accordingly, back-calculated lengths at age of individual trout were computed using Frazer's proportionality formula (Tesch 1971). Mean back-calculated lengths were obtained with separation by lake and by year-class for the examination of within- and among-lake variation in growth. Calculations were performed using the computer program of Nickerson et al. (1980). For the remaining three species, represented by fewer fish from each lake each year, the mean length of fish from each lake in each age-group at capture was generated for comparisons of variation in growth in length among lakes.

Variation in the growth in length of brook trout among the lakes was also examined using a summary growth statistic from each population. This growth statistic, mean age of trout at 200 mm, is inversely proportionate to the rapidity of growth and was derived simply as described by Ryan and Harvey (1977). Mean calculated lengths at age in each population were plotted against age, adjacent means joined by straight lines, and the age corresponding to the selected lengths read from the abscissa to the nearest tenth of a year. Age at 200 mm was selected for the growth statistic as 200 mm approximated the average length of trout captured during the study.

Where sample sizes were adequate, data were derived for comparisons of growth in weight within and among populations in the following manner. With data from each population separated by year of capture, weight-length relationships were obtained by least-squares regressions (Dixon and Massey 1969) of $\log_{10}$ weight (g) on $\log_{10}$ fork length (mm). Data employed were from the fish which had been scale sampled for age determination or, if those sample sizes were small, from fish which had been measured for both length and weight. The resulting equations were solved to provide an estimate of mean calculated weight of 200 mm brook trout or 150 mm Atlantic salmon. These lengths approximated the average lengths of freshwater forms of the two species captured during the study. The mean calculated weights obtained provided comparable measures of fitness, robustness, or well-being which are analogous to condition factors frequently employed in fisheries biology (Tesch 1971).

Part 1 - Within-Lake Variation in the Relative Abundance, Size Composition, and Growth of Fishes

INTRODUCTION

The purpose of this section of the report is the examination of data for evidence of changes in the individual fish populations resulting from the experimental fishery and the provision of baseline information for future comparative studies of change within the individual populations.

There are no published studies of the impact of repeated fish harvesting on freshwater fish populations in Newfoundland. As previously stated, techniques developed to estimate fish yields from physical-chemical lake characteristics are not likely applicable to Newfoundland lakes because of factors such as their comparatively high flushing rates, high color, and low productivity (Ryder 1982). In addition, there are no published estimates of total salmonid abundance in lakes in the area of Gros Morne National Park. Thus, there was no *a priori* indication of the potential salmonid harvests in the study lakes and no indication of whether or not catches obtained were high enough to result in measurable changes in the fish populations. Accordingly, it was considered necessary to examine the data for evidence of change in the individual populations so that it might be determined if the obtained catches were less than, equal to, or greater than maximum sustainable yields.

Knowledge of maximum sustainable yields of salmonids in Gros Morne Park will, of course, assist in the management of the populations. Knowledge of whether or not catches during the present study approached, equaled, or exceeded maximum sustainable yield levels will assist in future studies done for the purpose of recognizing the impact of environmental change. For example, average catches obtained from a population during the present study would provide an appropriate basis for future comparison only if the population had not been appreciably altered during the study. Similarly, knowledge of the relationship of the catches to maximum sustainable yield levels would assist in the understanding of the factors affecting fish production in Gros Morne Park and elsewhere. Examination of the relationships between average fish catches and physical-chemical lake characteristics would have to take into account disproportionate levels of harvest among the populations.

In this section of the report, variations in catch rates, yields, and growth rates within individual salmonid populations are examined for evidence of responses to the experimental fishery.

MATERIALS AND METHODS

A number of variables in the processed data from the individual populations were examined as potential indicators of responses to the experimental fishery. A response to the experimental fishery was considered as a change in a characteristic of the population that was attributable to the fishery. The examination of the individual variables, together with the rationale for their examination, was as follows.

Catch per unit effort, as number and weight of fish captured per net night, was examined for consistent changes in catch rate with time. A decreasing catch per unit effort with time and a decreasing catch relative to the catch of related species are symptoms of reductions in population size due to overfishing (Watt 1968). Conversely, an increase in catch per unit effort at the same level of effort is suggestive of an increase in population density (Ricker 1975; Ryan 1984; Langeland 1986).

Catch per unit effort (kg) and yield ($kg \cdot ha^{-1}$) were compared to fishing intensity (net efforts$\cdot ha^{-1}$) in an application of the surplus yield model of Schaefer (see Ricker 1975; Panayotou 1982). This model assumes that catch per unit effort is a reflection of fish abundance and that as the intensity of fishing increases, catch per unit effort drops, reflecting a reduction in biomass in the population. As the population size is reduced, compensatory changes in the population, such as the increased growth rate of individuals and earlier age at maturity, are thought to occur so that population growth is maximized to a point beyond which overfishing has occurred and population growth declines. Thus, as fishing intensity increases, fish yields increase as a result of the increased growth rate of the population but subsequently level off and decline with overfishing. The catch at which yield is maximal is considered the maximum sustainable yield. The Schaefer model is depicted in Fig. 2. Ideal application of the model requires that the population is allowed to equilibrate to new levels of fishing intensity. In practice, equilibrium conditions are often approximated by averaging fishing intensity over the number of years that a year-class contributes significantly to the catch (Rivard 1982).

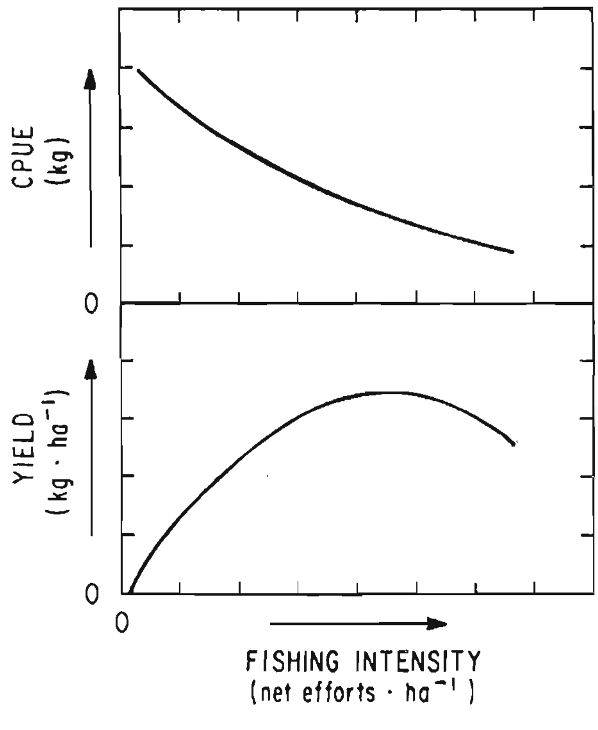

Fig. 2. Theorized relationships of catch per unit effort (CPUE) and yield to fishing intensity in the Schaefer Growth Model (see Ricker 1975).

Among the study lakes, the maximum fishing period was five years, equal to the maximum age of fish encountered. Thus, if densities had been sufficiently reduced to result in compensatory responses, it is unlikely that the populations would have had time to fully equilibrate to reduced stock sizes. As a result, leveling off or declines in yields suggestive of overfishing would occur at yields less than maximum sustainable yield levels. In addition, if yields were small in relation to fish density, at a constant fish density, catch per unit effort would decrease with increasing fishing intensity simply as a result of competition by an increasing number of nets for a constant number of fish. At the same time yield would tend to increase with increased fishing intensity simply as a result of a greater catch from a greater effort. Accordingly, measurable reductions in population size were considered to have occurred if catch per unit effort was inversely related to fishing intensity and yields leveled off or decreased at the highest levels of fishing intensity.

Changes in the size composition of fish in the study lakes were inferred from the examination of changes in the relative abundance of fish in the mesh sizes producing the greatest catch per unit effort and of changes in the mean weight of fish in the different and combined mesh sizes. Larger mesh sizes tend to catch longer, heavier, older fish with some overlap between mesh sizes (Ryan 1980; Hammar and Filipsson 1985). Thus, changes in the proportions of fish in the different mesh sizes and in the mean weight of individuals captured are suggestive of changes in the size and age structure of fish in the population. Reductions in population densities during a fishery may result in an increased proportion of large fish due to increased growth rates (Langeland 1986) or result in a lesser proportion of large fish due to their selective removal (Panayatou 1982).

Variations in the length of fish at given ages and in the weight of fish at given lengths were examined for evidence of compensatory increases in growth rates due to density reductions during the experimental fishery. Increased rates of growth resulting from reduced densities have been previously documented for brook trout (St. Pierre and Moreau 1986), Atlantic salmon (Gibson and Dickson 1984), and Arctic charr (Langeland 1986).

POND POINT BIG POND

CATCHES

Brook trout was the only salmonid captured in Pond Point Big Pond over a 3 year period (Table 3). There was no indication of the presence of sea-run trout in the lake. American eels are known to be present. From 1975 to 1977, 34.4 units of gillnet effort captured 173 brook trout with a total weight of 15.90 kg, corresponding to an average annual yield of 0.52 $kg \cdot ha^{-1}$.

RESPONSES TO THE FISHERY

Brook trout catches in Pond Point Big Pond were not indicative of population responses to the experimental fishery. Catch per unit effort data showed little year-to-year variation and over the three-year period, no consistent change with time (Fig. 3). With few data there was no significant relationship between fishing intensity and catch per unit effort or yield (Fig. 4).

There was an indication of a reduction in trout size in Pond Point Big Pond over the course of the study. The relative abundance of trout in the largest of the two most efficient mesh sizes decreased, in relation to the

Table 3. Summarized effort and catch statistics from an experimental gillnet fishery in Pond Point Big Pond, Gros Morne National Park. For additional details, see Appendices 1 and 2.

Dates of capture	Units of net effort ($15\ m \cdot 24\ h^{-1}$)	Brook trout	
		Number	Weight (g)
Sept. 08-19, 1975	10.78	55	5356
Sept. 02-03, 1976	11.34	59	5862
Aug. 29-30, 1977	12.15	59	4680

Table 4. Least-squares regressions of $\log_{10}$ weight (g) on $\log_{10}$ fork length (mm) and calculated weight at 200 mm of brook trout from Pond Point Big Pond.

Year of sample	Intercept	Slope	Number of fish	Correlation coefficient	Calculated wt (g) at 200 mm
1975	-5.5147	3.247	15	0.9947	90.5
1976	-5.2084	3.120	31	0.9943	93.5
1977	-5.0974	3.077	22	0.9958	96.1
Means	-5.2735	3.148			93.4

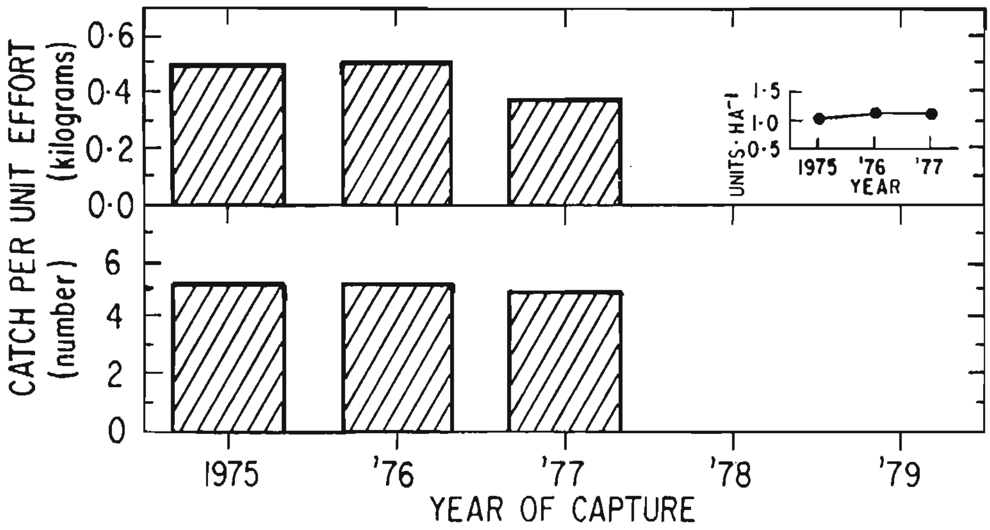

Fig. 3. Annual variation in the relative abundance of brook trout in the total catches from Pond Point Big Pond. Presented for comparison is the annual variation in fishing intensity. A unit of effort is 15 m of gill net fished for 24 h.

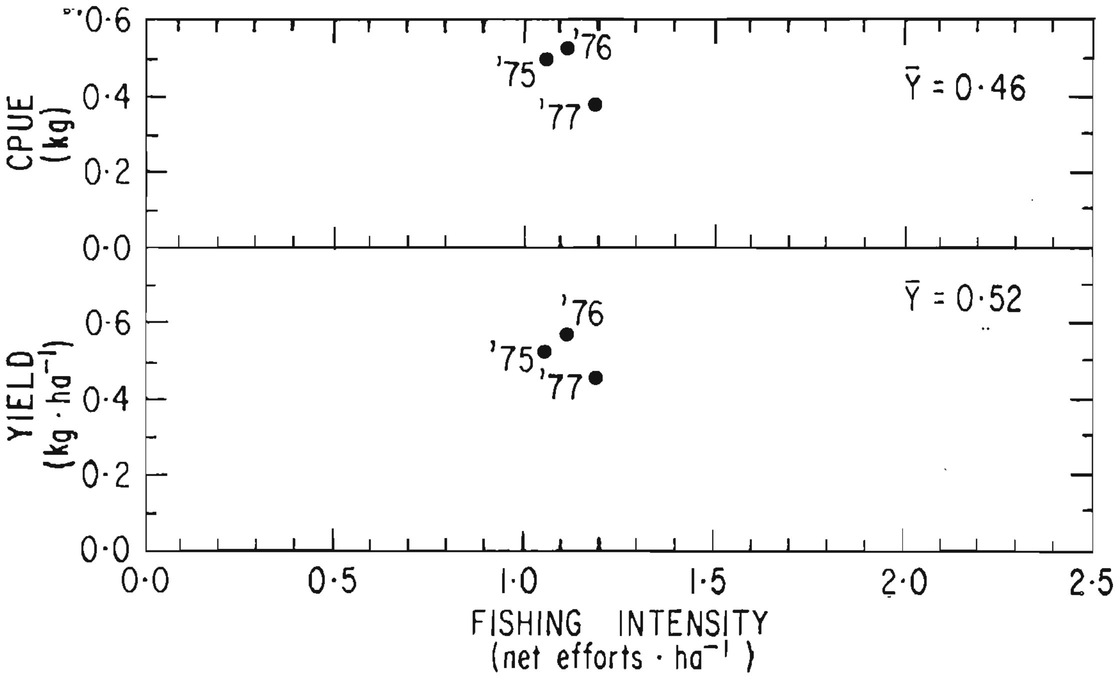

Fig. 4. Catch per unit effort (CPUE) and yield of brook trout compared to fishing intensity in Pond Point Big Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

smaller mesh, over the three-year period (Fig. 5). In addition, the mean weight of trout in the 38 mm mesh and in all mesh sizes combined decreased in 1977 (Fig. 6).

There was no evidence of a consistent change in the growth rates of brook trout in Pond Point Big Pond as a result of the experimental fishery. Weight-length regressions indicated that the calculated weight of 200 mm trout tended to increase with time but, with the exception of the small 1975 sample, this increase was only 2.6 g or 3% (Table 4). Back-calculated lengths of fish at ages 1 and 2 in 1976 and 1977 were less than the maximum mean lengths attained by their counterparts in previous years (Fig. 7). For example, the mean length of fish at age 2 was 125.2 mm in 1974 and 138.8 in 1975 (Appendix 4). In contrast, after the start of the fishery, the mean length of fish at age 2 was 129.2 mm in 1976 and 125.8 mm in 1977. Fewer data were available on the mean length of fish at age 3 but the mean length at that age decreased from a high of 185.5 mm in 1974 (3 fish) to 178.0 mm in 1975 (11 fish), increased to 183.6 mm in 1976 (10 fish), and decreased to 181.9 mm in 1977 (5 fish).

DISCUSSION

The small amount of variation in fishing intensity applied in Pond Point Big Pond and the short time series obtained precludes an accurate assessment of the magnitude of actual yields in relation to a maximum sustainable yield. However, the small amount of variation in the number of fish captured per unit effort over the course of the study suggests that the experimental fishery did not cause large changes in stock abundance and that the stock was not overfished. In two central Newfoundland lakes, catch per unit effort data were indicative of large natural changes in brook trout abundance when fishing intensity varied little (Ryan 1984).

The fluctuations in the mean weight of trout captured and their growth rates in Pond Point Big Pond are not atypical of naturally occurring variation in these parameters in other Newfoundland lakes (Ryan et al. 1981). However, the absence of a consistent increase in growth rates after the initiation of the study in 1975 suggests that stock size was not reduced enough to produce compensatory increases in the growth of surviving individuals.

Although there was no evidence of responses by the brook trout population to the experimental fishery in Pond Point Big Pond, data obtained in the present study may be useful in future investigations of long-term change in the lake. Future levels of fishing intensity similar to those applied in the present study would facilitate the recognition of changes in trout abundance in the lake, should they occur.

CANDLESTICK POND

CATCHES

Brook trout, Atlantic salmon, and Arctic charr were captured in Candlestick Pond over a four-year period (Table 5). There was no evidence of anadromous fish in the lake or of the presence of eels. Overall, 123.3 units

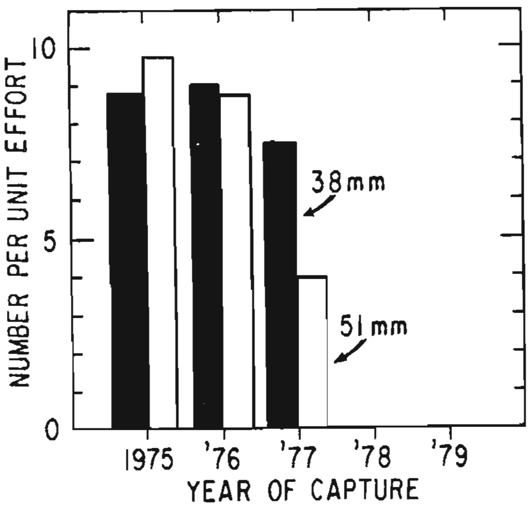

Fig. 5. Changes in the relative abundance of brook trout from Pond Point Big Pond in the two mesh sizes producing the greatest catch per unit effort.

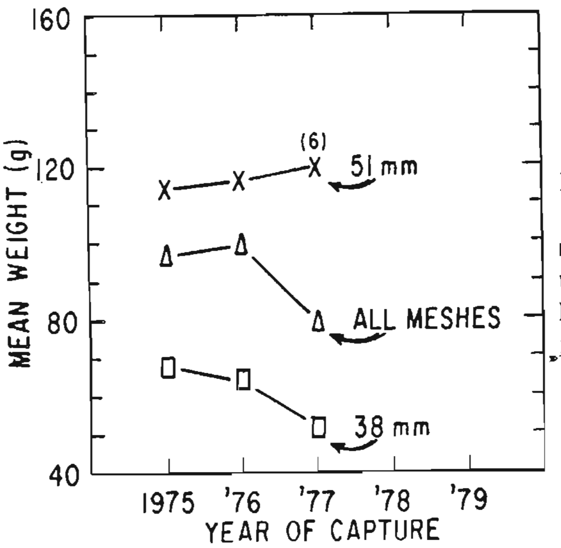

Fig. 6. Changes in the mean weight of brook trout from Pond Point Big Pond in the two mesh sizes producing the greatest catch per unit effort and in all mesh sizes combined. Data point based on 10 fish or less is indicated.

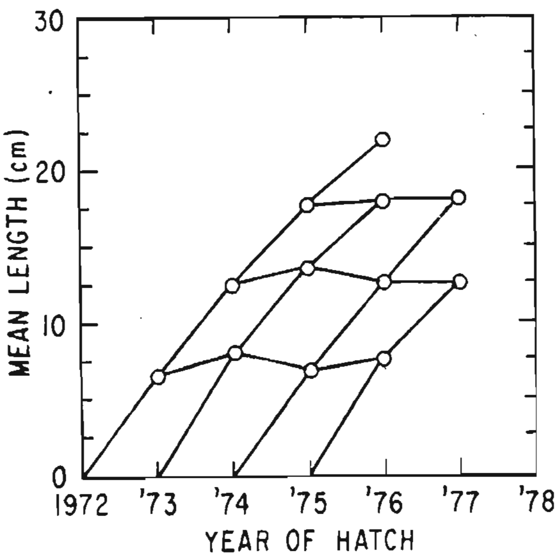

Fig. 7. Back-calculated growth of the year-classes of brook trout captured from 1975 to 1977 in Pond Point Big Pond. Mean lengths of the year-classes at the same ages are connected to facilitate recognition of changes in mean lengths at given ages with time. See Appendix 3 for body-scale relationships used for back-calculation and Appendix 4 for separation of data by year of capture. Only mean lengths based on five or more fish are included.

Table 5. Summarized effort and catch statistics from an experimental gillnet fishery in Candlestick Pond, Gros Morne National Park. For additional details, see Appendices 1 and 2.

Dates of capture	Units of net effort ($15\ m.24\ h^{-1}$)	Brook trout		Atlantic salmon		Arctic charr	
		Number	Wt (g)	Number	Wt (g)	Number	Wt (g)
Aug. 4-7, 1975	34.93	55	2772	28	2244	115	2021
Aug. 18-20, 1976	35.89	85	5077	39	3859	40	728
June 18-21, 1977	39.99	55	4352	33	2503	41	755
July 29-31, 1978	12.48	19	1338	3	339	9	144

of gillnet effort from 1975 to 1978 captured 214 trout weighing 13.54 kg, 103 salmon weighing 8.94 kg, and 205 charr weighting 3.65 kg. These catches correspond to average annual yields of 0.04 $kg \cdot ha^{-1}$ trout, 0.02 $kg \cdot ha^{-1}$ salmon, and 0.01 $kg \cdot ha^{-1}$ charr with a total average annual salmonid yield of 0.07 $kg \cdot ha^{-1}$.

RESPONSES TO THE FISHERY

Catch per unit effort data of brook trout from Candlestick Pond were not suggestive of a population response to the experimental fishery. Brook trout catch per unit effort varied only slightly with time and, in the last year of fishing, differed only by 0.05 $fish \cdot net\ effort^{-1}$ from the first year of fishing (Fig. 8). There was no indication of a significant relationship between catch per unit effort and fishing intensity ($r = 0.078$, $P>0.10$) (Fig. 9). Brook trout yield appeared to be a positive function of fishing intensity but the trend was not significant ($P>0.10$) and there was no indication of a leveling off or decline in yield at higher levels of intensity to suggest that a maximum sustainable yield had been reached or exceeded (Fig. 9).

Variation in brook trout size in the catches from Candlestick Pond was suggestive of a gradual increase in the average size of trout in the population over the course of the study. Some of the variation in trout size was most likely due to different times of capture in the different years of fishing (Table 5), but some of the variation in size appeared to be a result of changes in the size of individuals in a comparatively strong year-class. With all years data combined, the 38 mm and 51 mm mesh nets were the most efficient for the capture of trout in Candlestick Pond (Appendix 1). However, in 1975, the 25 mm mesh was the most efficient. In 1976 and subsequent years, the 38 mm mesh was the most efficient and this was accompanied by a slight gradual increase in the efficiency of the 51 mm mesh (Fig. 10). Concurrently, the mean weight of trout captured in the 38 mm mesh and in all mesh sizes combined increased from 1975 to 1977 (Fig. 11); a further suggestion of an increase in size, over the course of the study, of individuals in a dominant year-class. In 1978, the decrease in mean weight of brook trout was based on a total catch of only 19 fish.

Age and growth data of brook trout from Candlestick Pond obtained from the 1975 and 1976 catches, were not indicative of changes in growth as a result of the experimental fishery. The mean calculated weight of 200 mm trout changed by less than 1% from 1975 to 1976 (Table 6) and the mean calculated lengths at age of fish in age-groups 1 and 2 were less than those of their counterparts of previous years (Fig. 12).

Atlantic salmon catches in Candlestick Pond did not provide evidence of a population response to the experimental fishery. The increase in catch per unit effort from 1975 to 1976 and the decrease from 1976 to 1977 at relatively constant fishing intensity was suggestive of such factors as natural variation in population size or seasonal changes in catchability (Fig. 8). Salmon catch per unit effort was not a significant function of fishing intensity ($r = 0.727$, $P>0.10$) (Fig. 13). Yield appeared to be a positive function of intensity but the trend was below the level of statistical significance

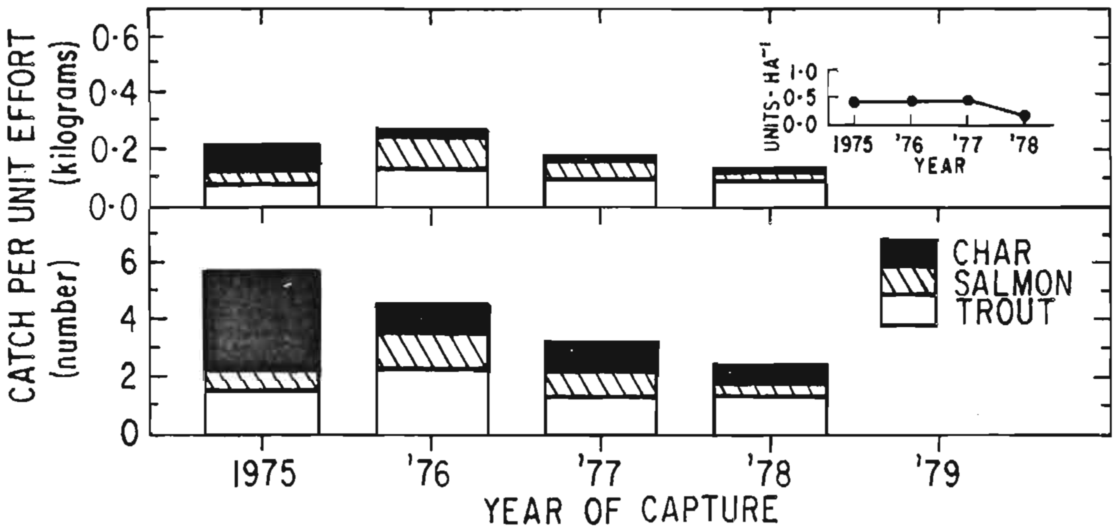

Fig. 8. Annual variation in the relative abundance of salmonids in the total catches from Candlestick Pond. Presented for comparison is the annual variation in fishing intensity. A unit of effort is 15 m of gill net fished for 24 h.

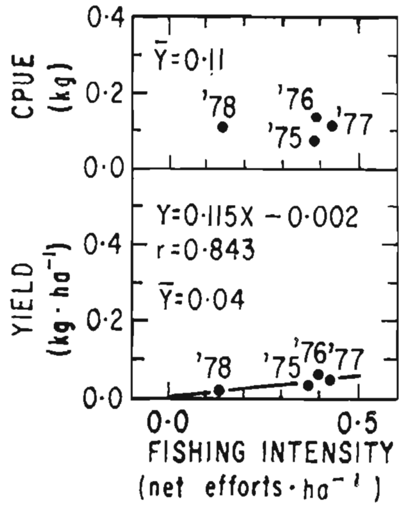

Fig. 9. Catch per unit effort (CPUE) and yield of brook trout compared to fishing intensity in Candlestick Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

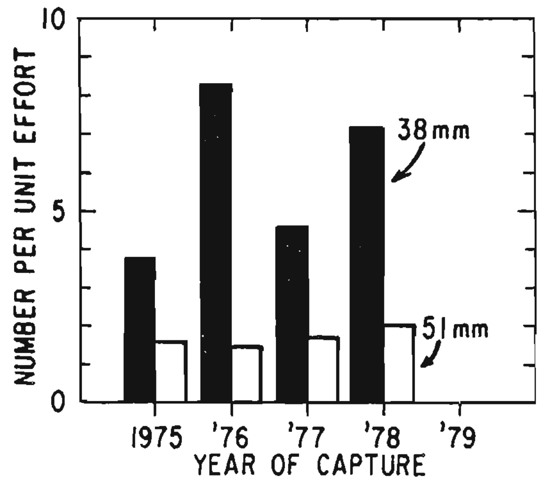

Fig. 10. Changes in the relative abundance of brook trout from Candlestick Pond in the two mesh sizes producing the greatest catch per unit effort.

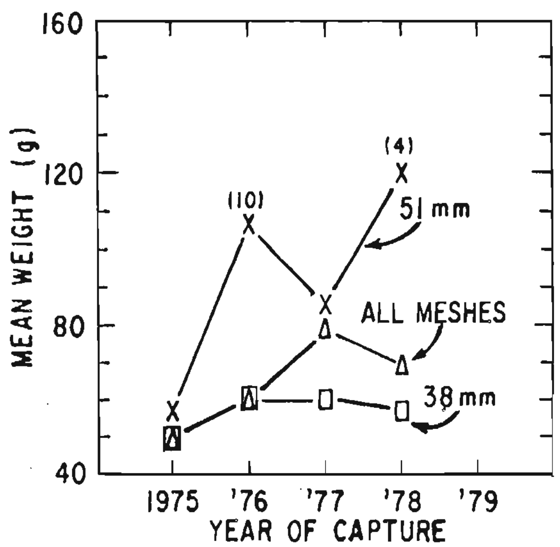

Fig. 11. Changes in the mean weight of brook trout from Candlestick Pond in the two mesh sizes producing the greatest catch per unit effort and in all mesh sizes combined. Data points based on 10 fish or less are indicated.

Table 6. Least-squares regressions of $\log_{10}$ weight (g) on $\log_{10}$ fork length (mm) and calculated weight at 200 mm of brook trout from Candlestick Pond.

Year of sample	Intercept	Slope	Number of fish	Correlation coefficient	Calculated wt (g) at 200 mm
1975	-4.6347	2.857	17	0.9847	87.0
1976	-4.8422	2.949	32	0.9926	87.8
Means	-4.7385	2.903			87.4

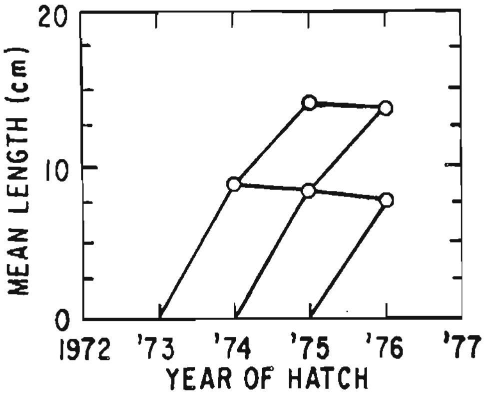

Fig. 12. Back-calculated growth of the year-classes of brook trout captured in 1975 and 1976 in Candlestick Pond. Mean lengths of the year-classes at the same ages are connected to facilitate recognition of changes in mean lengths at given ages with time. See Appendix 3 for body-scale relationships used for back-calculation and Appendix 4 for separation of data by year of capture. Only mean lengths based on five or more fish are included.

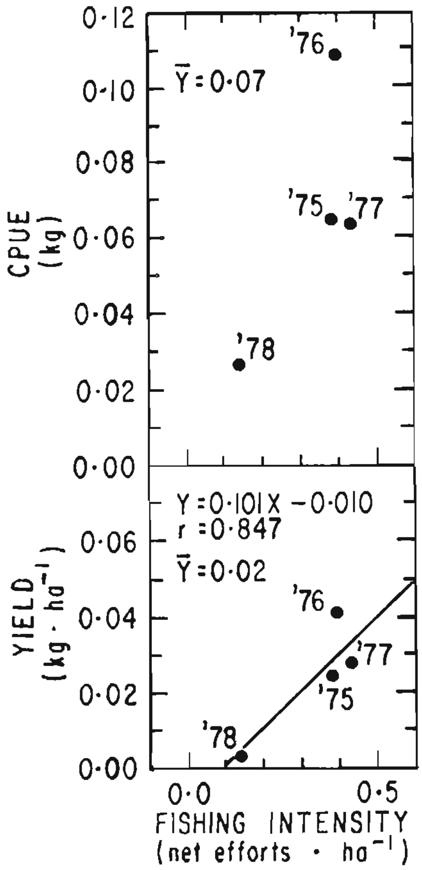

Fig. 13. Catch per unit effort (CPUE) and yield of Atlantic salmon compared to fishing intensity in Candlestick Pond. Years of effort are shown. Mean values of CPUE and yield are indicated (Ȳ).

(P>0.10) and there was no apparent decline in yield at higher levels of intensity (Fig. 13).

The mean weight of Atlantic salmon in the catches from Candlestick Pond varied from 75.8 g to 113.0 g as a probable result of the small sample sizes. The most efficient mesh size for the capture of salmon alternated each year between 38 mm and the 51 mm and the mean weight of captured salmon exhibited corresponding increases and decreases (Appendix 1).

Age and growth data of Atlantic salmon from Candlestick Pond for the years 1976 to 1978 have been analyzed previously by Barbour et al. (1979). Year-to-year fluctuations in mean lengths of the age-groups, weight-length relationships, and condition factors were strongly associated with the different months of capture of the fish and thus, could not be attributed to the experimental fishery.

Catch per unit effort data of Arctic charr from Candlestick Pond were suggestive of a consistent decrease in population size over the course of the study. Catch per unit effort declined with time although, for the first three years of the study, effort was varied little (Fig. 8). There was no significant relationship between catch per unit effort and fishing intensity ($r = 0.395$, $P>0.10$) or between yield and fishing intensity ($r = 0.558$, $P>0.10$) (Fig. 14).

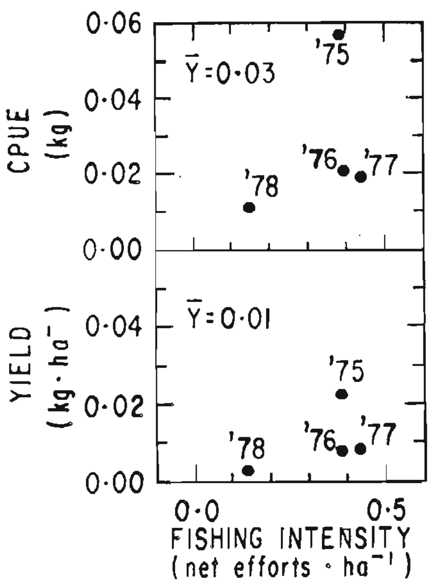

Fig. 14. Catch per unit effort (CPUE) and yield of Arctic charr compared to fishing intensity in Candlestick Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

The size of Arctic charr in the catches from Candlestick Pond varied little over the course of the study. The 25 mm mesh captured the greatest weight of charr per net effort each year and the mean weight of charr varied from a high of 18.4 g in 1977 to a low of 16.0 g in 1978 (Appendix 1).

Age and growth data of Arctic char captured in Candlestick Pond in 1976 and 1977 have been described by Rombough et al. (1978). Year-to-year differences in age-length relationships, weight-length relationships, and condition were attributable to different months of capture of the fish.

DISCUSSION

Brook trout catch, size, and growth data from Candlestick Pond did not provide evidence that brook trout catches approached or exceeded a maximum sustainable yield level. An increasing fishing intensity over a longer period of time may have resulted in measurable responses to the fishery. However, any responses to fishing pressure in Candlestick Pond may have been obscured by fish population responses to the hydrogen-ion concentration (Table 1) of the water. Water with a pH of less than 5.5 is considered borderline for brook trout survival (Power 1980) and may result in altered rates of growth (Rodgers 1984). In the future, levels of fishing intensity similar to those applied in the present study would provide data for the recognition of changes in the relative abundance of brook trout in Candlestick Pond. It is possible that the hydrogen-ion concentration of Candlestick Pond may effect such changes (Power 1980; Rodgers 1984).

If an attempt is made to obtain future catch per unit effort data for comparison with those of the present study, care should be taken to ensure comparable times of capture. Seasonal changes in the ease of capture of salmonids may obscure relationships between catch per unit effort and relative abundance (Ryan 1984). In addition, consideration should be given to the use of live-capture methods to monitor trout abundance (Ryan 1984) in Candlestick Pond since the use of gill nets may be extremely detrimental to the other salmonid populations in the lake.

Atlantic salmon catch, size, and growth data from Candlestick Pond did not indicate that a maximum sustainable yield level had been approached or exceeded. Much of the year-to-year variation in these parameters appears to have been due to the small sample sizes and differing months of capture. However, the calculations of Barbour et al. (1979) suggest that potential sustainable yields from this stock would be extremely low. These authors estimated that the population size of salmon at the usual age of maturity or older was only 152 fish or 1.6 fish$\cdot$ha^{-1}.

It is unlikely that attempts to estimate a maximum sustainable yield of salmon in Candlestick Pond by increasing fishing intensity with time would be useful since several characteristics of the stock appear to be responses to a marginal habitat, particularly a low pH (Barbour et al. 1979). The extremely low fecundity of the population (Barbour et al. 1979) suggests that attempts to monitor the long-term well being of the stock by the use of gill netting would severely reduce the population size. Live-capture methods such as the use of fyke nets could provide indices of population size with negligible fish mortality (Ryan 1984).

Arctic charr data from Candlestick Pond did provide some evidence of a response to the experimental fishery. While year-to-year variation in the average size of captured fish was small, and differences in growth data could be attributed to different months of capture, the consistent decline in catch per unit effort with time was suggestive of a reduction in stock size over the course of the study. The decline in catch per unit effort could not be attributed to different months of capture of the fish. For example, the timing of similar fishing efforts in 1975 and 1976 differed in date by only two weeks (Table 5) but catch per unit effort decreased from 3.3 fish weighing 58 g to 1.1 fish weighing 20 g over that period (Fig. 8).

It does not seem likely that this apparent decline in population size will, in the near future, be accompanied by measurable compensatory responses such as increased growth rates as the population recovers. Charr from Candlestick Pond are characterized by sexual maturity at a small size and early age and their comparatively slow growth rate appears to be due to low lake pH, low lake productivity, and competition from other salmonids (Rombough et al. 1978).

The documented low fecundity and rate of growth of charr in Candlestick Pond (Rombough et al. 1978), together with the consistent decreases in catch per unit effort with time observed in the present study, indicate that future attempts to monitor the charr population by means of gill netting could severely reduce the population size. Particular care should be taken to preserve the charr of Candlestick Pond since they appear to be of a form that has been largely displaced in Atlantic North America (Rombough et al. 1978). Long-term monitoring of this stock without damaging it could be done by live capture and subsequent release such as described by Ryan (1984).

SANDY POND

CATCHES

Brook trout and rainbow smelt were captured in Sandy Pond over the period 1975 to 1979 (Table 7). There was no indication of anadromy in these species in the lake or of the presence of eels. Overall, 200.5 units of gillnet effort captured 1,226 trout weighing 132.01 kg. This corresponds to an average annual trout yield of 0.25 $kg \cdot ha^{-1}$. In addition, 82 rainbow smelt weighing 1.94 kg were captured over the five-year period (Table 7). However, the small sample sizes of smelt and their low susceptibility to capture (Hammar and Filipsson 1985) precludes an assessment of within-lake variation in their growth and abundance over the course of the study.

RESPONSES TO THE FISHERY

Brook trout catches in Sandy Pond did not indicate any response of the population to the experimental fishery. Catch per unit effort data varied nearly twofold in terms of weight and more than twofold in terms of number during the study (Fig. 15). Although catch per unit effort was not significantly related ($P>0.10$) to fishing intensity, the magnitude of the correlation coefficient suggested that much of the variation in catch per unit effort (57%) was due to the varied fishing intensity (Fig. 16). Brook trout

Table 7. Summarized effort and catch statistics from an experimental gillnet fishery in Sandy Pond, Gros Morne National Park. For additional details, see Appendices 1 and 2.

Dates of capture	Units of net effort (15 m.24 h^{-1})	Brook trout		Rainbow smelt	
		Number	Weight (g)	Number	Weight (g)
Aug. 20-Sept. 1, 1975	23.42	219	23,270	11	236
Sept. 23-26, 1976	53.18	358	33,092	20	388
Aug. 19-21, 1977	33.09	268	25,706	2	46
Sept. 5-7, 1978	27.20	143	17,096	11	279
Sept. 18-21, 1979	63.63	238	32,850	38	995

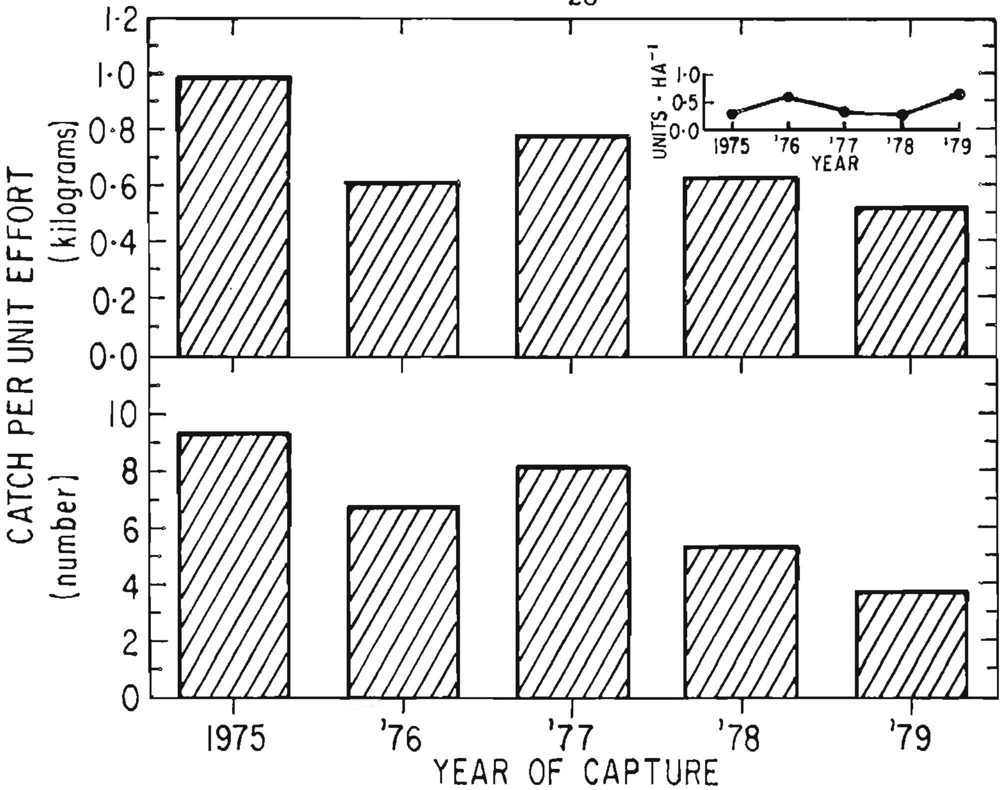

Fig. 15. Annual variation in the relative abundance of brook trout in the total catches from Sandy Pond. Presented for comparison is the annual variation in fishing intensity. A unit of effort is 15 m of gill net fished for 24 h.

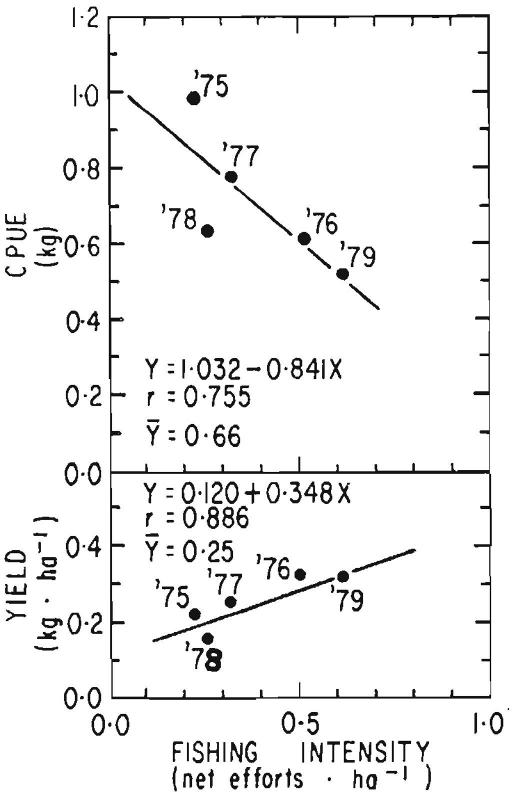

Fig. 16. Catch per unit effort (CPUE) and yield of brook trout compared to fishing intensity in Sandy Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

yields tended to increase significantly ($P<0.05$) with increased fishing intensity in Sandy Pond (Fig. 16). However, there was no indication of a leveling off or a decline in yield at the higher intensities to suggest that a maximum sustainable yield had been attained or the stock had been overfished.

Year-to-year changes in the size of brook trout in the catches were indicative of variation in the size structure of brook trout in the lake. The largest of the two most efficient mesh sizes captured the greater proportion of fish in 1975, the lesser proportion in 1976, and from 1977 to 1979, the greater proportion of fish (Fig. 17). Consistent with this pattern, the mean weight of individuals captured in all mesh sizes showed an initial decrease followed by an increase (Fig. 18). Fluctuations in the mean weight of individuals in the population were further indicated by changes in the mean weight of fish captured in the two most efficient mesh sizes (Fig. 18).

Changes in brook trout size in Sandy Pond appeared to be due more to fluctuations in the relative abundance of individuals hatched in different years and changes in their size with age than due to marked increases in individual growth rates. The mean calculated weight of 200 mm trout increased slightly after the start of the study but subsequently decreased (Table 8). Similarly, growth in length fluctuated irregularly (Fig. 19). Mean length of fish at age 1 increased from 1975 to 1976, subsequently decreased to less than it had been in 1974, and then increased in 1978 to 7% more than the 1974 mean. Mean length at age 2 was less each year from 1976 to 1979 than it had been in the first year of fishing.

DISCUSSION

The relationships of catch per unit effort and yield to fishing intensity in Sandy Pond, coupled with the lack of consistent increase in individual growth rates, suggest that brook trout yields were less than a maximum sustainable yield.

An increasing fishing intensity over a longer time period may have indicated a maximum sustainable yield level for brook trout in Sandy Pond. If it is considered desirable to start a similar study in the future, levels of fishing intensity greater than applied in the present study would appear to be appropriate for obvious reductions in stock size. Alternately, levels of fishing intensity similar to those applied in the present study would provide readily comparable data for the recognition of changes in the relative abundance of brook trout in Sandy Pond, should they occur.

WIGWAM POND

CATCHES

Brook trout, Atlantic salmon, Arctic charr, and rainbow smelt were captured in Wigwam Pond from 1977 to 1980 (Table 9). Sea-run individuals were identified in the trout and salmon catches and American eels are known to be present in the lake. Over the four-year period, 136.3 units of gillnet effort captured 615 trout weighing 74.75 kg, 84 salmon weighing 21.14 kg, and 210 charr weighing 36.67 kg. These catches represent average annual yields of

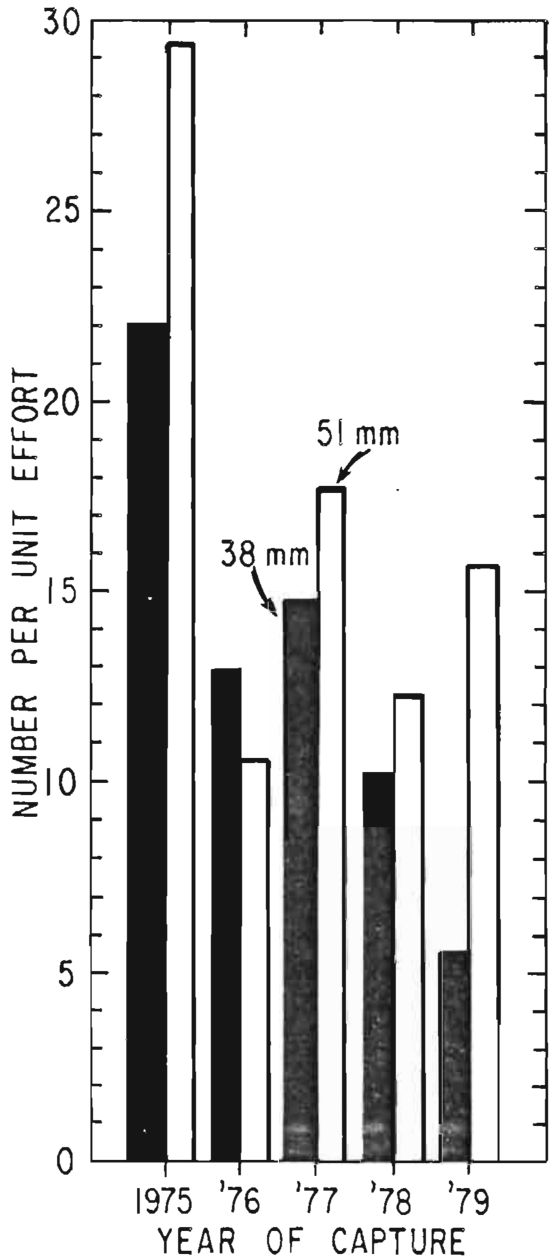

Fig. 17. Changes in the relative abundance of brook trout from Sandy Pond in the two mesh sizes producing the greatest catch per unit effort.

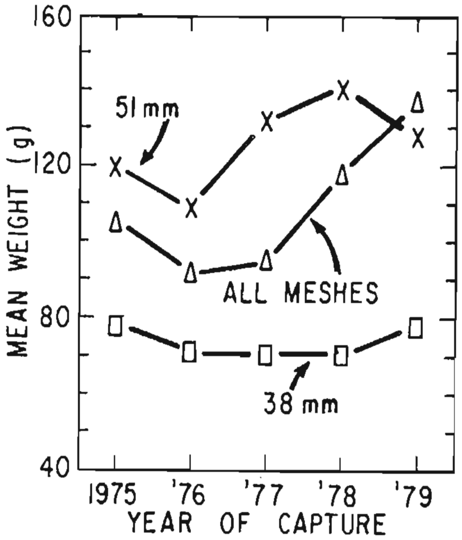

Fig. 18. Changes in the mean weight of brook trout from Sandy Pond in the two mesh sizes producing the greatest catch per unit effort and in all mesh sizes combined.

Table 8. Least-squares regressions of $\log_{10}$ weight (g) on $\log_{10}$ fork length (mm) and calculated weight at 200 mm of brook trout from Sandy Pond.

Year of sample	Intercept	Slope	Number of fish	Correlation coefficient	Calculated weight (g) at 200 mm
1976	-4.8544	2.942	44	0.9844	82.3
1977	-4.4345	2.762	77	0.9572	83.4
1978	-5.3449	3.148	25	0.9919	79.2
1979	-5.5596	3.235	44	0.9871	76.6
Means	-5.0484	3.022			80.4

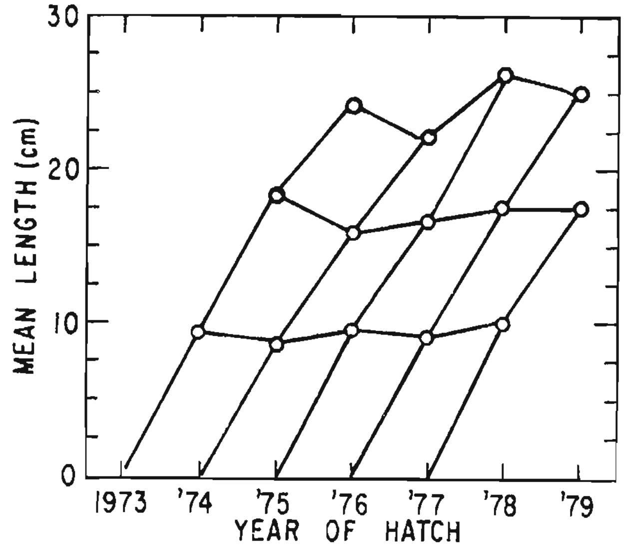

Fig. 19. Back-calculated growth of the year-classes of brook trout captured from 1975 to 1979 in Sandy Pond. Mean lengths of the year-classes at the same ages are connected to facilitate recognition of changes in mean lengths at given ages with time. See Appendix 3 for body-scale relationships used for back-calculation and Appendix 4 for separation of data by year of capture. Only mean lengths based on five or more fish are included.

Table 9. Summarized effort and catch statistics from an experimental gillnet fishery in Wigwam Pond, Gros Morne National Park. For additional details see Appendices 1 and 2.

Dates of capture	Units of net effort ($15\ m.24\ h^{-1}$)	Brook trout		Atlantic salmon		Arctic charr		Rainbow smelt	
		No.	Wt (g)	No.	Wt (g)	No.	Wt (g)	No.	Wt (g)
Sept. 12-16, 1977	50.31	267	24,401	39[a]	6,107	146	23,961	9	83
Oct. 5-6, 1978	21.98	106	13,466	6	181	32	6,858	2	16
Sept. 4-7, 1979	42.40	144	23,236	24[b]	5,939	32	5,852	-	-
Sept. 9-11, 1980	21.60	98	13,648	15[c]	8,914	-	-	-	-

[a]Includes 4 sea-run salmon weighing 4,956 g.

[b]Includes 6 sea-run salmon weighing 5,246 g.

[c]Includes 6 sea-run salmon weighing 8,519 g.

0.25 kg·ha^{-1} trout, 0.07 kg·ha^{-1} salmon, and 0.12 kg·ha^{-1} charr, for a total average annual salmonid yield of 0.44 kg·ha^{-1}. In addition, 11 rainbow smelt weighing 0.10 kg were captured during the study (Table 9) but their low probability of capture by the mesh sizes used (Hammar and Filipsson 1985) and the small sample sizes do not permit an assessment of year-to-year variation in characteristics of this smelt stock.

RESPONSES TO THE FISHERY

Brook trout catches in Wigwam Pond were not indicative of a population response to the experimental fishery. Catch per unit effort fluctuated over the course of the study (Fig. 20), but a statistically significant ($P<0.05$) inverse relationship indicated that most (95%) of the year-to-year variation in catch per unit effort was attributable to the varied fishing intensity (Fig. 21). Brook trout yield increased significantly ($P<0.01$) with fishing intensity but no leveling off or decline in yield occurred at the higher levels of intensity to suggest that a maximum yield level had been reached or that overfishing had occurred (Fig. 21).

The size structure of the Wigwam Pond brook trout population changed over the course of the study as indicated by the variation in size structures in the catches. The proportion of fish captured in the larger of the two most efficient mesh sizes increased from 1977 to 1979 and subsequently decreased (Fig 22). Concurrently, the mean weight of trout in the total catch increased from 1977 to 1979 and subsequently decreased, while the mean weight of trout in the two most efficient mesh sizes also fluctuated (Fig. 23).

Variation in brook trout size did not appear to be due to variation in the growth rates of individual fish caused by reduced densities. The mean calculated weight of 200 mm fish fluctuated irregularly over the course of the study and, at the end of the study, differed by only 1% from the calculated weight in the first year of fishing (Table 10). Growth in length also fluctuated, but fish hatched in 1978, the last year-class adequately sampled, grew slower than their counterparts hatched in previous years (Fig. 24). Similarly, the mean lengths at age of age-groups 2 and 3 were the lowest in the last year of the study (Fig. 24).

Atlantic salmon catches in Wigwam Pond were not indicative of a response to the experimental fishery. The number of salmon captured per unit of effort did not vary consistently with time (Fig. 20). The weight of salmon captured per unit effort showed marked year-to-year changes (Fig. 20) largely as a result of a varied number of sea-run adults captured (Table 9). With all data included, there was no indication of a relationship between catch per unit effort and fishing intensity ($r = 0.272$, $P>0.10$) or between yield and fishing intensity ($r = 0.231$, $P>0.10$). With the data of only those salmon that had not gone to sea, catch per unit effort was not significantly related to fishing intensity ($r = 0.676$, $P>0.10$) (Fig. 25). The yield of non-sea-run fish was a positive correlate of fishing intensity at just below the level of statistical significance ($0.05 \leq P \leq 0.10$) but there was no indication of a leveling off or decline in yield at higher levels of intensity (Fig. 25).

The mean weight of Atlantic salmon that had not gone to sea ranged from a low of 30.2 g in 1978 (6 fish) to a high of 43.9 g in 1980 (9 fish) and the 16

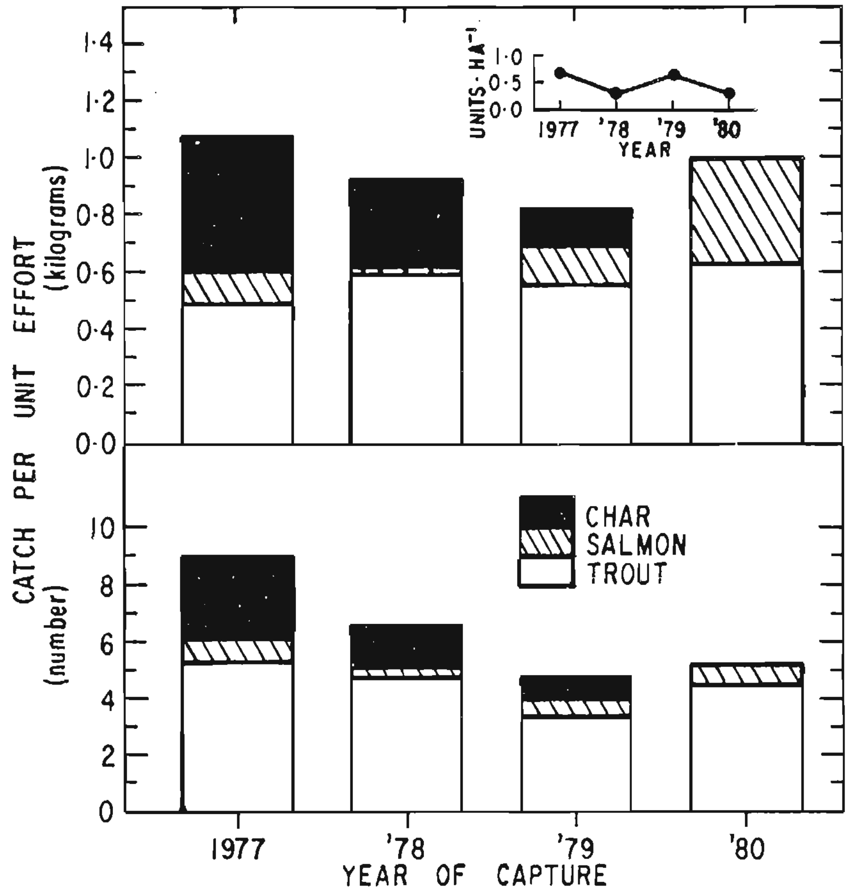

Fig. 20. Annual variation in the relative abundance of salmonids in the total catches from Wigwam Pond. Presented for comparison is the annual variation in fishing intensity. A unit of effort is 15 m of gill net fished for 24 h.

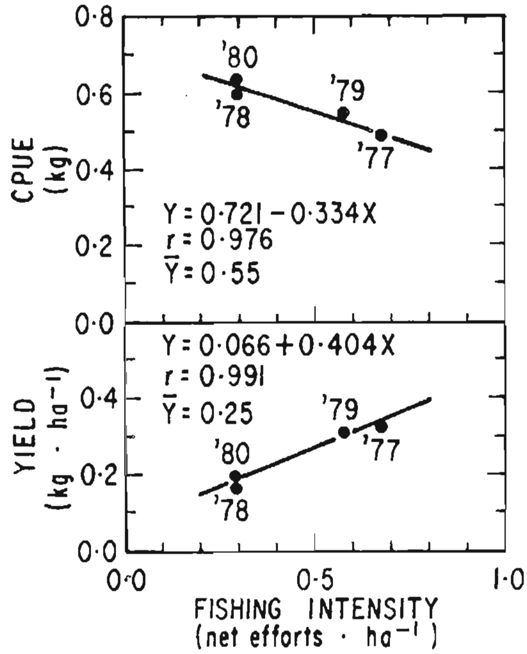

Fig. 21. Catch per unit effort (CPUE) and yield of brook trout compared to fishing intensity in Wigwam Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

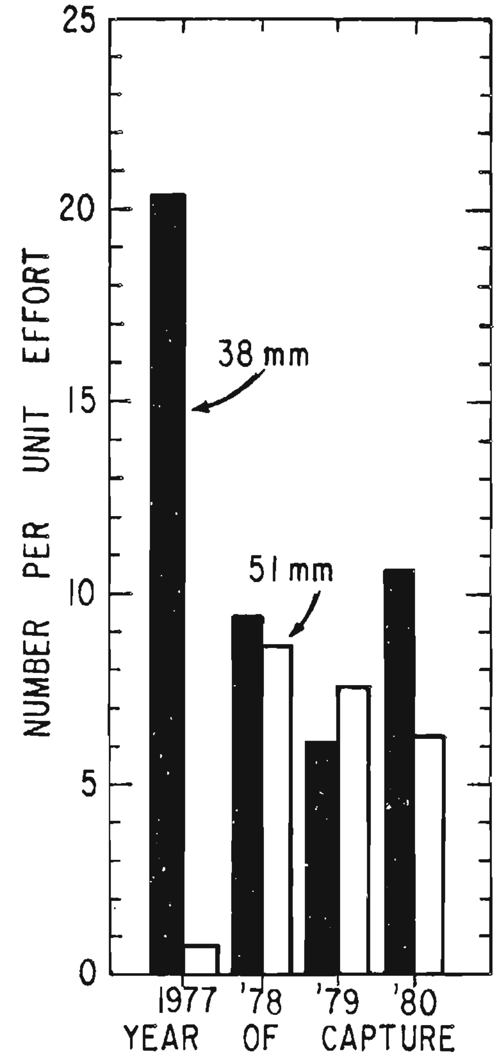

Fig. 22. Changes in the relative abundance of brook trout from Wigwam Pond in the two mesh sizes producing the greatest catch per unit effort.

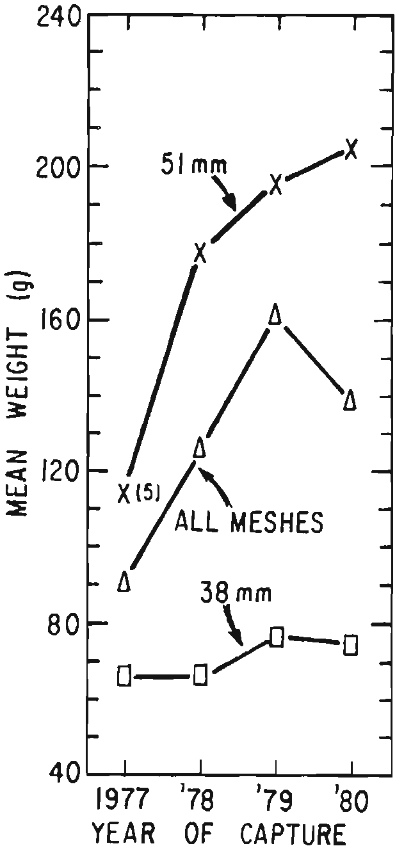

Fig. 23. Changes in the mean weight of brook trout from Wigwam Pond in the two mesh sizes producing the greatest catch per unit effort and in all mesh sizes combined. Data point based on 10 fish or less is indicated.

Table 10. Least-squares regressions of $\log_{10}$ weight (g) on $\log_{10}$ fork length (mm) and calculated weight at 200 mm of brook trout from Wigwam Pond.

Year of sample	Intercept	Slope	Number of fish	Correlation coefficient	Calculated weight (g) at 200 mm
1977	-5.2432	3.122	41	0.9965	87.2
1978	-5.5407	3.211	53	0.9936	70.5
1979	-4.4550	2.785	54	0.9735	89.8
1980	-4.3797	2.744	71	0.9751	86.0
Means	-4.9047	2.966			83.2

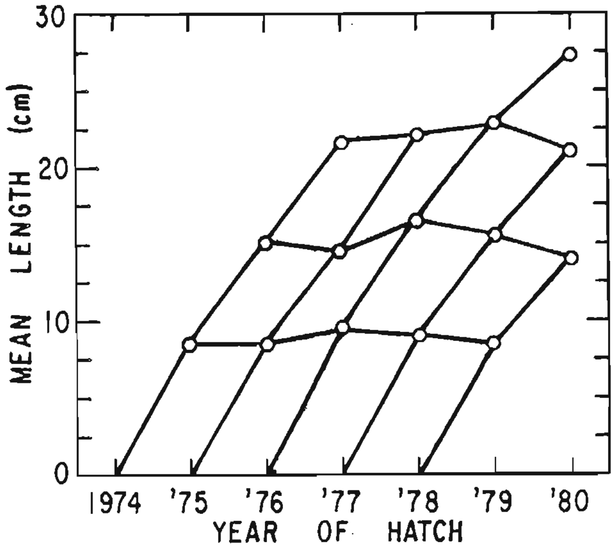

Fig. 24. Back-calculated growth of the year-classes of brook trout captured from 1977 to 1980 in Wigwam Pond. Mean lengths of the year-classes at the same ages are connected to facilitate recognition of changes in mean lengths at given ages with time. See Appendix 3 for body-scale relationships used for back-calculation and Appendix 4 for separation of data by year of capture. Only mean lengths based on five or more fish are included.

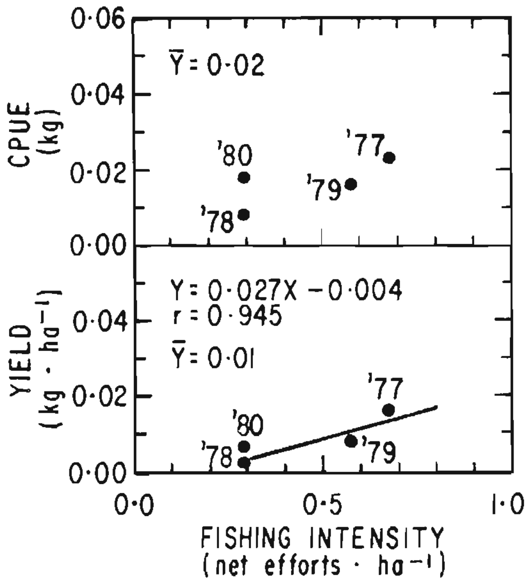

Fig. 25. Catch per unit effort (CPUE) and yield of non-sea-run Atlantic salmon compared to fishing intensity in Wigwam Pond. Years of effort are shown. Mean values of CPUE and yield are indicated (Ȳ).

sea-run fish averaged 1170.1 g (Table 9). The number of salmon captured in Wigwam Pond was not large enough to permit an assessment of year-to-year variation in size, growth in weight, and growth in length resulting from the experimental fishery. Available data on growth in length are summarized in Appendices 3 and 5.

Arctic charr catches in Wigwam Pond were suggestive of a decrease in population size over the course of the study. Catch per unit effort declined with time until, in the last year of fishing, no charr were captured (Fig. 20). The decline in catch per unit effort could not be attributed to variation in fishing intensity as these two variables were only weakly related ($r = 0.552$, $P>0.10$) (Fig. 26). Arctic charr yields also decreased with time and yield was not a significant function of fishing intensity ($r = 0.778$, $P>0.10$) (Fig. 26).

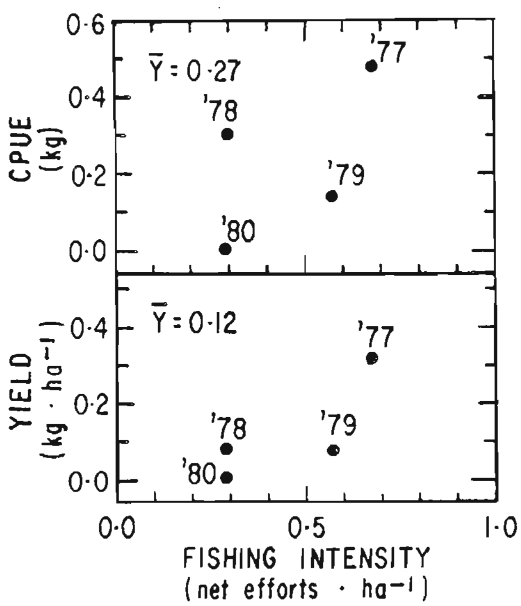

Fig. 26. Catch per unit effort (CPUE) and yield of Arctic charr compared to fishing intensity in Wigwam Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

The mean weight of Arctic charr captured ranged from a low of 164.1 g in 1977 (146 fish) to a high of 214.3 g in 1978 (32 fish). The small number of charr captured after 1977 precluded assessment of variation in size, growth in weight, and growth in length resulting from the fishery. Available data on growth in length are summarized in Appendices 3 and 6.

DISCUSSION

As indicated by the relationships of catch per unit effort and yield to fishing intensity, and the absence of a consistent increase in individual growth rates, brook trout yields in Wigwam Pond were less than a maximum sustainable yield.

The observed variation in the size and growth rates of brook trout in the catches from Wigwam Pond may have been contributed to by factors such as varying proportions of sea-run individuals in the lake and different times of capture of the fish. The timing of brook trout migrations to and from the ocean and the age and size of the migrants may vary (Power 1980). Seaward migration tends to result in faster growth and a larger size (Power 1980). Similarly, different segments of the trout population may have been fished in different years as the period of fishing, varying from early September to early October (Table 9), was proximate to spawning time (Power 1980). Different proportions of the population may have made movements to spawning areas in different years.

An increased fishing intensity over a longer time period than in the present study may reveal a maximum sustainable yield level for the brook trout population in Wigwam Pond. Similarly, future changes in the relative abundance of brook trout in the population may be revealed by changes in catch per unit effort at levels of fishing intensity similar to those applied in the present study. However, the anadromous nature of the population may make interpretation of results difficult. The magnitude and timing of the migrations could be monitored with fish counting fences on tributaries (Craig 1980).

The use of gill nets to monitor the brook trout population of Wigwam Pond may be detrimental to the charr population, as indicated by the declining catch per unit effort of charr over the course of the present study. Accordingly, if future monitoring is to be carried out, consideration should be given to the use of live-capture equipment such as fyke nets (Ryan 1984).

Atlantic salmon data from Wigwam Pond could not, particularly as a result of the small sample sizes, be considered as evidence of any response to the experimental fishery. The anadromous nature of the stock would make any assessment of a sustainable yield difficult over a short time period using the techniques of the present study. Production of young Atlantic salmon appears to be, under usual conditions, primarily a function of the number of sea-run adults available as spawners (Chadwick 1985). While the use of lake habitat by young salmon is common in Newfoundland (Pepper 1976; Chadwick and Green 1985; Ryan 1986a), low catches of sea-run adults during lake surveys (Scruton 1983, 1984; Ryan 1986a; M. O'Connell, Biologist, Department of Fisheries and Oceans, P.O. Box 5667, St. John's, Nfld. A1C 5X1, pers. comm.) suggest that the adults are often more likely found in riverine habitat while in fresh water. In addition, there is evidence that, in some river systems, the young salmon do not usually migrate to the lakes from stream spawning areas until their second year of life and later (Pepper 1976; Hutchings 1986; Ryan 1986a). Thus, a lack of susceptibility of the stock to capture lessens the usefulness of the techniques of the present study in assessments of maximum sustainable yield levels of anadromous Atlantic salmon.

Generally, the number of sea-run Atlantic salmon adults in excess of those required for the maximum production of young is considered the harvestable portion of a stock (Chadwick 1985). The number of adults required for spawning is calculated from the size of available spawning and rearing habitat while the number of adults available for spawning may be obtained from the use of counting fences or inferred from angler success rates (Chadwick 1985; Ryan 1986a). Prior to future monitoring of the salmon inhabiting Wigwam Pond, consideration should be given to the use of information obtained by these methods.

The Department of Fisheries and Oceans has routinely monitored angler success rates on the Lomond River system which drains Wigwam Pond (Ash and O'Connell 1986) and obtained fishway counts of sea-run adults returning to the system (O'Connell et al. 1983). If future assessments of the salmon of Wigwam Pond are carried out, the resulting data could, in conjunction with those described above, serve a variety of functions such as the monitoring of freshwater survival and production (Chadwick 1985) and the prediction of angler success rates for Atlantic salmon in advance of the fishing season (Ryan 1986b).

The marked decline in Arctic charr catches over the course of the study is strongly suggestive of a marked reduction in the charr population size caused by the experimental fishery. It is recognized that it is difficult, without long-term harvesting, to estimate optimal yield levels in charr populations (Langeland 1986). However, the observed marked decline in catches during the present study is indicative of harvests in excess of a maximum sustainable yield level (Watt 1968).

It is possible that some of the year-to-year variation in catch could have been due to the presence of a varying number of sea-run charr in the lake. The recognition of migratory fish may be difficult (Scott and Crossman 1973; Johnson 1980). No charr were identified as being anadromous during the experimental fishery in Wigwam Pond but the charr have had access to the sea as indicated by the presence of anadromous trout and salmon. However, since individuals in most seagoing populations of charr have a mean length in excess of 400 mm (Johnson 1980) and few fish of this length range were captured in Wigwam Pond, it seems probable that if some of the charr were anadromous, they constituted only a small portion of the total.

Because the apparent rapid reduction in charr population size in Wigwam Pond may have been due to the experimental fishery, it may be desirable to obtain some measure of the population size in the lake in the future. If the population has been dramatically reduced, such a measure may provide an indication of the time required for a return to an equilibrium level and provide for future assessment of the effects of other environmental factors such as acid precipitation. Monitoring of the charr population could be carried out by live capture methods such as fyke nets (Ryan 1984) and stream counting fences (Craig 1980) with minimal impact on the population.

HALF MOON POND

CATCHES

Brook trout, Atlantic salmon, and Arctic charr were captured in Half Moon Pond from 1975 to 1979 (Table 11). Sea-run trout and salmon were identified and eels are present in the lake. During the course of the study, 249.6 units of gillnet effort obtained 556 trout weighing 61.39 kg, 238 salmon weighing 12.69 kg, and 768 charr weighing 11.75 kg. These catches correspond to average annual yields of 0.37 $kg \cdot ha^{-1}$ trout, 0.08 $kg \cdot ha^{-1}$ salmon, and 0.07 $kg \cdot ha^{-1}$ charr for a total average annual salmonid yield of 0.52 $kg \cdot ha^{-1}$.

Table 11. Summarized effort and catch statistics from an experimental gillnet fishery in Half Moon Pond, Gros Morne National Park. For additional details see Appendices 1 and 2.

Dates of capture	Units of net effort (15 m.24 h^{-1})	Brook trout No.	Brook trout Wt (g)	Atlantic salmon No.	Atlantic salmon Wt (g)	Arctic charr No.	Arctic charr Wt (g)
Sept. 18-20, 1975	31.18	103	8,953	34	1,386	13	234
Sept. 20-23, 1976	53.11	129	16,181	86	3,814	49	1,188
Sept. 26-29, 1977	49.94	144	15,341	60	2,081	351	5,235
Sept. 27-30, 1978	47.60	96	10,465	23[a]	2,754	234	3,124
Oct. 2-5, 1979	67.80	85	10,451	35[b]	2,656	121	1,971

[a] Includes 1 sea-run salmon weighing 2,118 g.

[b] Includes 1 sea-run salmon weighing 1,260 g.

RESPONSES TO THE FISHERY

Brook trout catches in Half Moon Pond were indicative of an annual variation in fish density during the study but this variation could not be attributed to the experimental fishery. Catch per unit effort did not vary consistently with time (Fig. 27). Catch per unit effort was not significantly related to fishing intensity ($r = 0.625$, $P>0.10$). However, it appeared that some of the variation in catch per unit effort was due to the varied fishing intensity since the lowest catch rate occurred at the highest level of intensity (Fig. 28). Yield was not a significant linear function of fishing intensity ($r = 0.269$, $P>0.10$) (Fig. 28). As a result of the low 1979 catch, there was a suggestion of a reduction in yield at the highest level of intensity, but variation in the size structure of trout in the catches indicated that a large part of the variation in catch was due to a varying abundance of individuals hatched in different years and/or annual variation in the number of migrants to and from the lake.

The size structure of brook trout in the catches from Half Moon Pond varied considerably over the course of the study as indicated by the varying proportions of trout captured in the two most efficient mesh sizes (Fig. 29). The proportion of fish captured in the larger of these two meshes and the catch per unit effort in that mesh increased from 1975 to 1977, suggestive of the appearance of individuals in a comparatively strong year-class and increases in their size with time. In 1978, the proportion of fish captured and the catch per unit effort in the larger mesh decreased; consistent with an increased age of individuals in a strong year-class and a resultant lesser number of survivors. Consistent with an increasing size of individuals in a dominant year-class and a subsequent decrease in their density, the mean weight of trout captured in the 38 and 51 mm mesh nets increased after 1975, peaked in 1977 or 1978, and then decreased (Fig. 30). Fluctuations in the mean weight of individuals captured in all mesh sizes was likely contributed to by differing proportions of effort with different mesh sizes in different years (Appendix 1).

Variation in the individual growth rates of brook trout could not be considered as indicative of a response to the experimental fishery. The mean calculated weight of 200 mm fish varied irregularly and, in the last year of fishing was less than it had been in previous years (Table 12). Similarly, growth in length did not exhibit consistent increases suggestive of reduced densities. The mean calculated length of trout at age 1 in 1978 was greater (6.6 mm or 8%) than that of their counterparts in 1973 (Fig. 31). The mean length of trout at age 2 in 1979 was only slightly greater (2.1 mm or 1%) than the mean length of trout at that age in 1974, and trout at age 3 in 1979 were smaller than trout at that age in the first year of the experimental fishery (Fig. 31).

Catches of Atlantic salmon in Half Moon Pond were indicative of a marked variation in salmon density in the lake. The varying size structure of fish in the catches suggested that this variation in density was due, to a large extent, to a variation in year class strength and/or a differing degree of migration to and from the lake. The number and weight of salmon captured per unit of effort did not vary consistently with time (Fig. 27) but some of the variation was due to the capture of sea-run adults in the last two years of the fishery (Table 11). With the sea-run fish excluded, both catch per unit

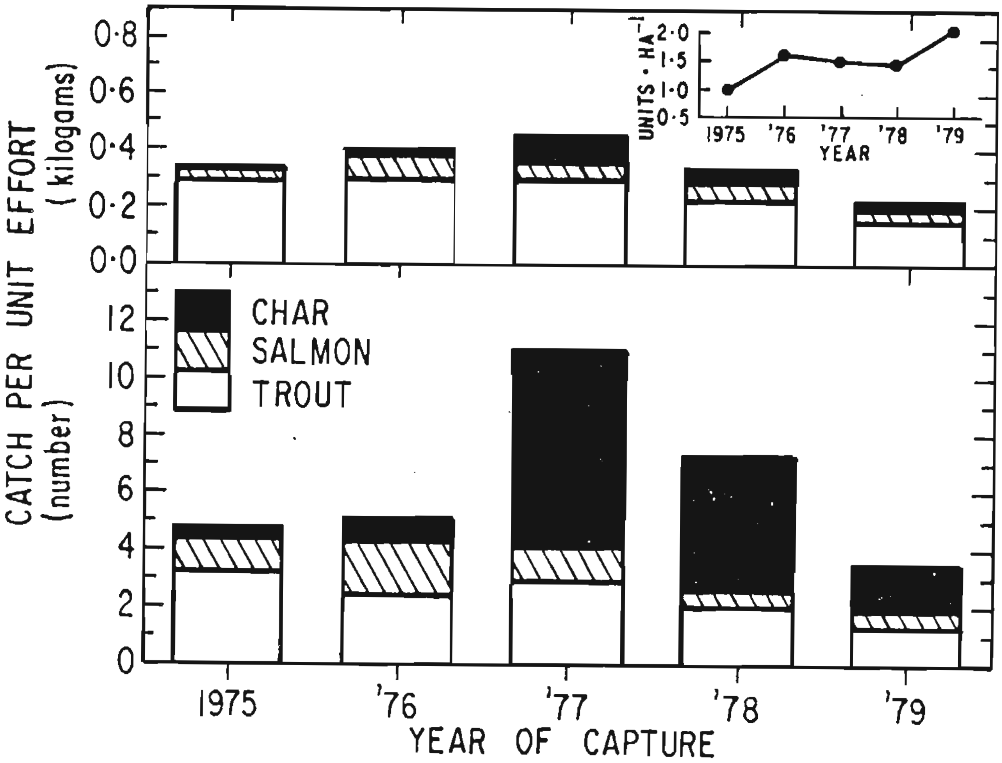

Fig. 27. Annual variation in the relative abundance of salmonids in the total catches from Half Moon Pond. Presented for comparison is the annual variation in fishing intensity. A unit of effort is 15 m of gill net fished for 24 h.

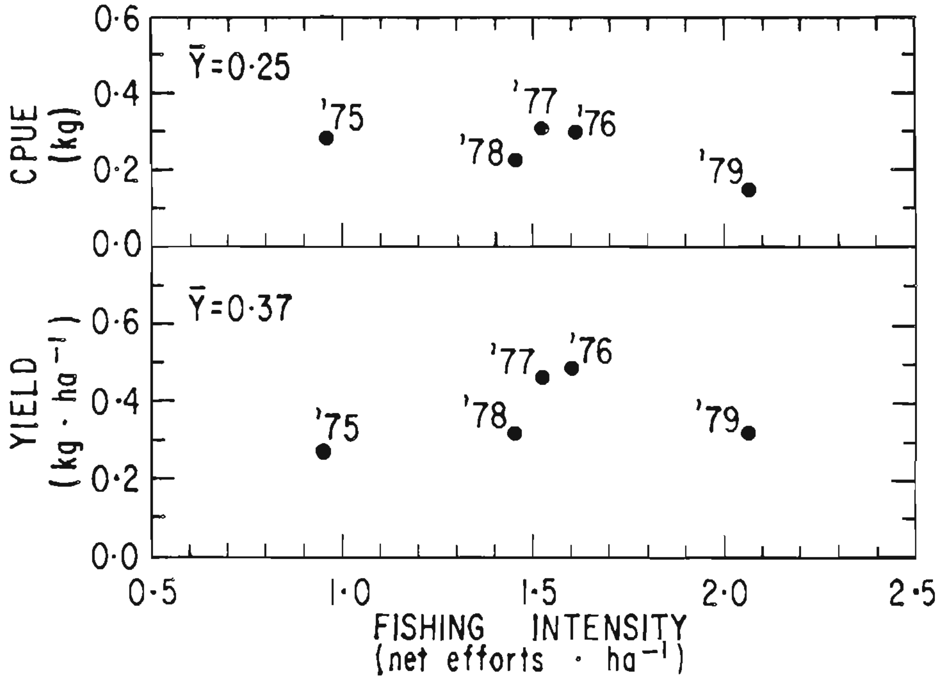

Fig. 28. Catch per unit effort (CPUE) and yield of brook trout compared to fishing intensity in Half Moon Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

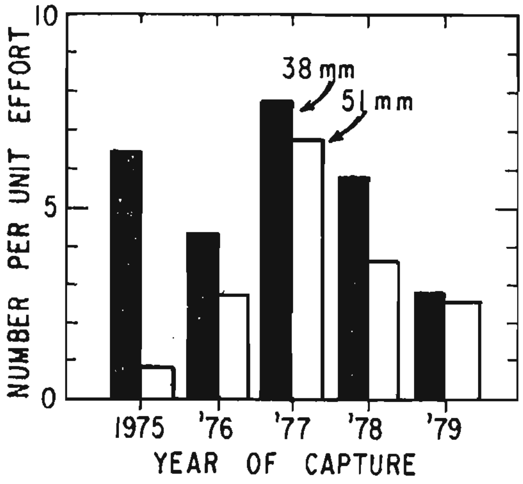

Fig. 29. Changes in the relative abundance of brook trout from Half Moon Pond in the two mesh sizes producing the greatest catch per unit effort.

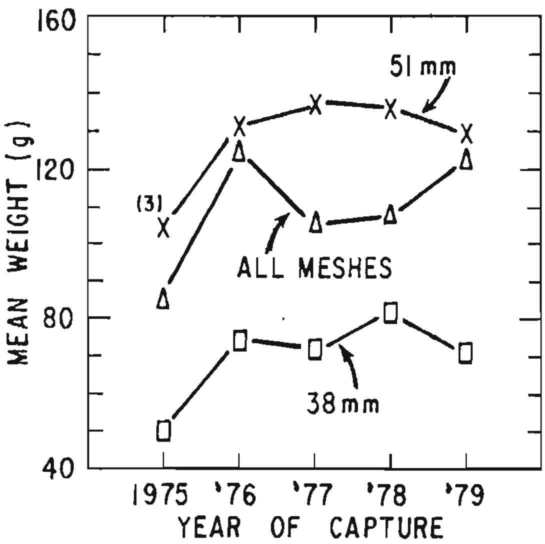

Fig. 30. Changes in the mean weight of brook trout from Half Moon Pond in the two mesh sizes producing the greatest catch per unit effort and in all mesh sizes combined. Data point based on 10 fish or less is indicated.

Table 12. Least-squares regressions of $\log_{10}$ weight (g) on $\log_{10}$ fork length (mm) and calculated weight at 200 mm of brook trout from Half Moon Pond.

Year of sample	Intercept	Slope	Number of fish[a]	Correlation coefficient	Calculated weight (g) at 200 mm
1975	-5.2327	3.121	11	0.9946	88.9
1976	-5.2548	3.128	38	0.9940	87.7
1977	-5.2332	3.070	89	0.9916	67.8
1978	-4.9071	2.966	57	0.9762	82.8
1979	-5.0423	3.019	85	0.9816	80.3
Means	-5.1340	3.061			81.5

[a]Regressions from 1975 and 1976 obtained from fish sampled for ageing as additional individual lengths and weights were not available. Regressions from 1977 to 1979 obtained from fish sampled for length and weight only.

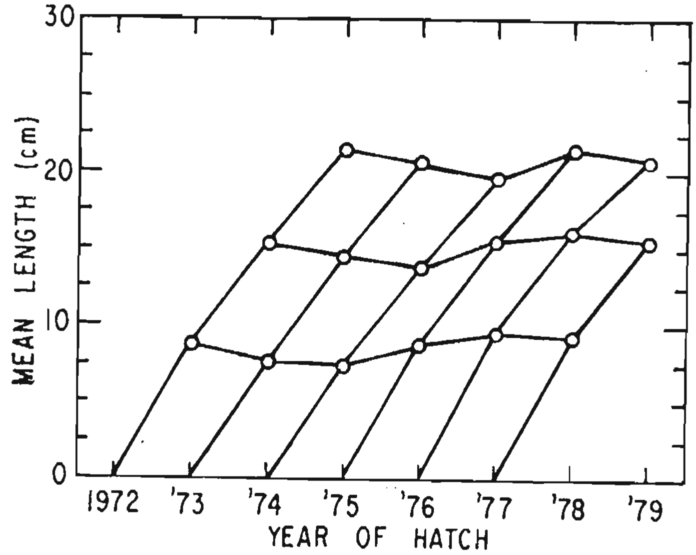

Fig. 31. Back-calculated growth of the year-classes of brook trout captured from 1975 to 1979 in Half Moon Pond. Mean lengths of the year-classes at the same ages are connected to facilitate recognition of changes in mean lengths at given ages with time. See Appendix 3 for body-scale relationships used for back-calculation and Appendix 4 for separation of data by year of capture. Only mean lengths based on five or more fish are included.

effort and yield exhibited an initial increase from 1975 to 1976 (Fig. 32). From 1976 to 1978, with little variation in fishing intensity (1.5 to 1.6 units·ha^{-1}), catch per unit effort decreased dramatically. Subsequently, both increased at the highest level of intensity. There was no indication of a relationship between catch per unit effort and fishing intensity ($r = 0.229$, $P>0.10$) nor between yield and fishing intensity ($r = 0.147$, $P>0.10$) (Fig. 32).

Variation in the abundance of salmon hatched in different years and migrating to and from the lake was indicated by varying proportions of fish captured in the two most efficient mesh sizes. The greatest proportion of fish was taken in the larger mesh in 1975 and 1976, the smaller mesh in 1977 and 1978, and the largest mesh in 1979 (Fig. 33). Concurrently, variation in the mean weight of individuals captured was consistent with this pattern in its indication of a dominance of larger fish early in the study, subsequent decreases in their relative abundance with time, and near the end of the study, an increased abundance of fish in the larger size groups (Fig. 34). These patterns were suggestive of the presence of individuals in a comparatively strong year-class in the lake early in the study, increases in their size with time, their subsequent smoltification and departure, and the increased size of individuals in a subsequent year-class.

The small amount of data obtained from Atlantic salmon in Half Moon Pond were prohibitive of a detailed examination of within-lake variation in growth. The mean calculated weight of 150 mm salmon increased during the study but, as a result of the small sample sizes and the short time series, this increase could not be considered a result of the experimental fishery (Table 13). Available data on growth in length are summarized in Appendices 3 and 4.

Arctic charr catches from Half Moon Pond provided evidence of a marked variation in charr density over the course of the study but this variation could not be considered a result of the experimental fishery. Catch per unit effort rose to a maximum from 1975 to 1977 and subsequently decreased (Fig. 27). At similar levels of fishing intensity in 1976 and 1977 (1.6 and 1.5 units·ha^{-1}), catch per unit effort increased by more than a factor of four, suggestive of an increase in charr density over that period. Catch per unit effort was not a significant function of fishing intensity ($r = 0.150$, $P>0.10$) and, at the highest level of intensity in the last year of fishing, was greater than it had been in the first year (Fig. 35). Yield was not a significant function of intensity ($r = 0.275$, $P>0.10$) and increased more than fourfold at similar levels of intensity from 1976 to 1977 (Fig. 35).

Changes in the size composition of Arctic charr occurred in the catches during the study. Over the five-year period, the two most efficient mesh sizes were, respectively, the 25 and 19 mm meshes. Less than 1% of the charr captured were taken in larger meshes in all years except 1976 when 41% were captured in mesh sizes 38 mm and greater (Appendix 1). Catch per unit effort in those meshes increased in 1976 but decreased in 1977, suggestive of a movement to the lake and a subsequent departure by the largest fish (Fig. 36). In contrast, a marked increase in catch per unit effort in the 19 and 25 mm mesh nets in 1977 was suggestive of an increase in the density of smaller fish in that year (Fig. 36).

The mean weight of charr captured in the 25 mm mesh decreased from 1975 to 1978 and subsequently increased, perhaps as a reflection of an increasing

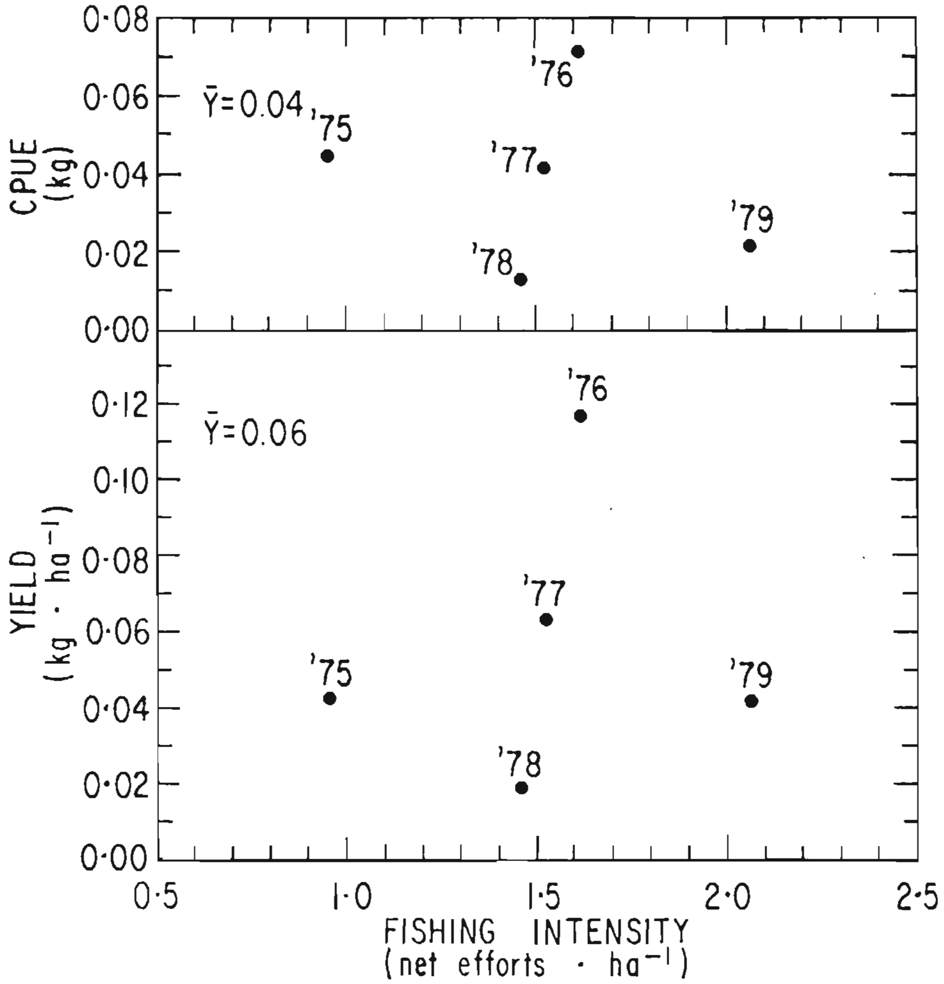

Fig. 32. Catch per unit effort (CPUE) and yield of non-sea-run Atlantic salmon compared to fishing intensity in Half Moon Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

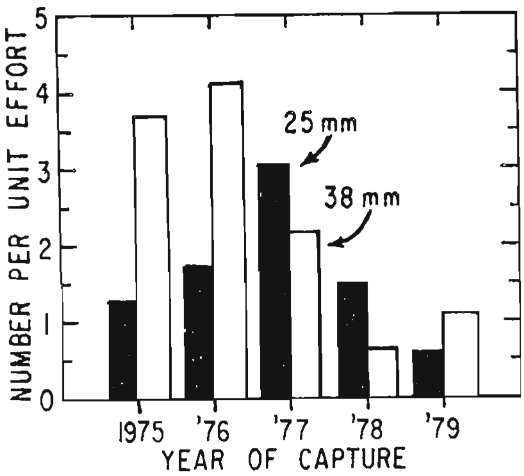

Fig. 33. Changes in the relative abundance of non-sea-run Atlantic salmon from Half Moon Pond in the two mesh sizes producing the greatest catch per unit effort.

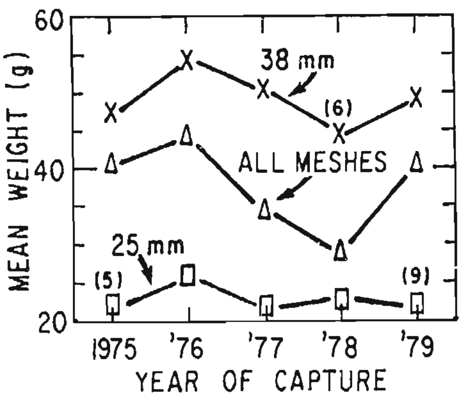

Fig. 34. Changes in the mean weight of non-sea-run Atlantic salmon from Half Moon Pond in the two mesh sizes producing the greatest catch per unit effort and in all mesh sizes combined. Data points based on 10 fish or less are indicated.

Table 13. Least-squares regressions of $\log_{10}$ weight (g) on $\log_{10}$ fork length (mm) and calculated weight at 150 mm of Atlantic salmon from Half Moon Pond. Only non-sea-run fish were included.

Year of sample	Intercept	Slope	Number of fish[a]	Correlation coefficient	Calculated weight (g) at 150 mm
1977	-4.7947	2.869	44	0.9929	28.1
1978	-4.0643	2.572	22	0.9768	34.1
1979	-3.9169	2.516	34	0.9528	36.2
Means	-4.2586	2.652			32.8

aInsufficient data available from 1975 and 1976.

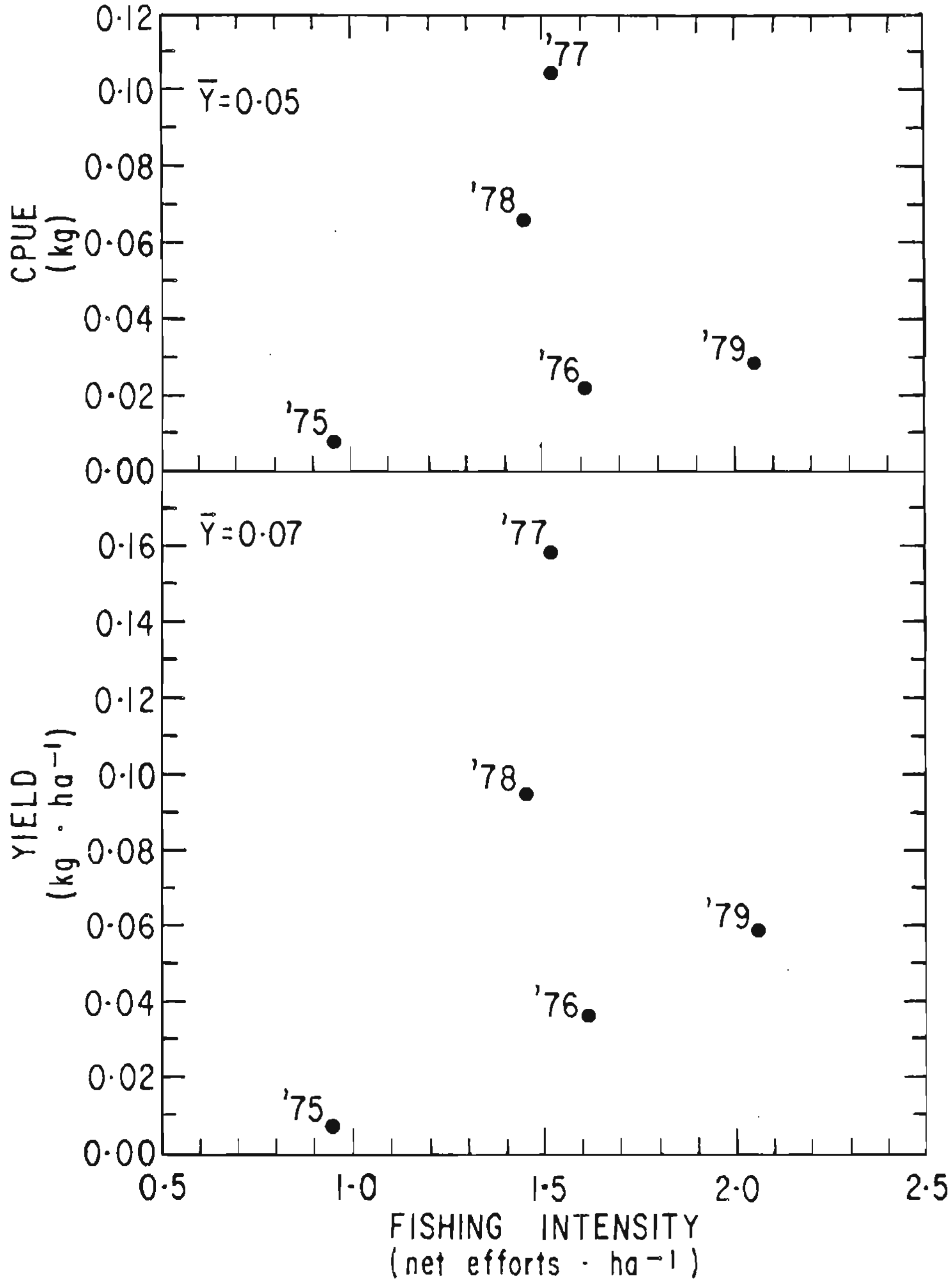

Fig. 35. Catch per unit effort (CPUE) and yield of Arctic charr compared to fishing intensity in Half Moon Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

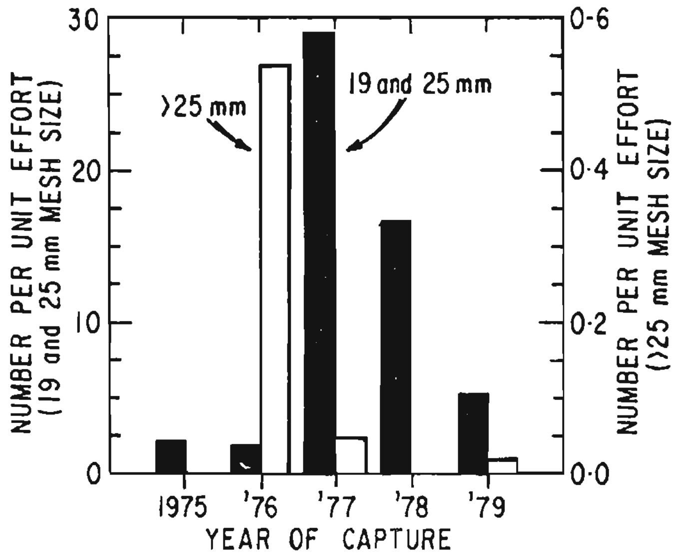

Fig. 36. Changes in the relative abundance of Arctic charr from Half Moon Pond in the two most efficient mesh sizes and in mesh sizes greater than 25 mm.

proportion of smaller fish in the lake and their subsequent growth (Fig. 37). The mean weight of charr captured in all mesh sizes was similar to that of the most efficient mesh in all years except for 1976 when the abundance of charr in the largest mesh sizes was the greatest (Fig. 37).

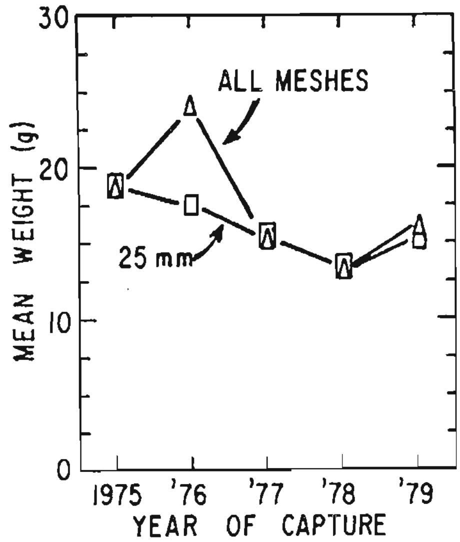

Fig. 37. Changes in the mean weight of Arctic charr from Half Moon Pond in the most efficient mesh size and in all mesh sizes combined.

Age and growth data from Arctic charr from Half Moon Pond precluded, because of small sample sizes, a detailed examination of within-lake variation in growth. The mean calculated weight of 150 mm charr did not increase consistently during the final years of the study (Table 14). Available data on growth in length of charr from Half Moon Pond are summarized in Appendices 3 and 6.

DISCUSSION

Brook trout data from Half Moon Pond did not provide evidence of catches in excess of a maximum sustainable yield as indicated by an absence of consistent variation in catch per unit effort with time, the lack of relationships of catch per unit effort and yield to fishing intensity, and by the absence of consistent increases in individual growth rates.

The appearance of individuals in a dominant year-class in the lake early in the study and changes in their abundance with time, suggested by the varying efficiency of gillnet mesh sizes, could have obscured evidence of overfishing during the period of study. Similarly, the potentially variable proportion of the brook trout population which migrates to the sea and the possible variation in the timing of the migrations could lessen the opportunity for the recognition of overfishing, if it occurred.

An increasing fishing intensity over a longer period than in the present study, coupled with the use of stream counting fences to monitor migration (Craig 1980), may provide an indication of a maximum sustainable yield level in the brook trout population of Half Moon Pond. Alternatively, in the

Table 14. Least-squares regressions of $\log_{10}$ weight (g) on $\log_{10}$ fork length (mm) and calculated weight at 150 mm of Arctic charr from Half Moon Pond.

Year of sample	Intercept	Slope	Number of fish[a]	Correlation coefficient	Calculated weight (g) at 200 mm
1977	-3.8693	2.412	88	0.9144	24.0
1978	-4.3071	2.672	52	0.9312	32.2
1979	-3.0358	2.071	25	0.9265	29.4
Means	-3.7383	2.385			28.5

[a]Insufficient data available from 1975 and 1976.

future, differing values of catch per unit effort at levels of fishing intensity similar to those applied in the present study could provide an indication of long-term changes in the relative abundance of brook trout in the population, should they occur.

Atlantic salmon data from Half Moon Pond did not provide evidence of responses to the experimental fishery. A large part of the observed year-to-year variation appeared to be due to a varying year-class strength which, in turn, was likely a primary result of varying numbers of sea-run adults (Chadwick 1985). Thus, as was the case with the salmon of Wigwam Pond, the techniques employed in the present study would not likely result in recognizable changes in the anadromous population over a short period of time.

If future monitoring of the salmon of Half Moon Pond is undertaken, consideration should be given to the use of complementary information obtained by the Department of Fisheries and Oceans on angling statistics from the Deer Brook system which drains Half Moon Pond (Moores and Ash 1984). Data pertaining to the relative abundance of the juvenile portion of the stock in fresh waters, in conjunction with angling statistics, may assist in the monitoring of production and the management of the stock (Chadwick 1985; Ryan 1986b).

Variation in Arctic charr catches from Half Moon Pond appeared to be primarily due to a variation in the numbers of charr migrating to and from the lake during the study rather than due to the experimental fishery. There was no indication that charr in the lake are anadromous but, as indicated by the presence of anadromous trout and salmon, charr migrations could have occurred to and from other locations on the river system draining Half Moon Pond. Outer Deer Pond, a 236 ha lake less than 0.5 km downstream of Half Moon Pond (Kerekes and Schwinghamer 1975b), may have been a source and subsequent destination of charr in Half Moon Pond although there is, as yet, no record of charr in that lake (Kerekes 1978).

Charr migrations to and from Half Moon Pond could obscure evidence of overfishing since a varying proportion of the stock would be susceptible to capture in Half Moon Pond. As is the case with other migrating populations in the study lakes, the use of stream counting fences (Craig 1980) may provide an indication of the extent of migration in the charr population.

If the charr inhabiting Half Moon Pond represent only a small portion of a larger population, it is unlikely that a continued, more intensive fishery in Half Moon Pond would provide an indication of a maximum sustainable yield. However, the continuous monitoring of the charr population by the use of live-capture methods may provide an indication of charr abundance in the entire population. This was found to be the case with a small segment of an anadromous salmon population in central Newfoundland (Ryan 1986a, 1986b).

NORTH NARROWS POND

CATCHES

Brook trout was the only salmonid captured in North Narrows Pond from 1975 to 1979 (Table 15). Some individuals were identified, at capture, as being

Table 15. Summarized effort and catch statistics from an experimental gillnet fishery in North Narrows Pond, Gros Morne National Park. For additional details, see Appendices 1 and 2.

Dates of capture	Units of net effort ($15\ m.24\ h^{-1}$)	Brook trout	
		Number	Weight (g)
Sept. 20-23, 1975	46.67	98	9,382
Sept. 13-16, 1976	54.83	120	13,161
Sept. 19-24, 1977	83.22	256	25,296
Sept. 13-25, 1978	88.40	179	19,974
Sept. 12-15, 1979	72.00	131	13,675

sea-run trout. American eels are known to be present in the lake. Over the five-year period, 345.1 units of gillnet effort captured 784 brook trout with a total weight of 81.49 kg, corresponding to an average annual yield of 0.28 $kg \cdot ha^{-1}$.

RESPONSES TO THE FISHERY

Brook trout catches in North Narrows Pond did not provide evidence of a population response to the experimental fishery. Catch per unit effort increased up to 1977 and subsequently decreased to levels similar to those encountered at the start of the study (Fig. 38). Catch per unit effort and fishing intensity were not significantly related ($r = 0.425$) ($P>0.10$) (Fig. 39). Yield tended to increase with increased fishing intensity at just below the level of statistical significance ($0.05<P<0.10$) but, no leveling off or decline in yield was apparent at the higher intensities to suggest that a maximum sustainable yield had been attained or that overfishing had occurred (Fig. 39).

The size structure of brook trout in the catches from North Narrows Pond changed dramatically over the course of the study, apparently as a result of the appearance in the lake of a relatively abundant group of larger than average size fish early in the study and increases in their size with time. The smaller of the two most efficient mesh sizes captured the greater proportion of fish and an increasing abundance of fish until 1978 when the larger mesh became more efficient (Fig. 40). Concurrently, there was an increase in the mean weight of fish captured in the 38 mm mesh in 1977, and, subsequently, increases in the mean weight of fish captured in the 51 mm mesh (Fig. 41).

There were indications of fluctuations in the growth rates of captured trout but increases did not appear to be consistent enough to be attributable to density reductions by the experimental fishery. The calculated weight of 200 mm fish increased slightly from 1975 to 1976 but subsequently showed a small decrease (Table 16). The calculated length of fish at age 1 was greater each year after the start of the fishery than it had been from 1972 to 1975 (Fig. 42). Of the older age groups, fish at age 2 in 1979 were larger by 11.2 mm, or 8%, than their counterparts in 1974 but the length of fish at age 3 in 1979 differed from the length of fish of that age in 1975 by less than 1 mm (Fig. 42).

DISCUSSION

The brook trout of North Narrows Pond did not appear to be overfished as indicated by the absence of a consistent variation in catch per unit effort with time, the lack of relationship between catch per unit effort and fishing intensity, the absence of an obvious decline in yield at high fishing intensity, and the absence of consistent increases in growth rate.

Overfishing may have been obscured by an influx of fish to the catchable population; as indicated by the low correlation between catch per unit effort and fishing intensity and by the fluctuations in the size structure of fish in the catch. Such changes in population size may have been due to natural

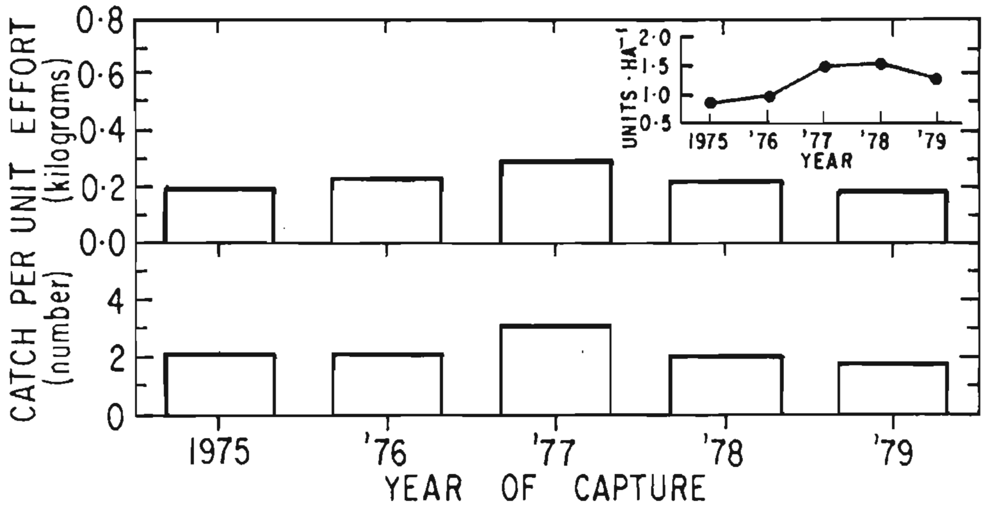

Fig. 38. Annual variation in the relative abundance of brook trout in the total catches from North Narrows Pond. Presented for comparison is the annual variation in fishing intensity. A unit of effort is 15 m of gill net fished for 24 h.

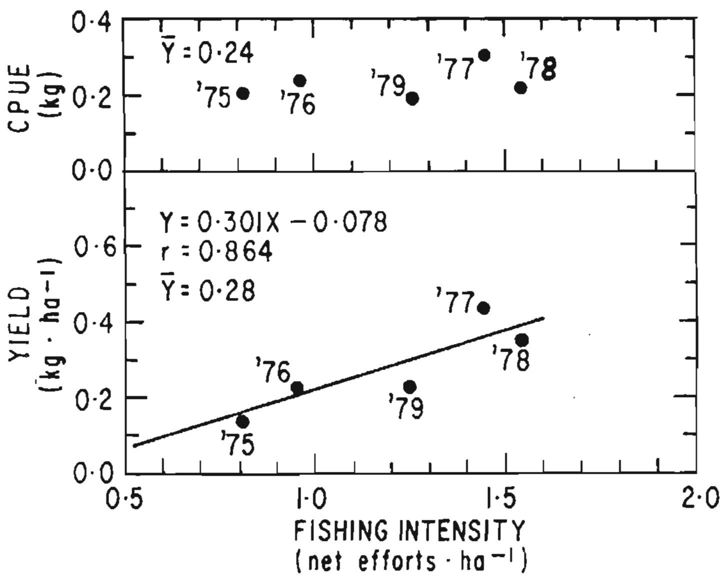

Fig. 39. Catch per unit effort (CPUE) and yield of brook trout compared to fishing intensity in North Narrows Pond. Years of effort are shown. Mean values of CPUE and yield are indicated ($\bar{Y}$).

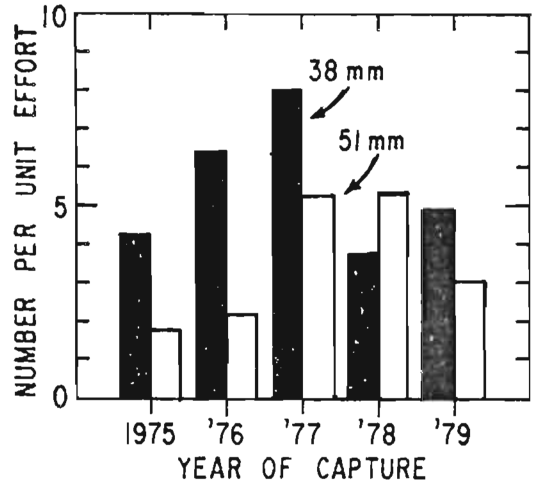

Fig. 40. Changes in the relative abundance of brook trout from North Narrows Pond in the two mesh sizes producing the greatest catch per unit effort.

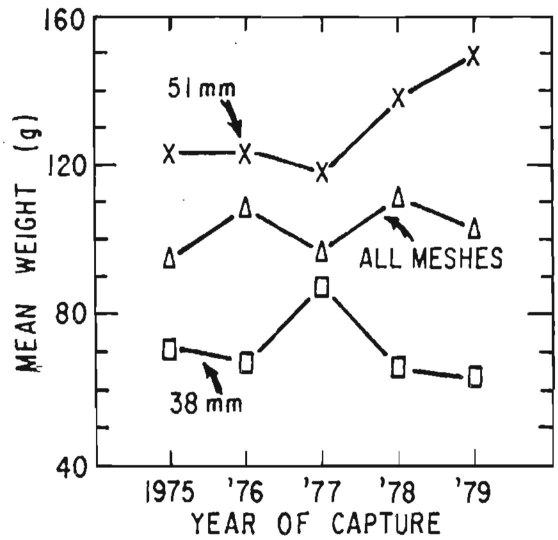

Fig. 41. Changes in the mean weight of brook trout from North Narrows Pond in the two mesh sizes producing the greatest catch per unit effort and in all mesh sizes combined.

Table 16. Least-squares regressions of $\log_{10}$ weight (g) on $\log_{10}$ fork length (mm) and calculated weight at 200 mm of brook trout from North Narrows Pond.

Year of sample	Intercept	Slope	Number of fish	Correlation coefficient	Calculated weight (g) at 200 mm
1975	-5.0345	3.040	8	0.9943	91.3
1976	-4.8571	2.971	45	0.9126	95.3
1977	-5.5837	3.273	63	0.9820	88.6
1978	-4.9311	2.992	46	0.9791	89.9
1979	-5.4117	3.199	47	0.9819	89.0
Means	-5.1636	3.095			90.8

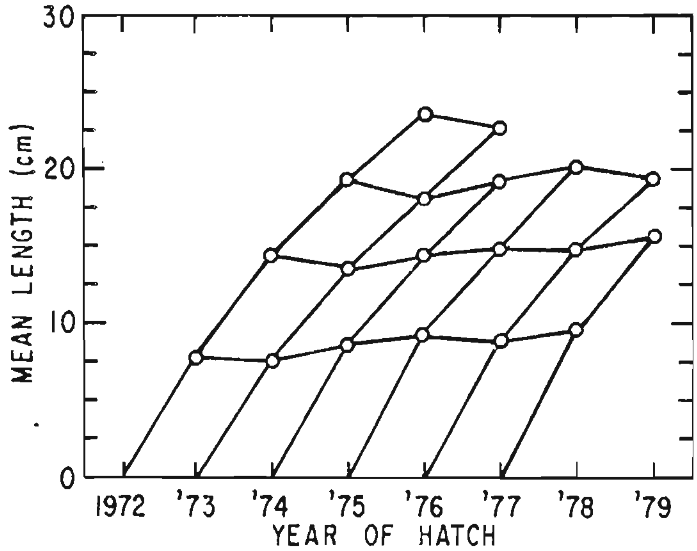

Fig. 42. Back-calculated growth of the year-classes of brook trout captured from 1975 to 1979 in North Narrows Pond. Mean lengths of the year-classes at the same ages are connected to facilitate recognition of changes in mean lengths at given ages with time. See Appendix 3 for body-scale relationships used for back-calculation and Appendix 4 for separation of data by year of capture. Only mean lengths based on five or more fish are included.

variation in year-class strength such as described in detail by Hunt (1974), varying proportions of the population migrating to and from the lake with a varied timing of such migrations (Power 1980) and combinations of these. The potentially variable proportion of sea-run fish in North Narrows Pond, with their potentially greater rate of growth (Power 1980) could have further obscured evidence of reduction in stock size.

If it is considered desirable to estimate maximum sustainable yield levels of North Narrows Pond brook trout in future studies, levels of fishing intensity higher than employed from 1975 to 1979 would appear to be appropriate for reduction in stock size. However, with the methods employed in the present study, there is a possibility of inadvertently overfishing the stock if catch rates become temporarily inflated by returning sea-run fish. Use of comparatively labor-intensive techniques such as fences for counting migrating fish (Chadwick 1981), spring and fall mark-recapture population estimates (Ryan 1986a), or the calculation of trout production throughout the entire system (Hunt 1974) may alleviate some of this difficulty. Alternatively, the application of levels of fishing intensity similar to those applied in the present study may, in the case of dramatic changes in catch per unit effort or yield, serve in the recognition of changes in trout abundance in the future.

CONCLUDING DISCUSSION - PART I

Data from only two of the populations examined provided evidence of responses to the experimental fishery. These were the Arctic charr populations of Candlestick and Wigwam ponds. Charr catch per unit effort in each of these lakes consistently declined with time but was not significantly related to fishing intensity ($r = 0.395$ and $r = 0.552$ respectively) over a four-year period of fishing ($P>0.10$). No charr were captured in the last year of fishing in Wigwam Pond. Such declines in catch per unit effort suggest that the populations were overfished (Watt 1968).

It is possible that the declines in charr catch per unit effort in these lakes were due to factors such as unrecognized fluctuations in year-class strength, annual variations in movements to and from the lakes, and temporal variation in susceptibility to capture over the short time period. However, because dramatic reductions in population size may have occurred over the short time period of the present study, during future examination, mortalities should be minimized until the status of the populations is more clearly understood. Use of live capture and release methods (Craig 1980) would be appropriate in this regard.

Data from the remaining populations suggest that longer periods of study, coupled with an increasing fishing intensity, would have been required for the recognition of overfishing from declines in yield levels at high levels of intensity. Most of the variation in catch per unit effort in these populations appeared to be due, apart from changing fishing intensities, to naturally occurring changes in fish density rather than reductions in density caused by the experimental fishery. Naturally occurring changes in population density such as those due to a marked variation in year-class strength would make precise assessment of the status of individual populations difficult in short-term studies such as the present one. A similar constraint applies to the assessment of migratory populations (i.e. salmon in Wigwam and Half Moon ponds) where only a small part of the stock may be susceptible to sampling at a given time.

In spite of the difficulties inherent in stock assessments made over a short time period, future levels of fishing intensity similar to those applied in the present study may serve in the recognition of marked changes in the status of individual stocks. For example, over a three-year period in Pond Point Big Pond, fishing intensity varied from only 10.8 to 12.2 units$\cdot$ha^{-1} and catch per unit effort of brook trout varied from only 3.85 to 5.17 kg (Appendix 2). A fishing intensity of 11 units$\cdot$ha^{-1} yielding only 1 kg$\cdot$unit^{-1} or less would suggest that the trout population size had been reduced. Investigations could be carried out to determine probable cause (i.e. reduced pH, siltation of spawning beds, etc.) and remedial actions could be taken. Similarly, other data obtained in the present study, such as age and growth data, may serve as baseline information for the purpose of recognizing future environmental change. Examples of such comparisons, made for the assessment of acid rain effects, are described by Harvey (1982).

There was no evidence to suggest that 10 of the 12 fish populations studied had been measurably affected by the experimental fishery. Accordingly, in the following section of this report, year-to-year variation in year-class strength and growth rate within the individual populations is compensated for, to some extent, by averaging values of catch per unit effort, yield, and measures of growth. These average values are employed to examine lake-to-lake variation in fish abundance and growth and make inferences concerning the possible causes of the differences among the populations.

Part 2 - Lake-to-Lake Variation in the Relative Abundance, Size Composition, and Growth of Fishes

INTRODUCTION

The purpose of this section of the report is the examination of variations in population characteristics among the study lakes so that factors influencing the variations could be identified. Knowledge of the causes of variations among the populations will assist in fisheries management in Gros Morne Park and elsewhere. In addition, knowledge of the causes of variation among the populations will assist in the identification of factors responsible for long-term change, should it occur.

MATERIALS AND METHODS

Average yield ($kg \cdot ha^{-1}$) from each salmonid population was employed as a measure of relative fish abundance for comparisons among populations. At a constant level of effort, catches tend to vary with population size (Ricker 1975; Ryan 1984; Langeland 1986). If catches are small in relation to total fish abundance, catches can be expected to increase with increasing fishing intensity and thus, comparisons among populations require a correction for the variation in fishing intensity among lakes (Carlander 1955; Ryder et al. 1974). Accordingly, catch data were standardized, by the following method, to correct for this variation.

Individual values of yield for each salmonid species were regressed on the individual values of fishing intensity, producing a regression equation based on all data for each of the species. Then for each population, the appropriate species equation was solved to obtain an expected average yield at the average fishing intensity applied. Subsequently, each average obtained yield was expressed as a percentage of the expected average yield, resulting in a measure of the deviation of each obtained yield from the calculated regression equation. This procedure produced, for each population, a yield statistic corrected for the variation in fishing intensity among populations. Sea-run Atlantic salmon were not included in the calculations as the majority of their weight was accrued in the ocean and thus, their biomass is not a primary function of factors in the freshwater environment.

For comparisons of total salmonid biomass among the lakes, salmonid yield was calculated as a percentage of the sums of expected yields for the individual species. This procedure produced a standardized salmonid yield statistic for each lake.

The relationship of the standard salmonid yield statistic to the morphoedaphic index (Ryder et al. 1974) was examined by regression analysis (Dixon and Massey 1969). Within similar types of lakes, fish yield tends to be greater with greater values of this index of potential productivity and marked deviations from the trend are indicative of unusual conditions (Ryder et al. 1974).

Differences in the relative abundance of rainbow smelt were inferred directly from average annual yields as fishing intensity was similar in both lakes where smelt were captured.

Population differences in fish size were inferred from the differences among the lakes in the mean weights of all captured fish of each species which had not been damaged by eels and from the length distributions of fish subsampled for length measurements.

Comparisons of brook trout growth among populations were based upon the differences among the mean back-calculated lengths at various ages, the summary growth statistic (mean age at 200 mm), and the summary weight statistic (mean weight at 200 mm). Calculated lengths at ages and age at 200 mm from each population were based upon all individuals sampled for age and growth. The mean weight at 200 mm for each population was calculated by averaging the calculated weights at 200 mm of fish captured in the different years. This summary weight statistic was standardized for fish age in the following manner, since it tends to increase with fish age (Rounsefell and Everhart 1953) and there were substantial differences among the populations in the mean age of fish of 200 mm. Mean weight at 200 mm was regressed on mean age at 200 mm and the deviation of each mean weight from the regression line was calculated. This procedure produced a standardized measure, for each population, of weight at 200 mm corrected for variation in age at 200 mm among the populations.

Comparisons of the growth of Atlantic salmon, Arctic charr, and rainbow smelt among populations were based on the differences among the mean lengths of the age-groups at capture.

RESULTS

RELATIVE ABUNDANCE

Brook trout yield was a highly significant ($P<0.01$) correlate of fishing intensity with 47% of the variation in yield attributable to the varied fishing intensity (upper panel Fig. 43). The deviations of the average annual yields from the regression line were indicative of marked differences in the biomass of brook trout among the study lakes (lower panel Fig. 43). Trout yield as a percentage of expected trout yield ranged from 31% in Candlestick Pond to 189% in Sandy Pond (standard yield of Table 17).

The yield of non-sea-run Atlantic salmon was also a highly significant correlate ($P<0.01$) of fishing intensity, with intensity accounting for 57% of the variation in yield (upper panel Fig. 44). The deviations of average annual yields from the regression line indicated that salmon biomass was highest for the non-anadromous stock of Candlestick Pond (lower panel Fig. 44, Table 17). The lower standard yields were obtained from the two lakes having anadromous stocks whose individuals spend a lesser portion of their life in the lake environment.

Arctic charr yield was only weakly related to fishing intensity at below the level of statistical significance ($P>0.10$) (upper panel Fig. 45). The greatest deviation of individual yield values occurred with the data from Wigwam Pond. Data from that lake were indicative of overfishing (Part 1) and thus, comparatively high catches in relation to density probably inflated the calculated value of standard yield from that lake. A similar bias may have occurred with the calculation of standard charr yield from Candlestick Pond where there was indication of a reduction in stock size over the course of the study (Part 1). Calculated standard yields indicated that charr biomass was

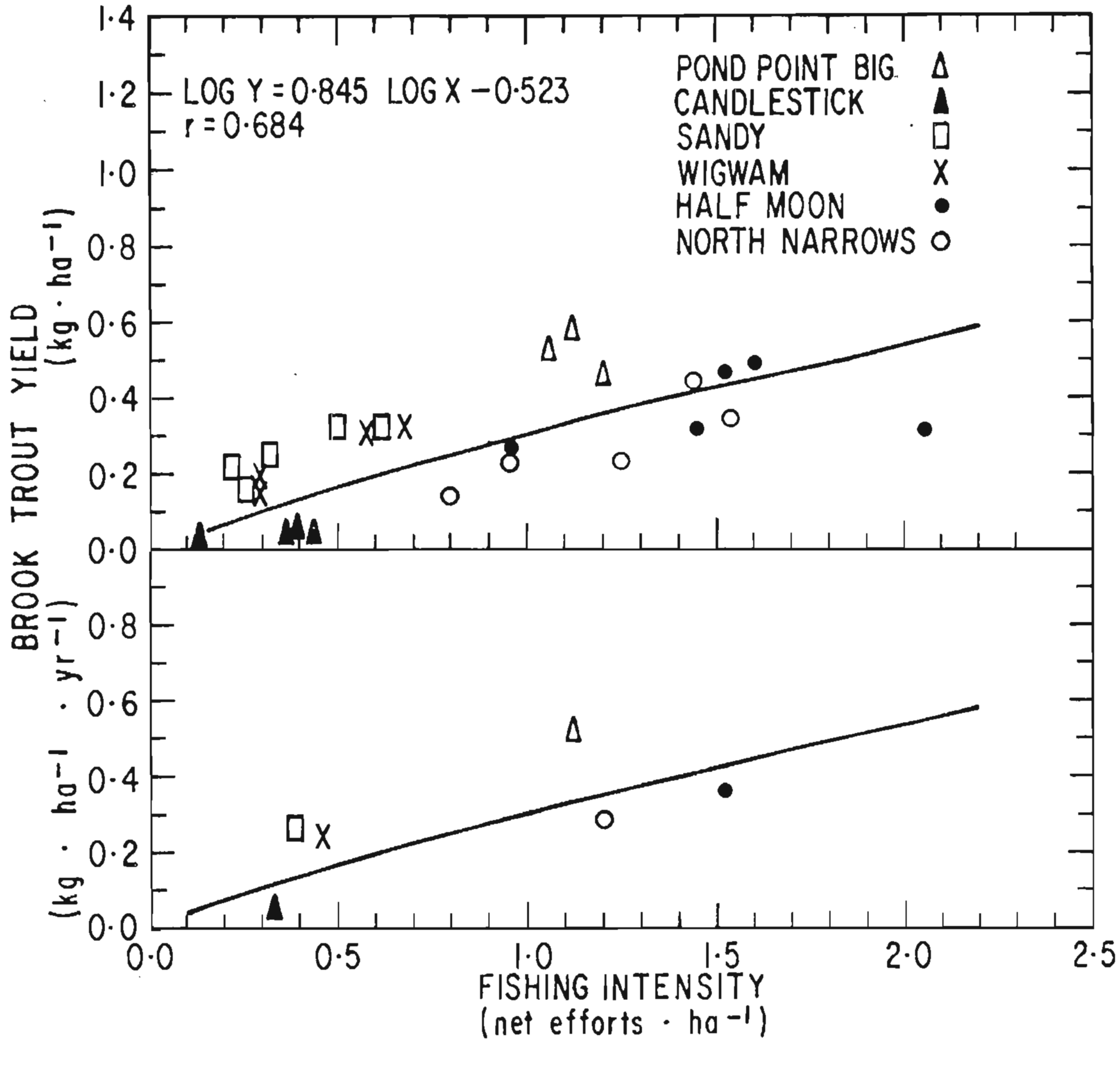

Fig. 43. Brook trout yield related to fishing intensity in the study lakes. Individual values of yield and intensity (upper panel) were used to calculate the regression line. Average values from each population are shown in relation to the regression line in the lower panel.

Table 17. Standardized average annual salmonid yields from the study lakes. Standard yield is average annual yield as a percentage of expected average annual yield at the average annual level of fishing intensity applied in each lake.

		Brook trout			Atlantic salmon[a]			Arctic charr			Σ All salmonids[a]		
Lake name	Average fishing intensity (units of effort·ha^{-1})	Average yield (kg·ha^{-1})	Expected average yield (kg·ha^{-1})	Standard yield (%)	Average yield (kg·ha^{-1})	Expected average yield (kg·ha^{-1})	Standard yield (%)	Average yield (kg·ha^{-1})	Expected average yield (kg·ha^{-1})	Standard yield (%)	Σ Average yield (kg·ha^{-1})	Σ Expected average yield (kg·ha^{-1})	Standard yield (%)
Pond Point Big Pond	1.12	0.5195	0.3305	157.2							0.5195	0.3305	157.2
Candlestick Pond	0.33	0.0366	0.1164	31.4	0.0242	0.0098	246.9	0.0099	0.0449	22.1	0.0706	0.1711	41.3
Sandy Pond	0.39	0.2539	0.1342	189.2							0.2539	0.1342	189.2
Wigwam Pond	0.46	0.2495	0.1545	161.5	0.0081	0.0140	57.9	0.1224	0.0557	219.8	0.3800	0.2242	169.5
Half Moon Pond	1.52	0.3732	0.4290	87.0	0.0566	0.0497	113.9	0.0714	0.0956	74.7	0.5013	0.5743	87.3
North Narrows Pond	1.20	0.2834	0.3506	80.8							0.2834	0.3506	80.8

[a]Does not include sea-run salmon.

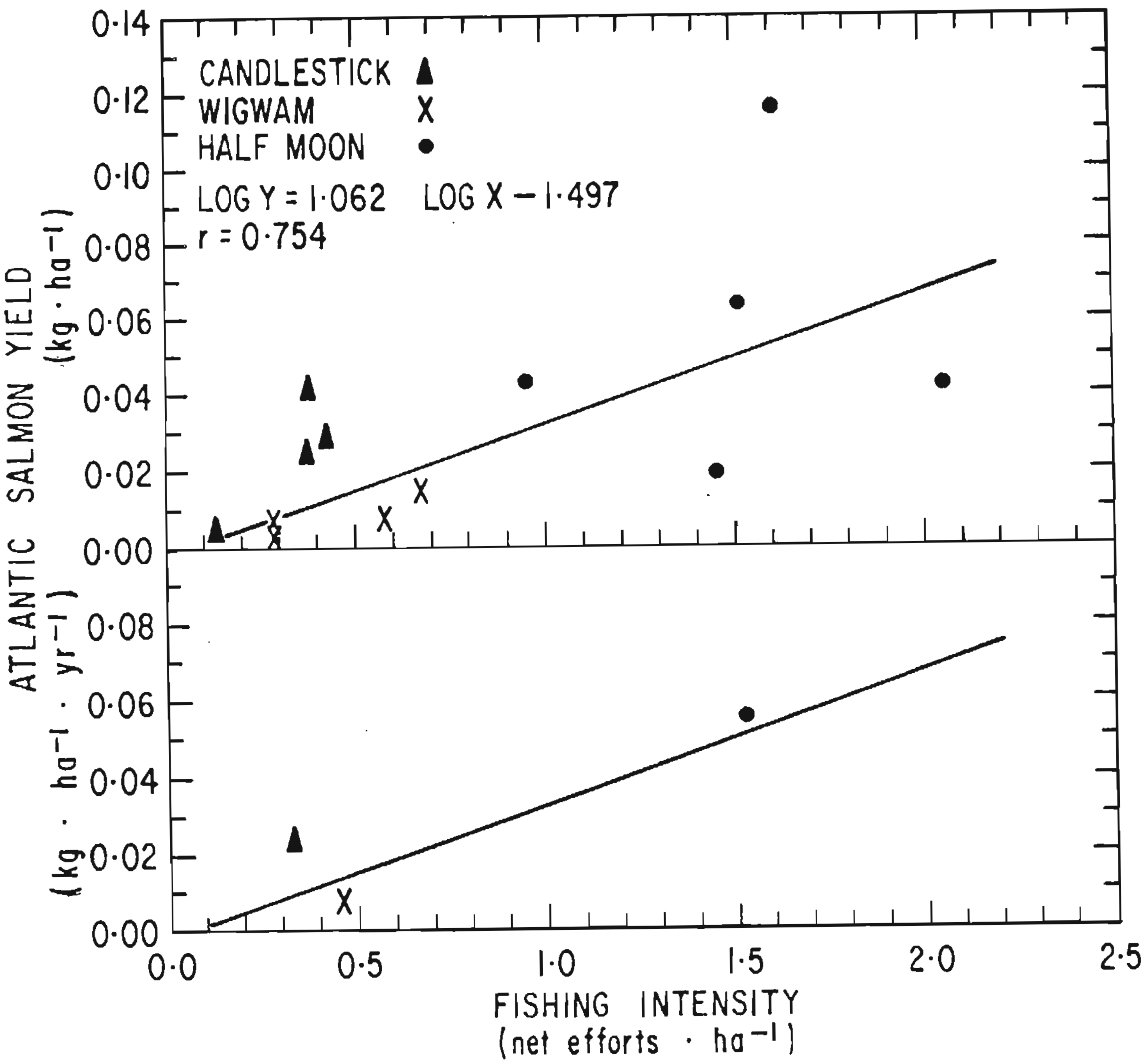

Fig. 44. Atlantic salmon yield related to fishing intensity in the study lakes. Only non-sea-run fish were included. Individual values of yield and intensity (upper panel) were used to calculate the regression line. Average values from each population are shown in relation to the regression line in the lower panel.

greatest in Wigwam Pond and least in Candlestick Pond (lower panel Fig. 45, Table 17).

The calculated standard yields of all salmonids were indicative of a large variation in salmonid biomass among the study lakes with standard yield ranging from 81% in North Narrows Pond to 189% in Sandy Pond (Table 17).

Standard salmonid yield was a significant ($P<0.05$) function of the index of potential lake productivity, but only if the two lakes containing rainbow smelt were excluded from the regression (Fig. 46). Standard yields from Sandy and Wigwam ponds were the highest obtained and were considerably higher than those from other lakes having similar morphoedaphic indices but no smelt. In the remaining four lakes, standard yields tended to increase with increasing values of the morphoedaphic index, but were higher than expected in the two lakes containing sea-run fish and lower than expected in the two lakes containing entirely non-anadromous populations. Thus, it appeared that the primary effectors of variation in total salmonid biomass among the study lakes were, in order of importance, the presence or absence of rainbow smelt as forage fish, inherent differences in lake productivity, and the use of ocean habitat by the fish populations.

Catches of rainbow smelt in Sandy and Wigwam ponds were small, likely as a result of their low susceptibility to capture by the mesh sizes employed (Hammar and Filipsson 1985). Overall, catch per unit effort was 0.41 fish or 9.7 g per unit effort in Sandy Pond as opposed to 0.08 fish or 0.7 g per unit effort in Wigwam Pond (Appendix 2). Average fishing intensity was similar in both lakes (0.39 net efforts·ha^{-1} in Sandy Pond vs 0.46 net efforts·ha^{-1} in Wigwam Pond). Thus, the catch data suggest that smelt are more abundant in Sandy Pond. Smelt in Wigwam Pond may have been part of an anadromous population as were the brook trout and Atlantic salmon. If so, most of the population, particularly the mature fish, would be expected to have left fresh waters prior to the time of experimental fishing in the study lakes (Scott and Crossman 1973).

FISH SIZE

Without exception, among the study lakes a greater mean weight of fish captured corresponded to a greater mean length of fish measured for each of the salmonid species (Table 18).

Larger brook trout size was associated with the presence of rainbow smelt as forage, the use of ocean habitat, and greater potential lake productivity (Fig. 47). Mean trout weight was greater than the average in those populations having sea-run individuals or smelt as forage. The greatest mean weight of trout occurred in Wigwam Pond where both smelt and anadromous trout were present. In the two lakes where smelt were absent and the trout were non-anadromous, trout size was less than the average for the six-lake set and the mean weight of trout was greater in the lake with the higher potential productivity. The length-frequency distributions of measured brook trout reflected the differences in mean weights among the populations. The modal or most frequently encountered length was greatest in Sandy Pond where smelt were present and the trout were not anadromous (Fig. 48).

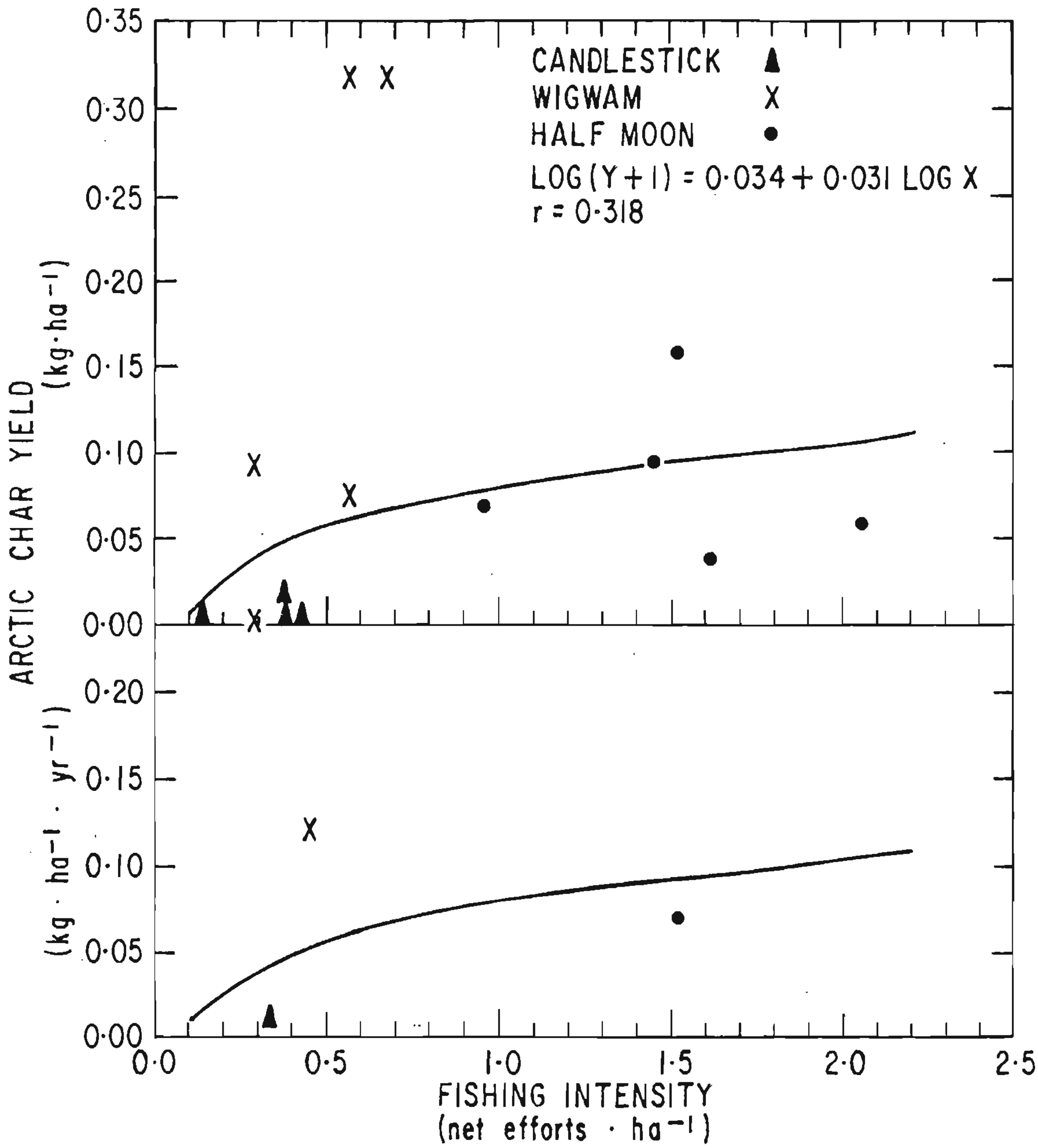

Fig. 45. Arctic charr yield related to fishing intensity in the study lakes. Individual values of yield and intensity (upper panel) were used to calculate the regression line. Average values from each population are shown in relation to the regression line in the lower panel.

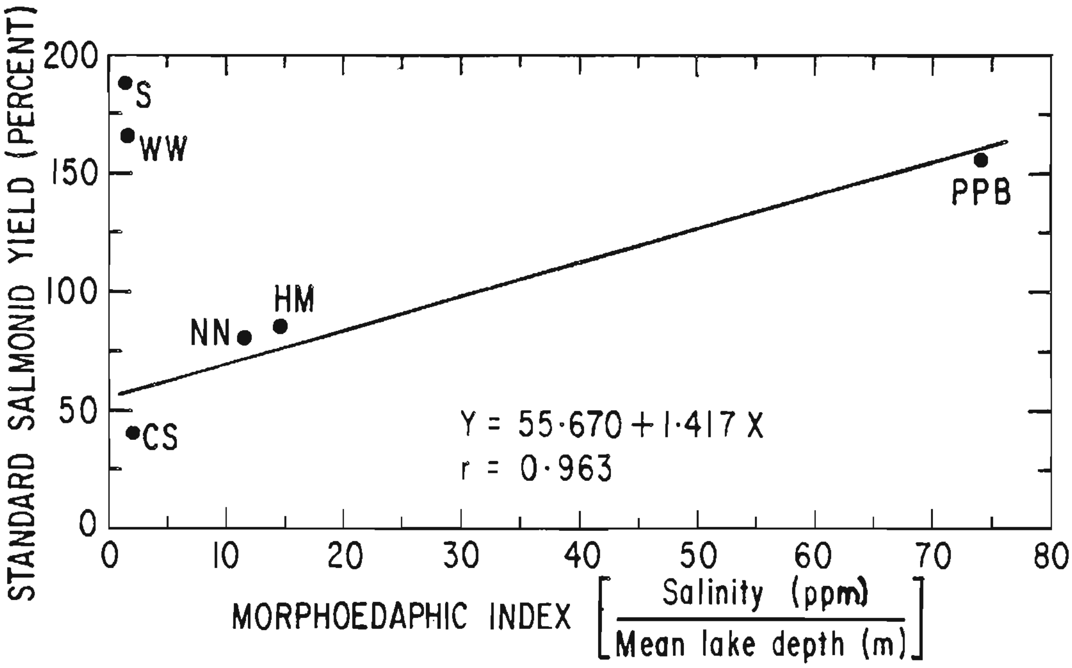

Fig. 46. Standard salmonid yield related to the morphoedaphic index for four of the study lakes. Lake names are indicated by initials (see text). Sandy and Wigwam ponds (upper left corner) were not included in the regression as they deviated markedly from the trend and differ from the other lakes by having smelt populations. Standard salmonid yield is yield ($kg \cdot ha^{-1} \cdot yr^{-1}$) corrected for variation in fishing intensity among the lakes and is a measure of relative salmonid biomass ($kg \cdot ha^{-1}$).

Table 18. Summarized size statistics of salmonids captured in the study lakes. Mean weights are based on all undamaged fish captured. Mean lengths are based on samples of the total catches. Bracketed ( ) numerals indicate numbers of fish used in calculations of means.

Lake name	Years of fishing	Brook trout Mean weight (g)	Brook trout Mean length (mm)	Atlantic salmon Mean weight (g)	Atlantic salmon Mean length (mm)	Arctic charr Mean weight (g)	Arctic charr Mean length (mm)
Pond Point Big Pond	1975-77	91.9 (149)	198.9 (94)				
Candlestick Pond	1975-78	63.3 (214)	163.4 (48)	86.8 (103)	195.6 (51)	17.6 (205)	119.5 (49)
Sandy Pond	1975-79	107.7 (1226)	211.3 (608)				
Wigwam Pond	1977-80	121.5 (609)	217.2 (555)	251.7 (84)[a]	237.2 (71)[b]	174.6 (210)	264.3 (200)
Half Moon Pond	1975-79	110.4 (497)	216.7 (328)	53.3 (238)[c]	158.5 (110)[d]	15.3 (768)	118.8 (698)
North Narrows Pond	1975-79	103.9 (733)	205.0 (539)				
Mean of means		99.8	202.1	130.6	197.1	69.2	167.5

[a]Includes 16 sea-run fish weighing 18,721 g. Mean weight of non-sea-run fish was 35.6 g.

[b]Includes 16 sea-run fish.

[c]Includes 2 sea-run fish weighing 3,378 g. Mean weight of non-sea-run fish was 39.5 g.

[d]Includes 2 sea-run fish.

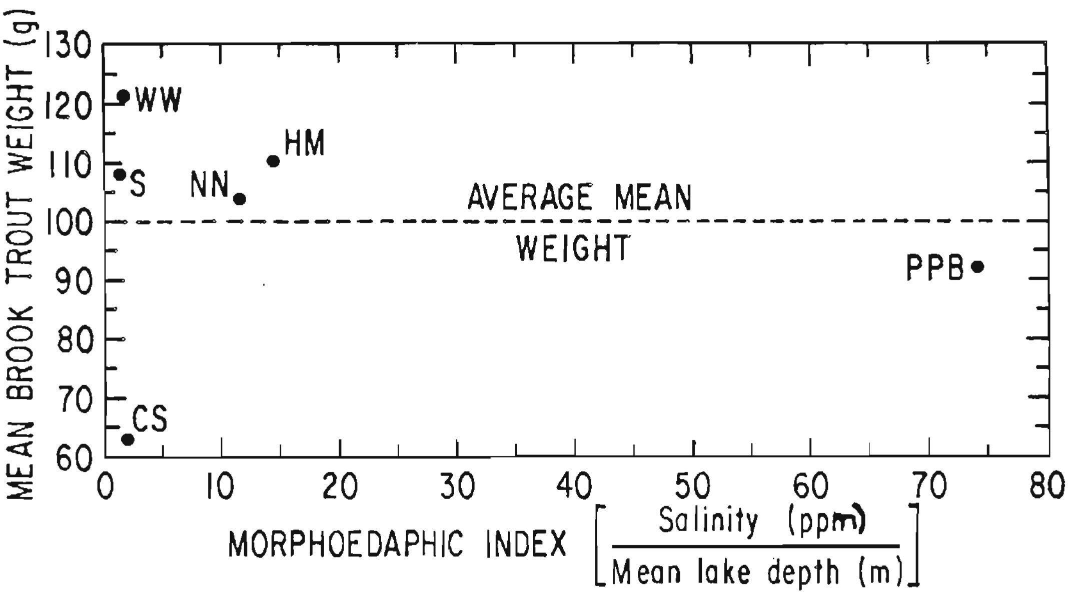

Fig. 47. Mean brook trout weight compared to the morphoedaphic index in the study lakes. Lake names are indicated by initials (see text). The average of the mean weights is indicated by the dashed horizontal line.

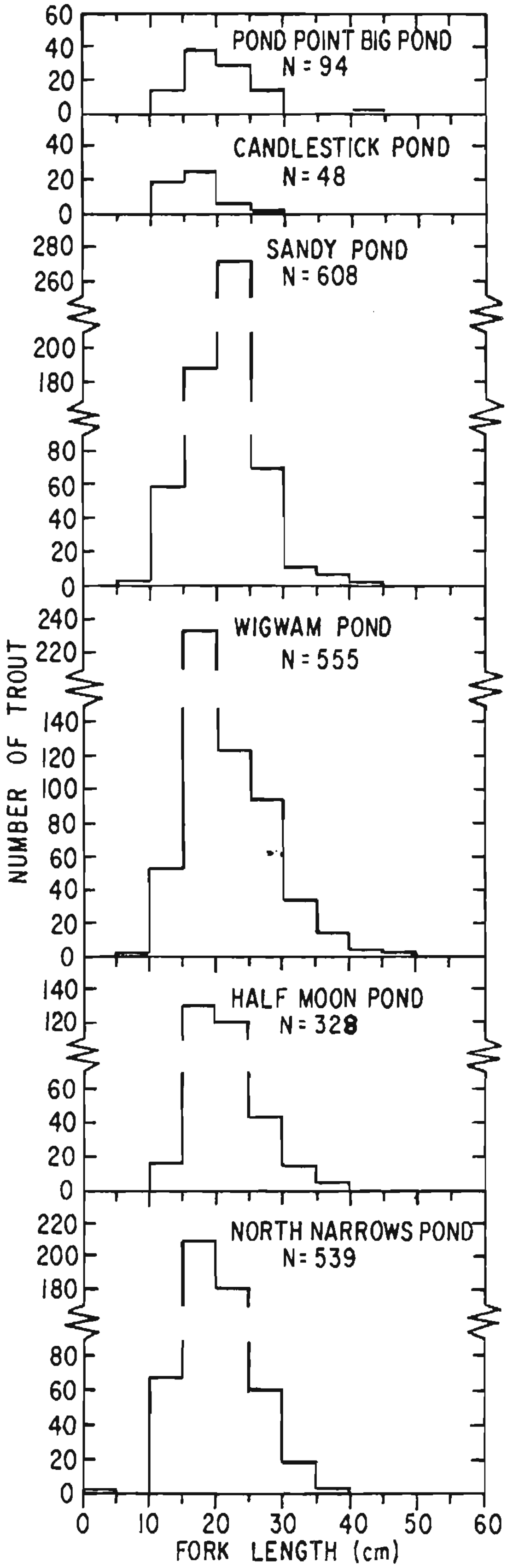

Fig. 48. Length-frequency distributions of measured brook trout from the study lakes. Note truncations on Y axis.

A large part of the variation in the average size of Atlantic salmon from the study lakes was due to the presence of varying numbers of sea-run fish (Table 18). Much of the variation in the average size of fish that had not gone to sea could be attributed to the anadromous or non-anadromous nature of the stocks. The mean weights of non-sea-run salmon in Wigwam and Half Moon ponds were similar and less than half the mean weight of fish from the non-anadromous Candlestick Pond population (Table 18). After attaining a size threshold in the spring, salmon from Wigwam and Half Moon ponds would tend to smoltify and go to sea while the landlocked fish of Candlestick Pond would remain and continue to grow in fresh water. In insular Newfoundland, the average length at smoltification is about 15-18 cm, corresponding to a mean weight of about 30-50 g (Chadwick 1981). The length-frequency distributions of salmon from the study lakes were consistent with this pattern (Fig. 49). Apart from sea-run fish (greater than 40 cm) only one fish with a length greater than 20 cm was recorded for Wigwam and Half Moon ponds while, in contrast, the modal length of fish from Candlestick Pond was greater than 20 cm.

Arctic charr from the study lakes exhibited a considerable variation in size with mean weight varying more than tenfold and mean length more than twofold (Table 18). Charr from Half Moon and Candlestick ponds had similar length distributions with few or no fish larger than 20 cm being encountered (Fig. 50). In marked contrast, charr from Wigwam Pond were distributed over a much wider range of lengths. Rombough et al. (1978) have described the characteristics of Candlestick Pond charr as typical of non-anadromous populations in oligotrophic waters. Thus, as appeared to be the case with the trout populations, the larger size of charr in Wigwam Pond may have been a result of the availability of smelt as forage fish in that lake. Scott and Crossman (1964) have stated that smelt, when present, would probably constitute a major food item of larger charr.

Rainbow smelt captured in Sandy and Wigwam ponds were suggestive of substantial between-lake differences in smelt size. The mean weight of 82 smelt captured in Sandy Pond was 24 g in contrast to 11 smelt with a mean weight of 9 g in Wigwam Pond (Appendix 1). In addition, the mean weight of smelt captured in each mesh size in Sandy Pond was equal to, or greater than, those captured in the corresponding mesh size in Wigwam Pond (Appendix 1). If the smelt in Wigwam Pond are part of an anadromous stock, as were the trout and salmon, the largest fish would likely have returned to the ocean prior to the time of sampling (Scott and Crossman 1973).

FISH GROWTH

Average rates of growth in length of brook trout from the study lakes were within the range previously reported from the province of Newfoundland (Fig. 51). Greatest lengths at ages 1 and 2 were associated with the populations having rainbow smelt as forage fish (Sandy and Wigwam ponds) or populations having sea-run individuals (Wigwam, Half Moon, and North Narrows pond) (Table 19). Generally, the summary growth statistic mean age at 200 mm reflected the relative rapidity of growth indicated by the lengths at given ages (Table 19, Fig. 51). However, likely as a result of the small sample size from Candlestick Pond, the summary statistic implied a slightly more

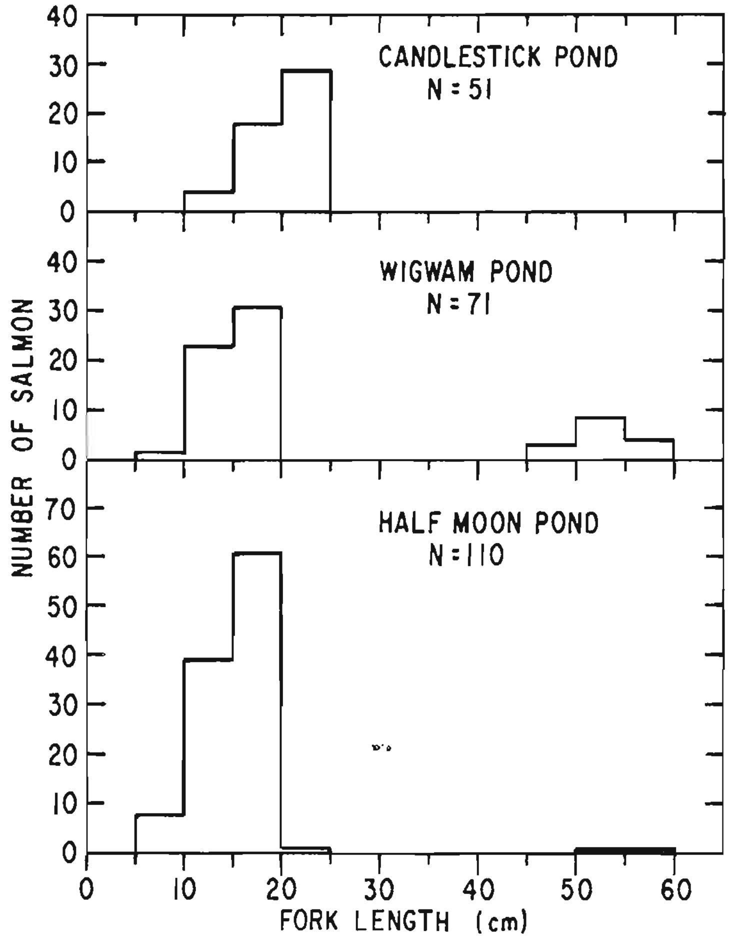

Fig. 49. Length-frequency distributions of measured Atlantic salmon from the study lakes.

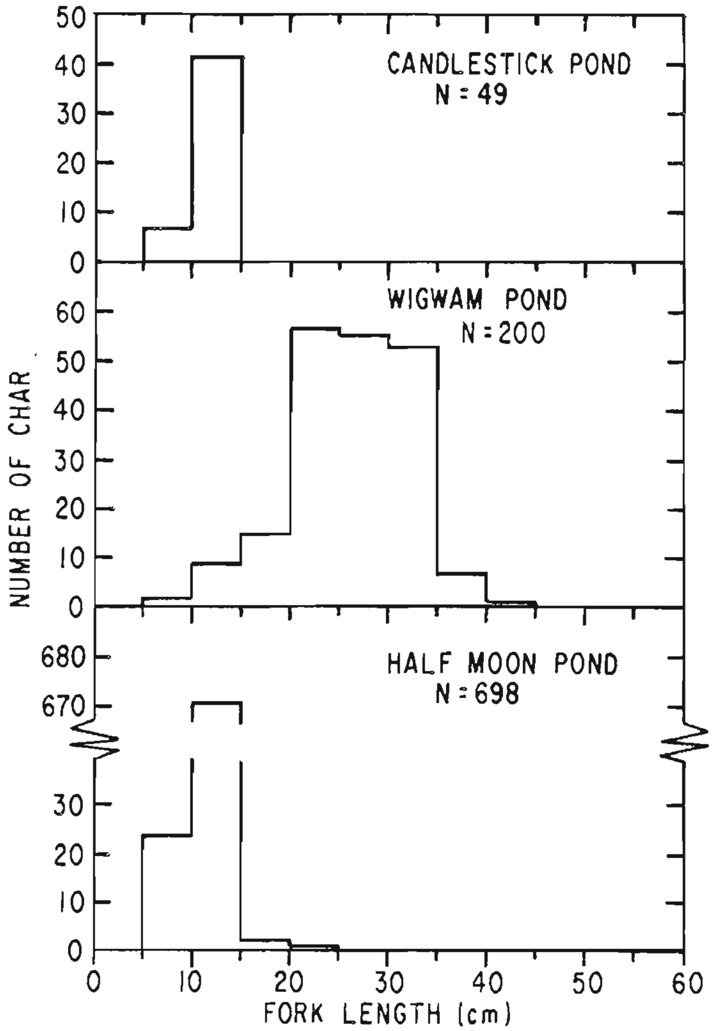

Fig. 50. Length-frequency distributions of measured Arctic charr from the study lakes. Note truncation on Y axis.

Table 19. Summarized growth statistics of brook trout from six lakes of Gros Morne National Park. Bracketed ( ) numerals indicate number of fish used in calculation of means. See Appendix 3 for a numerical summary of the data employed for comparisons of growth in length and body-scale relationships used for back-calculating lengths at ages. Further separation of the data by year-class and year of capture is contained in Appendix 4.

Lake name	Years of capture	Mean calculated fork length (mm) at age 1	2	3	4	5	Mean age (yr) at 200 mm	Mean weight (g) at 200 mm	Standard weight (g) at 200 mm
Pond Point Big Pond	1975-77	75 (69)	131 (60)	181 (29)	226 (13)	375 (1)	3.4	93.4	+1.4
Candlestick Pond	1975-76	85 (49)	140 (31)	194 (1)	249 (1)		3.1	87.4	-0.8
Sandy Pond	1976-79	96 (190)	172 (145)	245 (40)	317 (9)	353 (2)	2.4	80.4	+1.0
Wigwam Pond	1977-80	92 (219)	156 (203)	227 (70)	278 (17)	358 (2)	2.6	83.2	+1.3
Half Moon Pond	1975-79	87 (112)	152 (106)	210 (43)	265 (5)	347 (1)	2.8	81.5	-2.9
North Narrows Pond	1975-79	87 (209)	145 (180)	190 (95)	231 (32)	266 (2)	3.3	90.8	+0.1
Mean of means		87	149	208	261	340	2.9	86.1	

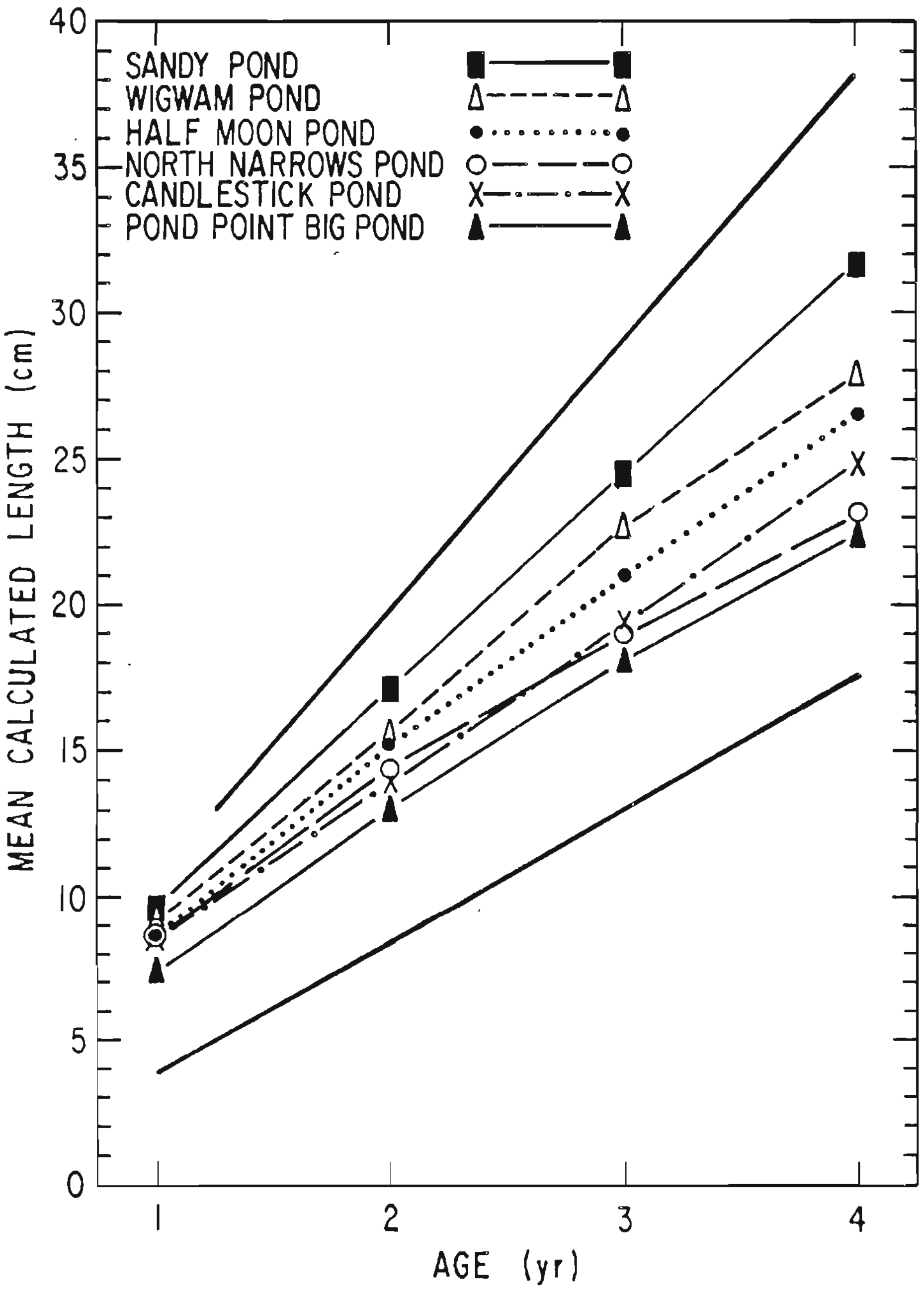

Fig. 51. Age-length relationships of brook trout in six lakes of Gros Morne National Park. Solid lines without symbols approximate the greatest (Flick 1977) and least (Whelan and Wiseman 1977) mean lengths at age reported for the province of Newfoundland. See Appendix 3 for a numerical summary of the data employed for comparisons of growth in length and body-scale relationships used for back-calculating lengths at ages. Further separation of the data by year-class and year of capture is contained in Appendix 4.

rapid growth of fish in that population than in the anadromous population of North Narrows Pond.

Mean weight of brook trout at 200 mm was a strong ($P<0.01$) positive correlate of mean age at 200 mm (Fig. 52), consistent with the usual trend of increased robustness with increased age (Rounsefell and Everhart 1953). Deviations of the mean weights from the regression line of Figure 52 provided a standard weight statistic for each population (Table 19). Standard weight was not a significant function ($P>0.10$) of the summary statistic for growth in length but, if the two lakes containing rainbow smelt were not included in the regression, the measure of growth in length was positively related to the measure of growth in weight ($P<0.05$) (Fig. 53). This suggested that, in four of the study lakes, body growth was a reciprocal function of growth in length and growth in weight. However, the two lakes containing rainbow smelt as forage fish had brook trout with comparatively rapid growth in both length and weight (Fig. 53).

Average freshwater rates of growth in length of Atlantic salmon from the study lakes were within the range previously reported for the species in Newfoundland (Fig. 54). Lengths of fish in the youngest age-group were similar in the sea-run populations of Wigwam and Half Moon ponds and least in the non-anadromous population of Candlestick Pond (Fig. 54, Table 20). The slow growth of Candlestick Pond salmon has been attributed to the limited resources of a very oligotrophic system, a comparatively short summer, and rigorous winter (Barbour et al. 1979). Longer growing seasons are likely for the lower elevation populations of Wigwam and Half Moon ponds.

The majority of sea-run salmon aged from Wigwam Pond (age-groups 4+ and 5+) migrated to sea in their fourth year of life (Table 20), consistent with the truncated length distribution of fish in the smaller of the two size groups from that lake (Fig. 49). A yearly seaward migration of a segment of the stock in Wigwam and Half Moon ponds would also provide better opportunities for the growth of remaining individuals.

Lengths of the age-groups of Arctic charr tended to rank in the same order as those of brook trout and Atlantic salmon from the study lakes (Table 21). Lengths at age were greater in Wigwam Pond and less in Candlestick Pond than reported for other areas in the province of Newfoundland (Fig. 55). The apparent rapid growth of charr in Wigwam Pond may have been, as suggested by the brook trout data, a function of the availability of smelt as forage fish. In addition, lengths at given ages may have been artificially inflated as a result of the use of scales for age assessment. A number of investigators have reported that scales were not the most satisfactory tissues for aging Arctic charr (Johnson 1980) and the use of scales has lead to underestimates of age for other species in the genus Salvelinus (Beamish and McFarlane 1987). The slow growth of charr in Candlestick Pond has been suggested to be a result of low lake pH, low lake productivity, and competition for scarce food with other salmonids (Rombough et al. 1978). The slightly more rapid growth of charr in Half Moon Pond was associated with a higher potential lake productivity, as indicated by the morphoedaphic index (Fig. 47).

Rainbow smelt growth rates were within the range previously reported from the province of Newfoundland (Fig. 56). Comparative data were very few

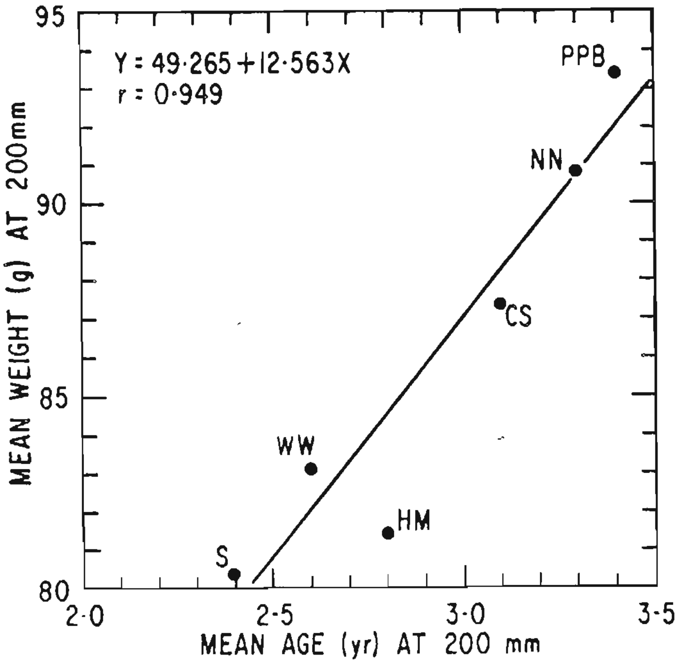

Fig. 52. Relationship of the mean weight of 200 mm brook trout to their mean age in the study lakes. Lake names are indicated by initials (see text).

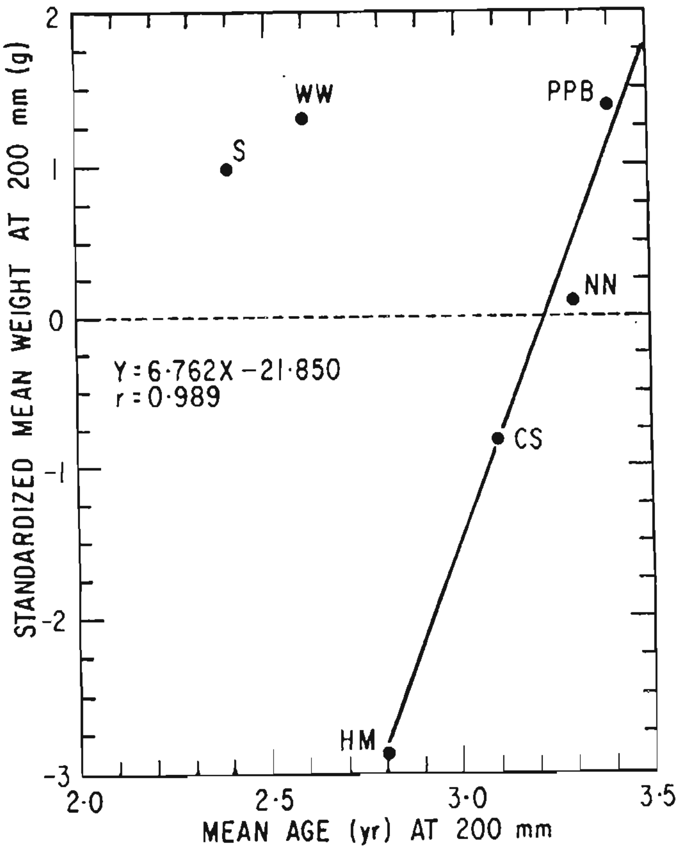

Fig. 53. Comparison of the standard weight of brook trout to the summary statistic for growth in length in the study lakes. Lake names are indicated by initials (see text). Wigwam and Sandy ponds were not included in the regression. Standard weight is the weight of 200 mm fish corrected for variation in age.

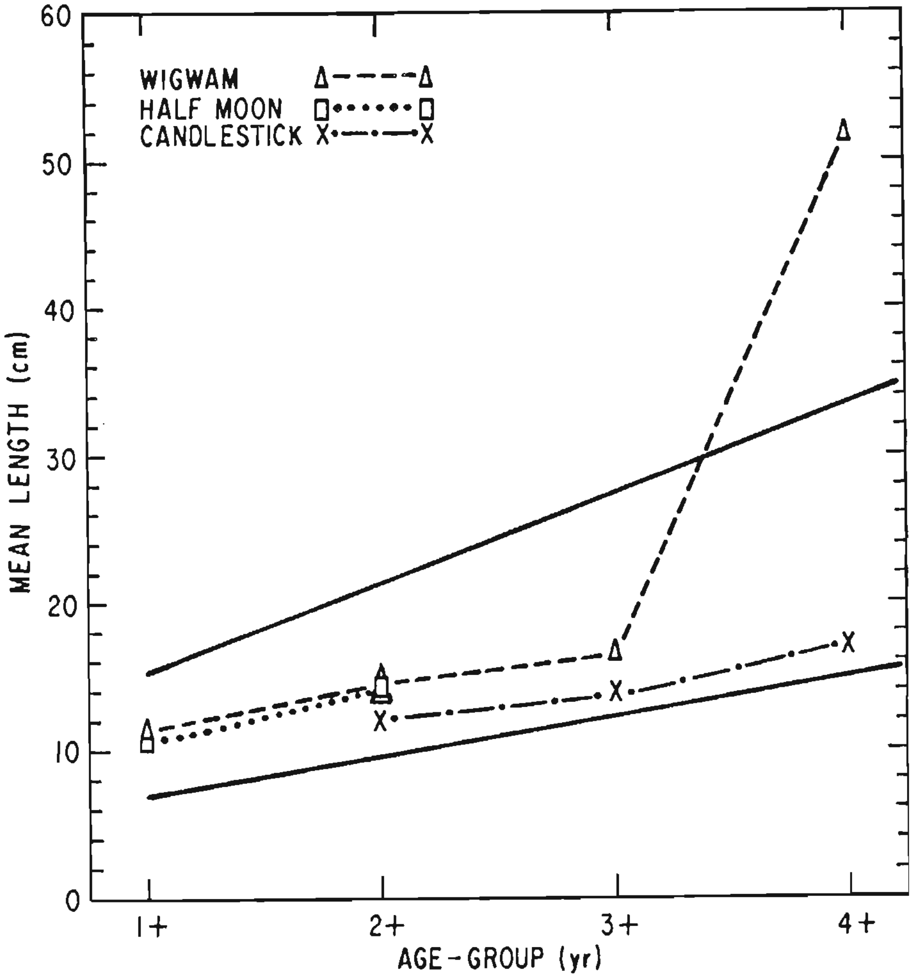

Fig. 54. Age-length relationships of Atlantic salmon in three lakes of Gros Morne National Park. Solid lines without symbols approximate previously reported minimum (Bruce 1976) and maximum (Ryan 1980) rates of growth for freshwater forms of the species in the province of Newfoundland. See Appendix 3 for a numerical summary of the data employed for comparisons of growth in length and body-scale relationships. Further separation of the data by year-class and year of capture is contained in Appendix 5.

Table 20. Summarized growth statistics of Atlantic salmon from three lakes of Gros Morne National Park. Bracketed ( ) numerals beneath mean lengths indicate number of fish used in calculation of means. Bracketed figures beside lengths indicate freshwater and marine ages, respectively, of sea-run salmon. Further separation of the data by year-class and year of capture is contained in Appendix 5.

		Mean fork length (mm) in age-group				
Lake name	Dates of capture	1	2	3	4	5
Candlestick Pond	Aug. 1976[a]		122 (3)	139 (1)	173 (6)	205 (15)
Wigwam Pond	Sept. 1977, 1979-80	114 (4)	144 (19)	165 (1)	519 (3:1) (8)	535 (4:1) (1)
Half Moon Pond	Sept. 1977-78	108 (8)	144 (13)			

[a]From Barbour et al. (1979).

Table 21. Summarized growth statistics of Arctic charr from three lakes of Gros Morne National Park. Bracketed ( ) numerals indicate number of fish used in calculation of means. Further separation of data by year-class and year of capture is contained in Appendix 6.

		Mean fork length (mm) in age-group						
Lake name	Dates of capture	1	2	3	4	5	6	7
Candlestick Pond[a]	Aug. 1976, June 1977	86 (6)	102 (1)	117 (33)	123 (26)	137 (5)	–	164 (1)
Wigwam Pond[b]	Sept.-Oct. 1977-79	116 (6)	204 (12)	259 (30)	301 (8)	387 (1)		
Half Moon Pond[b]	Sept.-Oct. 1975-79	118 (36)	120 (25)	160 (6)	192 (1)	158 (1)		

[a]From fin-ray and otolith age data of Rombough et al. (1978).

[b]From scale age data of present study.

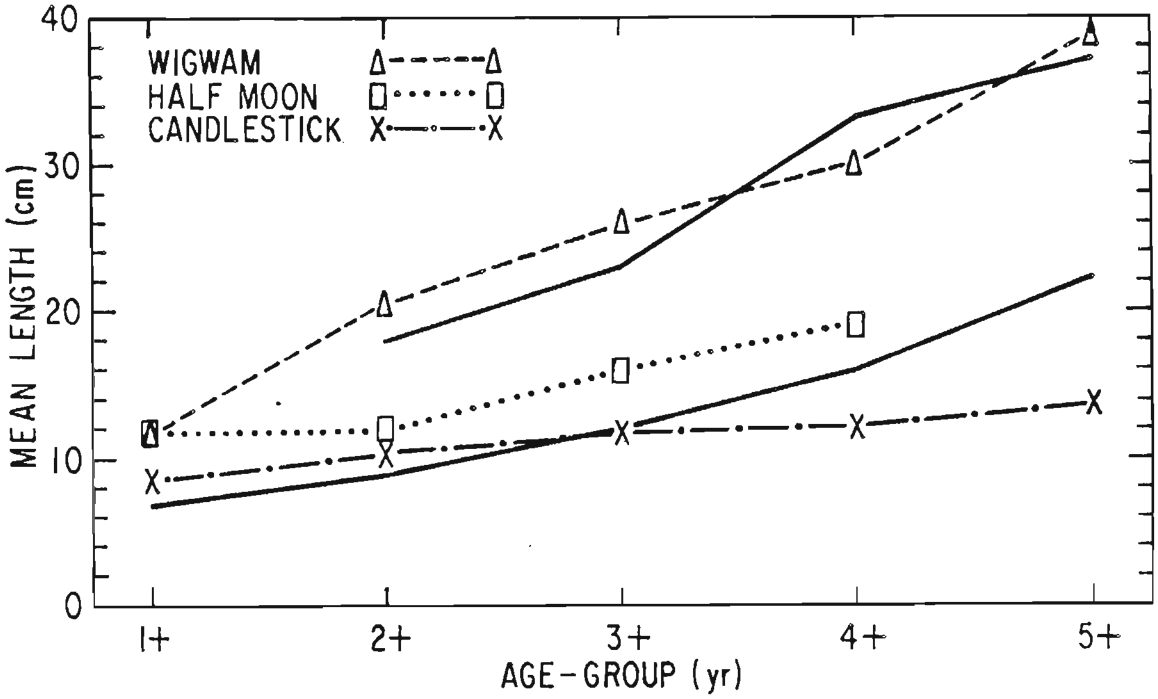

Fig. 55. Age-length relationships of Arctic charr in three lakes of Gros Morne National Park. Ages of fish from Candlestick Pond are from otolith and fin-ray age data of Rombough et al. (1978). Those from Wigwam and Half Moon ponds are from scale age data of the present study. Solid lines without symbols approximate minimum (Dempson and Green 1985) and maximum (Peet 1971) rates of growth reported for other areas in the province of Newfoundland. Both stocks are anadromous. See Appendix 3 for a numerical summary of the data employed for comparisons of growth in length and body-scale relationships. Further separation of the data by year-class and year of capture is contained in Appendix 6.

(Table 22) but suggestive of a more rapid rate of growth in Sandy Pond than in Wigwam Pond, as was the case with the salmonid fishes.

DISCUSSION

Three factors appear to be major determinants of variation in salmonid population characteristics among the study lakes. These factors are the presence or absence of rainbow smelt as forage fish, inherent differences in lake productivity, and the use of ocean habitat by the fish of anadromous populations.

The comparatively high relative biomass and the comparatively large sizes and rapid growth rates of salmonids in the two study lakes containing rainbow smelt are consistent with observations from other populations. Faster growth rates and the attainment of larger sizes are well-documented effects of the availability of smelt as food for salmonid fishes in Newfoundland and elsewhere (Scott and Crossman 1964; Wiseman 1969; Havey and Warner 1970). These effects have led to introductions of smelt in order to improve the quality of angling (Scott and Crossman 1964; Havey and Warner 1970). There have been no post-introduction studies published on the effects of smelt transplants in Newfoundland. In the United States, introductions have been considered beneficial to the sport fishery for landlocked salmon (Havey and Warner 1970). However, smelt are carnivorous fish and, as a result of competition or predation, may be harmful to native fish populations (Scott and Crossman 1973).

Differences in potential lake productivity, indicated by differences in morphoedaphic indices (Ryder et al. 1974), also likely effected variation in salmonid population characteristics through differences in the availability of food. The positive relationship between fish yield and the morphoedaphic index (Ryder et al. 1974) within lake sets of otherwise similar physical-chemical characteristics is thought to be due to a greater transfer of solar energy through the aquatic system to the fish in lakes having greater values of the morphoedaphic index (Ryder 1982). In addition, the use of macrozoobenthos biomass as the numerator in the morphoedaphic index has proven to be a strong predictor of fish yield and biomass (Hansen and Leggett 1982). Benthic macroinvertebrates are a principal food source of all of the salmonids of the present study, particularly when forage fish are absent (Scott and Crossman 1973). Thus, it is likely that the positive relationship between standard salmonid yield and the morphoedaphic index among the four study lakes lacking smelt is a direct result of a greater supply of invertebrate food items in the lakes with greater morphoedaphic indices.

The use of ocean habitat is a well-known effector of the increased growth rates of anadromous salmonids as a result of a greater availability of food in the marine environment (Scott and Crossman 1964), although anadromy does not always lead to growth rate increases (Power 1980). Of the four study lakes not containing rainbow smelt, the average size of brook trout was greater and, where sample sizes were representative, lengths at ages were greater in the anadromous populations. Thus, it appears that higher than expected standard salmonid yields (when compared to yields predicted from the morphoedaphic

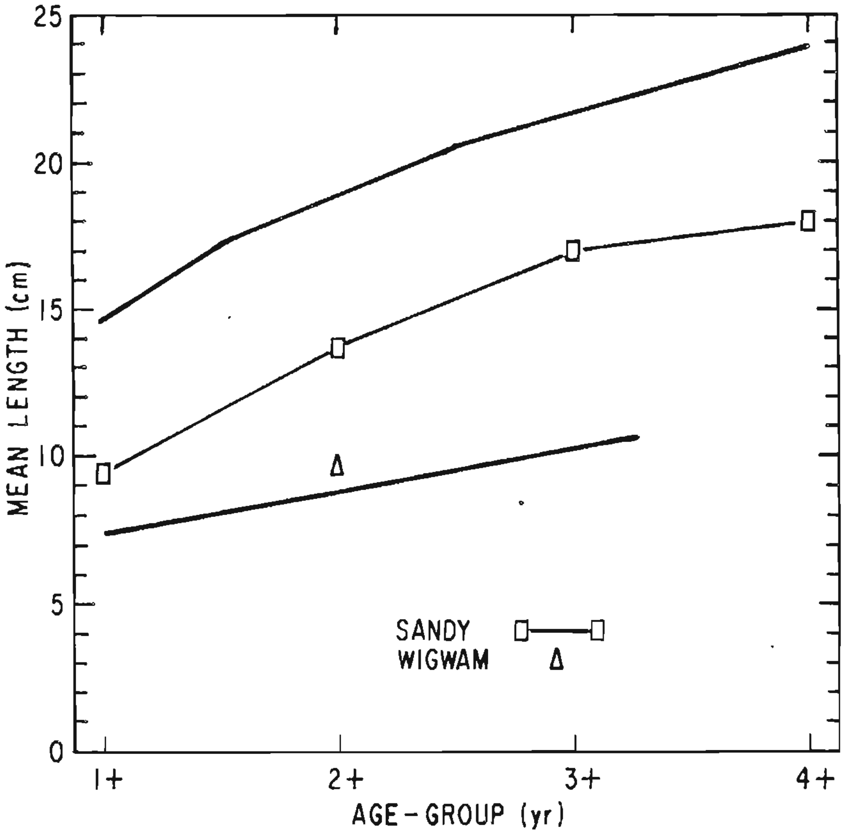

Fig. 56. Age-length relationships of rainbow smelt in two lakes of Gros Morne National Park. Solid lines without symbols approximate minimum (Bruce 1975) and maximum (Nhwani 1973) rates of growth reported for other areas in the province of Newfoundland. See Appendix 3 for a numerical summary of the data employed for comparisons of growth in length and body-scale relationships. Further separation of the data by year-class and year of capture is contained in Appendix 7.

Table 22. Summarized growth statistics of rainbow smelt from two lakes of Gros Morne National Park. Bracketed ( ) numerals indicate number of fish used in calculation of means. Further separation of data by year-class and year of capture is contained in Appendix 7.

		Mean fork length (mm) in age-group			
Lake name	Dates of capture	1	2	3	4
Sandy Pond	Aug.-Sept. 1976-79	95 (1)	137 (15)	170 (25)	180 (2)
Wigwam Pond	Sept. 1977		98 (2)		

indices) in those lakes resulted from the increased food supply available to the brook trout that had gone to sea.

Differences among the study lakes in salmonid species composition, prey species composition, potential lake productivity, and the varying proportion of anadromous fishes preludes the precise quantitative modeling of cause-effect relationships in the six-lake data set. Additionally, American eels, known to be present in four of the study lakes, are potential competitors with, and predators of salmonid fishes (Scott and Crossman 1973). Their seaward migration as adults (Scott and Crossman 1973) represents a further complication in the modeling of ecosystem dynamics in the lakes of Gros Morne Park. However, as information on the fish populations in other lakes of Gros Morne Park is obtained, lakes could be grouped according to various characteristics. Subsequently, more precise assessments of the factors affecting fish production in the park could be made. The results of the present study will likely assist in such assessments.

ACKNOWLEDGMENTS

G. Janes and G. MacLean, Gros Morne Park Resources Officers, obtained fish data from five of the study lakes. S. Barbour and P. Rombough of the Canadian Wildlife Service provided fish data from one of the study lakes. J. Wright of the Canadian Wildlife Service assisted with computer programming for the analysis of age and growth data. L. Ryan interpreted the scales of many of the fish under a contract from the Canadian Wildlife Service. L. J. Cole of the Department of Fisheries and Oceans sorted and tabulated most of the catch data in preparation for analysis. A. Chaytor and R. Tucker of the Department of Fisheries and Oceans assisted with computer data entry and data processing. G. Marshall and D. Stansbury of the Department of Fisheries and Oceans provided advice and assistance for statistical analyses. B. Johnson and W. Speller of the Canadian Wildlife Service and B. Wiseman of the Department of Fisheries and Oceans provided effective administrative support during early phases of the study. H. Mullett drafted the figures. K. Harding of the Department of Fisheries and Oceans typed and arranged the format of the report. R. J. Gibson and M. F. O'Connell of the Department of Fisheries and Oceans constructively reviewed the manuscript.

REFERENCES

Anderson, T. C. 1985. The rivers of Labrador. Can. Spec. Publ. Fish. Aquat. Sci. 81: 389 p.

Ash, E.G.M., and M. F. O'Connell. 1986. Atlantic salmon fishery in Newfoundland and Labrador, commercial and recreational, 1983. Can. Data Rep. Fish. Aquat. Sci. 608: v + 304 p.

Barbour, S. E., P. J. Rombough, and J. J. Kerekes. 1979. A life history and ecologic study of an isolated population of dwarf ouananiche, Salmo salar, from Gros Morne National Park, Newfoundland. Nat. Can. 106: 305-311.

Beamish, R. J., and G. A. McFarlane. 1987. Current trends in age determination methodology, p. 15-42. In R. C. Summerfelt and G. E. Hall [ed.] The age and growth of fish. Iowa State Univ. Press, Iowa. 544 p.

Belding, D. L. 1938. The salmon of the Moisie River. Trans. Am. Fish. Soc. 67: 195-206.

Bruce, W. J. 1975. Some aspects of the biology of landlocked smelt, Osmerus eperlanus mordax (Mitchill) 1815, in selected Avalon Peninsula lakes. Resource Development Branch, St. John's, Nfld., Technical Rep. Series No. NEW/T-75-2: 107 p.

1976. Age, growth, maturity and food habits of landlocked salmon (Salmo salar) in Soldiers Pond, a Newfoundland lake. Fish. Mar. Serv. Res. Dev. Tech. Rep. 668: 16 p.

Carlander, K. D. 1955. The standing crop of fish in lakes. J. Fish. Res. Board Can. 12: 543-570.

1969. Handbook of freshwater fishery biology. Vol. 1. Life history data on freshwater fishes of the United States and Canada, exclusive of the Perciformes. Iowa State Univ. Press, Iowa. 752 p.

Chadwick, E.M.P. 1981. Biological characteristics of Atlantic salmon smolts in Western Arm Brook, Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. 1024: iv + 45 p.

1985. Fundamental research problems in the management of Atlantic salmon, Salmo salar L., in Atlantic Canada. J. Fish Biol. 27: 1-17.

Chadwick, E.M.P., and J. M. Green. 1985. Atlantic salmon (Salmo salar L.) production in a largely lacustrine Newfoundland watershed. Verh. Int. Ver. Limnol. 22: 2509-2515.

Craig, J. F. 1980. Sampling with traps, p. 55-70. In T. Backiel and R. L. Welcomme [ed.] Guidelines for sampling fish in inland waters. EIFAC Tech. Pap. 33: 176 p.

Dadswell, M. J. 1970. A physical and biological survey of the aquatic environment (freshwater) of the proposed Gros Morne National Park, Newfoundland. Can. Wildl. Serv. MS Rep. 76 p.

Dempson, J. B. 1984. Identification of anadromous Arctic charr stocks in coastal areas of northern Labrador, p. 143-162. In L.Johnson and B.L.Burns [ed.] Biology of the Arctic charr, Proceedings of the International Symposium on Arctic Charr, Winnipeg, Manitoba, May 1981. Univ. Manitoba Press, Winnipeg. 584 p.

Dempson, J. B., and J. M. Green. 1985. Life history of anadromous Arctic charr, Salvelinus alpinus, in the Fraser River, northern Labrador. Can. J. Zool. 63: 315-324.

Dixon, W. J., and F. J. Massey Jr. 1969. Introduction to statistical analysis. 3rd ed. McGraw-Hill Publications, New York, NY. 638 p.

Eales, J. G. 1968. The eel fisheries of eastern Canada. Fish. Res. Board Can. Bull. 166: 79 p.

Flick, W. A. 1977. Some observations, age, growth, food habits and vulnerability of large brook trout (Salvelinus fontinalis) from four Canadian lakes. Nat. Can. 104: 353-359.

Gibson, R. J., and T. A. Dickson. 1984. The effects of competition on the growth of juvenile Atlantic salmon. Nat. Can. 111: 175-191.

Hammar, J., and O. Filipsson. 1985. Ecological testfishing with the Lundgren gillnets of multiple mesh size: the Drottningholm technique modified for Newfoundland Arctic char populations. Rep. Inst. Freshw. Res., Drottningholm 62: 12-35.

Hansen, J. M., and W. C. Leggett. 1982. Empirical prediction of fish biomass and yield. Can. J. Fish. Aquat. Sci. 39: 257-263.

Harvey, H. H. 1982. Population responses of fishes in acidified waters, p. 227-242. In T. A. Haines and R. E. Johnson [ed.] Acid rain/fisheries. Proc. Int. Symp. Acid precipitation and fishery impacts in North America. Northeastern Division Am. Fish. Soc. 357 p.

Havey, K. A., and K. Warner. 1970. The landlocked salmon (Salmo salar). Its life history and management in Maine. Sport Fish. Inst. Washington, and Maine Rep. Inland. Fish. Game. 129 p.

Hunt, R. L. 1974. Annual production by brook trout in Lawrence Creek during eleven successive years. Dept. Nat. Res. Wisconsin. Tech. Bull. 82: 29 p.

Hutchings, J. A. 1986. Lakeward migrations by juvenile Atlantic salmon, Salmo salar. Can. J. Fish. Aquat. Sci. 43: 732-741.

Jamieson, A. 1974. A water quality atlas for streams and lakes of insular Newfoundland. Resource Development Branch, St. John's, Nfld., Data Record Series No. NEW/D-74-4: 22 p.

Johnson, L. 1980. The arctic charr, Salvelinus alpinus, p. 15-98. In E. K. Balon [ed.] Charrs: Salmonid fishes of the genus Salvelinus. Dr. W. Junk bv Publishers, The Hague, Netherlands. 928 p.

Kerekes, J. J. 1973. The influence of water renewal on the nutrient supply in small, oligotrophic (Newfoundland) and highly eutrophic (Alberta) lakes, p. 383-400. In E. R. Reinelt et al. [ed.] Proceedings of the Symposium Lakes West. Can., November 1972, Univ. Alberta, Edmonton, Alberta.

1974. Limnological conditions in five small oligotrophic lakes in Terra Nova National Park, Newfoundland. J. Fish. Res. Board Can. 31: 555-583.

1975. Phosphorus supply in undisturbed lakes in Kejimkujik National Park, Nova Scotia, Canada. Verh. Int. Ver. Limnol. 19: 349-357.

1977. Factors relating to annual planktonic primary production in five small oligotrophic lakes in Terra Nova National Park, Newfoundland. Int. Rev. Gesamten Hydrobiol. 62: 345-370.

1978. Limnological conditions. Aquatic resources inventory, Gros Morne National Park, Part 5. Can. Wildl. Serv. MS Rep. 155 p.

1983. Predicting trophic response to phosphorus addition in a Cape Breton Island lake. Proc. N.S. Inst. Sci. 33: 7-18.

Kerekes, J. J., and P. Schwinghamer. 1975a. Drainage basin and lake catalogue. Aquatic resources inventory, Gros Morne National Park, Part 1. Can. Wildl. Serv. MS Rep. 79 p.

1975b. Lake drainage and morphometry. Aquatic resources inventory, Gros Morne National Park, Part 2. Can. Wildl. Serv. MS Rep. 81 p.

1975c. Hydrographic maps, area and volume curves. Aquatic resources inventory, Gros Morne National Park, Part 3. Can. Wildl. Serv. MS Rep. 101 p.

1975d. Selected limnological measurements in 43 lakes and 72 streams. Aquatic resources inventory, Gros Morne National Park, Part 4. Can. Wildl. Serv. MS Rep. 44 p.

Langeland, A. 1986. Heavy exploitation of a dense resident population of Arctic charr in a mountain lake in central Norway. N. Am. J. Fish. Manage. 6: 519-525.

Moores, R. B., and E.G.M. Ash. 1984. Angled catch and effort data for Atlantic salmon in Newfoundland and Labrador, and for other fishes in Labrador, 1981. Can. Data Rep. Fish. Aquat. Sci. 451: xv + 88 p.

Nhwani, L. B. 1973. Growth, mortality, population structure and spawning biology of stocks of the Atlantic smelt *Osmerus mordax* (Mitchill) in Newfoundland. M.Sc. thesis, Memorial Univ. Newfoundland, St. John's, Nfld. 140 p.

Nickerson, S., P. M. Ryan, G. Somerton, and J. Wright. 1980. A computer program for processing fish age and growth data. Can. Tech. Rep. Fish. Aquat. Sci. 964: iv + 20 p.

O'Connell, M. F., J. B. Dempson, D. G. Reddin, and E.G.M. Ash. 1983. Status of Atlantic salmon stocks in Newfoundland and Labrador, 1983. CAFSAC Res. Doc. 83/80. 67 p.

Panayotou, T. 1982. Management concepts for small-scale fisheries: economic and social aspects. FAO Fish. Tech. Pap. 228: 53 p.

Peet, R. F. 1971. A report on the counting trap and reconnaissance surveys conducted in central coastal Labrador during 1967. Resource Development Branch, St. John's, Nfld., Progress Rep. 68: 286 p.

Pepper, V. A. 1976. Lacustrine nursery areas for Atlantic salmon in insular Newfoundland. Fish. Mar. Serv. Res. Dev. Tech. Rep. 671: 61 p.

Power, G. 1980. The brook charr, Salvelinus fontinalis, p. 141-203. In E. K. Balon [ed.] Charrs, salmonid fishes of the genus Salvelinus. Dr. W. Junk bv Publishers, The Hague, Netherlands. 928 p.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fish. Res. Board Can. Bull. 191: 382 p.

Rivard, D. 1982. APL programs for stock assessment (revised). Can. Tech. Rep. Fish. Aquat. Sci. 1091: 146 p.

Rodgers, D. W. 1984. Ambient pH and calcium concentration as modifiers of growth and calcium dynamics of brook trout, Salvelinus fontinalis. Can. J. Fish. Aquat. Sci. 41: 1774-1780.

Rombough, P. J., S. E. Barbour, and J. J. Kerekes. 1978. Life history and taxonomic status of an isolated population of Arctic char, Salvelinus alpinus, from Gros Morne National Park, Newfoundland. J. Fish. Res. Board Can. 35: 1537-1541.

Rounsefell, G. A., and W. H. Everhart. 1953. Fishery science: its method and applications. John Wiley and Sons Inc., NY. 444 p.

Ryan, P. M. 1980. Fishes of the Lower Churchill River, Labrador. Fish. Mar. Serv. Tech. Rep. 922: vii + 189 p.

1984. Fyke net catches as indices of the abundance of brook trout, Salvelinus fontinalis, and Atlantic salmon, Salmo salar. Can. J. Fish. Aquat. Sci. 41: 377-380.

1986a. Lake use by wild anadromous Atlantic salmon, Salmo salar, as an index of subsequent adult abundance. Can. J. Fish. Aquat. Sci. 43: 2-11.

1986b. Prediction of angler success in an Atlantic salmon, Salmo salar, fishery two fishing seasons in advance. Can. J. Fish. Aquat. Sci. 43: 2531-2534.

Ryan, P. M., L. J. Cole, D. P. Riche, and D. Wakeham. 1981. Age and growth of salmonids in the Experimental Ponds Area, central Newfoundland, 1977-80. Can. Data Rep. Fish. Aquat. Sci. 304: iv + 284 p.

Ryan, P. M., and H. H. Harvey. 1977. Growth of the rock bass, Ambloplites rupestris, in relation to the morphoedaphic index as an indicator of an environmental stress. J. Fish. Res. Board Can. 34: 2079-2088.

Ryan, P. M., and D. Wakeham. 1984. An overview of the physical and chemical limnology of the Experimental Ponds Area, central Newfoundland, 1977-82. Can. Tech. Rep. Fish. Aquat. Sci. 1320: v + 54 p.

Ryder, R. A. 1982. The morphoedaphic index - use, abuse, and fundamental concepts. Trans. Am. Fish. Soc. 111: 154-164.

Ryder, R. A., S. R. Kerr, K. H. Loftus, and H. A. Regier. 1974. The morphoedaphic index, a fish yield estimator-review and evaluation. J. Fish. Res. Board Can. 31: 663-688.

Scott, W. B., and E. J. Crossman. 1964. Fishes occurring in the fresh waters of insular Newfoundland. Dep. Fish. Ottawa: 124 p.

1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184: 966 p.

Scruton, D. A. 1983. A survey of headwater lakes in insular Newfoundland, with special reference to acid precipitation. Can. Tech. Rep. Fish. Aquat. Sci. 1195: v + 110 p.

1984. A survey of selected lakes in Labrador, with an assessment of lake status and sensitivity in relation to acid precipitation. Can. Tech. Rep. Fish. Aquat. Sci. 1296: v + 115 p.

St. Pierre, M. and G. Moreau. 1986. Reproduction de l'omble de fontaine, Salvelinus fontinalis (Mitchill), dans les lacs de différents pH. Hydrobiologia 141: 237-248.

Tesch, F. W. 1971. Age and growth, p. 93-120. In W. E. Ricker [ed.] Methods for assessment of fish production in fresh waters. 2nd ed. IBP Handbook, No. 3, Blackwell Scientific Publications Oxford. 348 p.

Watt, K.E.F. 1968. Ecology and resource management. McGraw-Hill Book Co., Toronto. 450 p.

Wetzel, R. G. Limnology. W. B. Saunders Co., Toronto. 743 p.

Wiseman, R. J. 1969. Some aspects of the biology of the speckled trout, Salvelinus fontinalis (Mitchell) 1815, in the waters of insular Newfoundland. M.Sc. thesis, Memorial Univ. Newfoundland, St. John's, Nfld. 381 p.

Whelan, W. G., and R. J. Wiseman. 1977. The limnology and sport fish populations of three lakes located on the Southern Shore, Avalon Peninsula, Newfoundland. Fish. Mar. Serv. Data Rep. 26: 28 p.

Appendix 1 -- Effort and Catch Statistics with Separation by Species, Lake, Year, and Mesh Size from Six Experimentally Fished Lakes of Gros Morne National Park, 1975-80. Information on the incidence of eel damage is included.

Table 1. Effort and catch statistics by mesh size for brook trout from Pond Point Big Pond, Gros Morne National Park, 1975-77. Statistics for individual mesh sizes refer to undamaged fish. Weights for combined mesh sizes are corrected for eel damage (product of mean weight of undamaged fish and total number captured). Bracketed ( ) numerals indicate the number of undamaged fish in catches containing damaged fish.

			Brook trout				
Date	Mesh size (mm)	Units of net effort (15 m·24 h^{-1})	Number	Weight (g)	Mean weight (g)	No. per net effort	Wt per net effort (g)
Sept 8-9, 1975	19	0.71	1	13.0	13.0	1.41	18.3
	25	1.42	2	128.0	64.0	1.41	90.1
	38	2.13	19	1286.0	67.7	8.92	603.8
	51	2.55	25	2844.0	113.8	9.80	1115.3
	64	2.55	6	890.0	148.3	2.35	349.0
	76	Not used	-	-	-	-	-
	89	1.42	0	0	0	0	0
	19-89	10.78	55 (53)	5355.8	97.4	5.10	496.8
Sept 2-3, 1976	19	0.67	0	0	0	0	0
	25	2.00	4	65.0	16.3	2.00	32.5
	38	2.00	18	1146.0	63.7	9.00	573.0
	51	2.40	21	2448.0	116.6	8.75	1020.0
	64	2.40	8	1499.0	187.4	3.33	624.6
	76	1.20	1	58.0	58.0	0.83	48.3
	89	0.67	1	50.0	50.0	1.49	74.6
	19-89	11.34	59 (53)	5862.2	99.4	5.20	517.0
Aug 29-30, 1977	19	0.75	0	0	0	0	0
	25	2.25	9	354.5	39.4	4.00	157.6
	38	2.25	17	860.5	50.6	7.56	382.4
	51	1.50	6	717.0	119.5	4.00	478.0
	64	2.70	3	515.0	171.7	1.11	190.7
	76	1.35	3	573.5	191.2	2.22	424.8
	89	1.35	5	390.0	78.0	3.70	288.9
	19-89	12.15	59 (43)	4679.5	79.3	4.86	385.1
All years combined	19	2.13	1	13.0	13.0	0.47	6.1
	25	5.67	15	547.5	36.5	2.65	96.6
	38	6.38	54	3292.5	61.0	8.46	516.1
	51	6.45	52	6009.0	115.6	8.06	931.6
	64	7.65	17	2904.0	170.8	2.22	379.6
	76	2.55	4	631.5	157.9	1.57	247.7
	89	3.44	6	440.0	73.3	1.74	127.9
	19-89	34.27	173 (149)	15897.5	91.9	5.05	463.9

Table 2a. Effort and catch statistics by mesh size for brook trout from Candlestick Pond, Gros Morne National Park, 1975-78.

Date	Mesh size (mm)	Units of effort (15 m·24 h⁻¹)	Brook trout Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Aug 4-7, 1975	19	1.69	1	8.0	8.0	0.59	4.7
	25	4.15	18	904.0	50.2	4.34	217.8
	38	5.77	22	1090.0	49.6	3.81	188.9
	51	7.35	12	685.0	57.1	1.63	93.2
	64	7.35	1	30.0	30.0	0.14	4.1
	76	4.31	0	0	0	0	0
	89	4.31	1	55.0	55.0	0.23	12.8
	19-89	34.93	55	2772.0	50.4	1.57	79.4
Aug 18-20, 1976	19	1.72	0	0	0	0	0
	25	11.86	11	185.4	16.9	0.93	15.6
	38	7.69	64	3825.3	59.8	8.32	497.4
	51	6.72	10	1066.3	106.6	1.49	158.7
	64	3.09	0	0	0	0	0
	76	3.09	0	0	0	0	0
	89	1.72	0	0	0	0	0
	19-89	35.89	85	5077.0	59.7	2.37	141.5
June 18-21, 1977	19	2.88	0	0	0	0	0
	25	10.93	3	604.0	201.3	0.27	55.3
	38	6.52	30	1805.5	60.2	4.60	276.9
	51	8.72	15	1288.0	85.9	1.72	147.7
	64	5.18	1	213.0	213.0	0.19	41.1
	76	2.88	4	236.0	59.0	1.39	81.9
	89	2.88	2	205.0	102.5	0.69	71.2
	19-89	39.99	55	4351.5	79.1	1.38	108.8
July 29-31, 1978	19	1.92	0	0	0	0	0
	25	1.92	0	0	0	0	0
	38	1.92	14	797.0	56.9	7.29	415.1
	51	1.92	4	484.0	121.0	2.08	252.1
	64	1.92	1	57.0	57.0	0.52	29.7
	76	Not used	-	-	-	-	-
	89	2.88	0	0	0	0	0
	19-89	12.48	19	1338.0	70.4	1.52	107.2
All years combined	19	8.21	1	8.0	8.0	0.12	1.0
	25	28.86	32	1693.4	52.9	1.11	58.7
	38	21.90	131	7517.8	57.4	5.98	343.3
	51	24.71	41	3523.3	85.9	1.66	142.6
	64	17.54	3	300.0	100.0	0.17	17.1
	76	10.28	4	236.0	59.0	0.39	23.0
	89	11.79	3	260.0	86.7	0.25	22.1
	19-89	123.29	214	13538.5	63.3	1.74	109.8

Table 2b. Effort and catch statistics by mesh size for Atlantic salmon from Candlestick Pond, Gros Morne National Park, 1975-78.

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Atlantic salmon: Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Aug 4-7, 1975	19	1.69	2	155.0	77.5	1.18	91.7
	25	4.15	7	594.0	84.9	1.69	143.1
	38	5.77	12	995.0	82.9	2.08	172.4
	51	7.35	5	375.0	75.0	0.68	51.0
	64	7.35	2	125.0	62.5	0.27	17.0
	76	4.31	0	0	0	0	0
	89	4.31	0	0	0	0	0
	19-89	34.93	28	2244.0	80.1	0.80	64.2
Aug 18-20, 1976	19	1.72	0	0	0	0	0
	25	11.86	1	17.5	17.5	0.08	1.5
	38	7.69	19	1653.7	87.0	2.47	215.0
	51	6.72	18	2115.4	117.5	2.68	314.8
	64	3.09	1	72.0	72.0	0.32	23.3
	76	3.09	0	0	0	0	0
	89	1.72	0	0	0	0	0
	19-89	35.89	39	3858.6	98.9	1.09	107.5
June 18-21, 1977	19	2.88	0	0	0	0	0
	25	10.93	0	0	0	0	0
	38	6.52	23	1747.5	76.0	3.53	268.0
	51	8.72	5	368.0	73.6	0.57	42.2
	64	5.18	0	0	0	0	0
	76	2.88	1	76.0	76.0	0.35	26.4
	89	2.88	4	311.0	77.8	1.39	108.0
	19-89	39.99	33	2502.5	75.8	0.83	62.6
July 29-31, 1978	19	1.92	0	0	0	0	0
	25	1.92	0	0	0	0	0
	38	1.92	0	0	0	0	0
	51	1.92	3	339.0	113.0	1.56	176.6
	64	1.92	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	2.88	0	0	0	0	0
	19-89	12.48	3	339.0	113.0	0.24	27.2
All years combined	19	8.21	2	155.0	77.5	0.24	18.9
	25	28.86	8	611.5	76.4	0.28	21.2
	38	21.90	54	4396.2	81.4	2.47	200.7
	51	24.71	31	3197.4	103.1	1.25	129.4
	64	17.54	3	197.0	65.7	0.17	11.2
	76	10.28	1	76.0	76.0	0.10	7.4
	89	11.79	4	311.0	77.8	0.34	26.4
	19-89	123.29	103	8954.1	86.1	0.84	72.6

Table 2c. Effort and catch statistics by mesh size for Arctic charr from Candlestick Pond, Gros Morne National Park, 1975-78.

Date	Mesh size (mm)	Units of effort ($15\ m \cdot 24\ h^{-1}$)	Arctic charr Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Aug 4-7, 1975	19	1.69	3	25.0	8.3	1.78	14.8
	25	4.15	78	1388.0	17.8	18.80	334.5
	38	5.77	34	608.0	17.9	5.89	105.4
	51	7.35	0	0	0	0	0
	64	7.35	0	0	0	0	0
	76	4.31	0	0	0	0	0
	89	4.31	0	0	0	0	0
	19-89	34.93	115	2021.0	17.6	3.29	57.9
Aug 18-20, 1976	19	1.72	7	46.0	6.6	4.07	26.7
	25	11.86	30	599.0	20.0	2.53	50.5
	38	7.69	0	0	0	0	0
	51	6.72	3	82.6	27.5	0.45	12.3
	64	3.09	0	0	0	0	0
	76	3.09	0	0	0	0	0
	89	1.72	0	0	0	0	0
	19-89	35.89	40	727.6	18.2	1.11	20.3
June 18-21, 1977	19	2.88	0	0	0	0	0
	25	10.93	35	619.5	17.7	3.20	56.6
	38	6.52	1	18.0	18.0	0.15	2.8
	51	8.72	5	117.5	23.5	0.57	13.5
	64	5.18	0	0	0	0	0
	76	2.88	0	0	0	0	0
	89	2.88	0	0	0	0	0
	19-89	39.99	41	755.0	18.4	1.03	18.9
July 29-31, 1978	19	1.92	4	25.5	6.4	2.08	13.3
	25	1.92	4	67.6	16.9	2.08	35.2
	38	1.92	1	51.0	51.1	0.52	26.6
	51	1.92	0	0	0	0	0
	64	1.92	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	2.88	0	0	0	0	0
	19-89	12.48	9	144.1	16.0	0.72	11.6
All years combined	19	8.21	14	96.5	6.9	1.71	11.8
	25	28.86	147	2674.1	18.2	5.09	92.7
	38	21.90	36	677.0	18.8	1.64	30.9
	51	24.71	8	200.1	25.0	0.32	8.1
	64	17.54	0	0	0	0	0
	76	10.28	0	0	0	0	0
	89	11.79	0	0	0	0	0
	19-89	123.29	205	3647.7	17.8	1.66	29.6

Table 2d. Effort and catch statistics by mesh size for all salmonids from Candlestick Pond, Gros Morne National Park, 1975-78.

Date	Mesh size (mm)	Units of effort (15 m·24 h⁻¹)	All salmonids Number	Weight (g)	No. per net effort	Wt. per net effort (g)
Aug 4-7, 1975	19	1.69	6	188.0	3.55	111.2
	25	4.15	103	2886.0	24.82	695.4
	38	5.77	68	2693.0	11.79	466.7
	51	7.35	17	1060.0	2.31	144.2
	64	7.35	3	155.0	0.41	21.1
	76	4.31	0	0	0	0
	89	4.31	1	55.0	0.23	12.8
	19-89	34.93	198	7037.0	5.67	201.5
Aug 18-20, 1976	19	1.72	7	46.0	4.07	26.7
	25	11.86	42	801.9	3.54	67.6
	38	7.69	83	5479.0	10.79	712.5
	51	6.72	31	3264.3	4.61	485.8
	64	3.09	1	72.0	0.32	23.3
	76	3.09	0	0	0	0
	89	1.72	0	0	0	0
	19-89	35.89	164	9663.2	4.57	269.2
June 18-21, 1977	19	2.88	0	0	0	0
	25	10.93	38	1223.5	3.48	111.9
	38	6.52	54	3571.0	8.28	547.7
	51	8.72	25	1773.5	2.87	203.4
	64	5.18	1	213.0	0.19	41.1
	76	2.88	5	312.0	1.74	108.3
	89	2.88	6	516.0	2.08	179.2
	19-89	39.99	129	7609.0	3.23	190.3
July 29-31, 1978	19	1.92	4	25.5	2.08	13.3
	25	1.92	4	67.6	2.08	35.2
	38	1.92	15	848.0	7.81	441.7
	51	1.92	7	823.0	3.65	428.7
	64	1.92	1	57.0	0.52	29.7
	76	Not used	-	-	-	-
	89	2.88	0	0	0	0
	19-89	12.48	31	1821.1	2.48	145.9
All years combined	19	8.21	17	259.5	2.07	31.6
	25	28.86	187	4979.0	6.48	172.5
	38	21.90	220	12591.0	10.05	574.9
	51	24.71	80	6920.8	3.24	280.1
	64	17.54	6	497.0	0.34	28.3
	76	10.28	5	312.0	0.49	30.4
	89	11.79	7	571.0	0.59	48.4
	19-89	123.29	522	26130.3	4.23	211.9

Table 3. Effort and catch statistics by mesh size for fishes from Sandy Pond, Gros Morne National Park, 1975-79.

			Brook trout					Rainbow smelt				
Date	Mesh size (mm)	Units of effort (15 m•24 h^{-1})	Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)	Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Aug 30-Sept 1, 1975	19	1.69	1	50.0	50.0	0.59	29.6	0	0	0	0	0
	25	3.38	16	778.0	48.6	4.73	230.2	6	122.0	20.3	1.78	36.1
	38	5.06	112	8753.0	78.2	22.13	1729.8	1	29.0	29.0	0.20	5.7
	51	2.48	73	8731.0	119.6	29.44	3520.6	1	21.0	21.0	0.40	8.5
	64	6.08	16	4918.0	307.4	2.63	808.9	3	64.0	21.3	0.49	10.5
	76	3.04	0	0	0	0	0	0	0	0	0	0
	89	1.69	1	40.0	40.0	0.59	23.7	0	0	0	0	0
	19-89	23.42	219	23270.0	106.3	9.35	993.6	11	236.0	21.5	0.47	10.1
Sept 23-26, 1976	19	2.77	0	0	0	0	0	6	83.5	13.9	2.17	30.1
	25	8.31	25	824.6	33.0	3.01	99.2	9	217.0	24.1	1.08	26.1
	38	14.38	186	13244.0	71.2	12.93	921.0	0	0	0	0	0
	51	9.98	106	11600.5	109.4	10.62	1162.4	2	21.5	10.8	0.20	2.2
	64	9.98	16	2828.0	176.8	1.60	283.4	1	21.0	21.0	0.10	2.1
	76	4.99	20	4127.5	206.4	4.01	827.2	1	30.0	30.0	0.20	6.0
	89	2.77	5	467.0	93.4	1.81	168.6	1	14.5	14.5	0.36	5.2
	19-89	53.18	358	33091.6	92.4	6.73	622.3	20	387.5	19.4	0.38	7.3
Aug 19-21, 1977	19	2.00	0	0	0	0	0	0	0	0	0	0
	25	5.46	44	1258.0	28.6	8.06	230.4	0	0	0	0	0
	38	6.00	88	6249.0	71.0	14.67	1041.5	0	0	0	0	0
	51	7.20	128	16969.0	132.6	17.78	2356.8	2	46.0	23.0	0.28	6.4
	64	6.83	2	506.0	253.0	0.29	74.1	0	0	0	0	0
	76	3.60	2	129.0	64.5	0.56	35.8	0	0	0	0	0
	89	2.00	4	595.0	148.8	2.00	297.5	0	0	0	0	0
	19-89	33.09	268	25706.0	95.9	8.10	776.9	2	46.0	23.0	0.06	1.4
Sept 5-7, 1978	19	2.00	0	0	0	0	0	1	7.0	7.0	0.50	3.5
	25	6.00	13	564.0	43.4	2.17	94.0	10	272.0	27.2	1.67	45.3
	38	6.00	61	4370.0	71.6	10.17	728.3	0	0	0	0	0
	51	4.00	49	6916.0	141.1	12.25	1729.0	0	0	0	0	0
	64	7.20	16	2947.0	184.2	2.22	409.3	0	0	0	0	0
	76	Not used	-	-	-	-	-	-	-	-	-	-
	89	2.00	4	2299.0	574.8	2.00	1149.5	0	0	0	0	0
	19-89	27.20	143	17096.0	119.6	5.26	628.5	11	279.0	34.2	0.40	1.3

Table 3 (cont'd)

Date	Mesh size (mm)	Units of effort (15 m•24 h^{-1})	Brook trout Number	Brook trout Weight (g)	Brook trout Mean weight (g)	Brook trout No. per net effort	Brook trout Wt. per net effort (g)	Rainbow smelt Number	Rainbow smelt Weight (g)	Rainbow smelt Mean weight (g)	Rainbow smelt No. per net effort	Rainbow smelt Wt. per net effort (g)
Sept 18-21, 1979	19	3.71	3	596.0	198.7	0.81	160.7	3	25.0	8.3	0.81	6.7
	25	15.63	6	448.0	74.7	0.38	28.7	35	970.0	27.7	2.24	62.1
	38	14.13	77	6012.0	78.1	5.45	425.5	0	0	0	0	0
	51	6.46	102	13110.0	128.5	15.79	2029.4	0	0	0	0	0
	64	16.95	48	11495.0	239.5	2.83	678.2	0	0	0	0	0
	76	Not used	-	-	-	-	-	-	-	-	-	-
	89	6.75	2	1189.0	594.5	0.30	176.2	0	0	0	0	0
	19-89	63.63	238	32850.0	138.0	3.74	516.3	38	995.0	26.2	0.60	15.6
All years combined	19	12.17	4	646.0	161.5	0.33	53.1	10	115.5	11.6	0.82	9.5
	25	38.78	104	3872.6	37.2	2.68	199.9	60	1581.0	26.4	1.55	40.8
	38	45.57	524	38628.0	73.7	11.50	847.7	1	29.0	29.0	0.02	0.6
	51	30.12	458	57326.5	125.2	15.21	1903.3	5	88.5	17.7	0.17	2.9
	64	47.04	98	22694.0	231.6	2.08	482.4	4	85.0	21.3	0.09	1.8
	76	11.63	22	4256.5	193.5	1.89	366.0	1	30.0	30.0	0.09	2.6
	89	15.21	16	4590.0	286.9	1.05	301.8	1	14.5	14.5	0.07	1.0
	19-89	200.52	1226	132013.6	107.7	6.11	658.4	82	1943.5	23.7	0.41	9.7

Table 4a. Effort and catch statistics by mesh size for brook trout from Wigwam Pond, Gros Morne National Park, 1977-80. Statistics for individual mesh sizes refer to undamaged fish except where indicated. Weights for combined mesh sizes are corrected for eel damage (product of mean weight of undamaged fish and total number captured). Bracketed ( ) numerals indicate the known number of undamaged fish in catches containing damaged fish.

			Brook trout				
Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Sept 12-16, 1977	19	2.96	0	0	0	0	0
	25	8.88	37	1927.0	52.1	4.17	217.0
	38	8.88	180	11940.5	66.3	20.27	1344.7
	51	7.13	5	569.5	113.9	0.70	79.9
	64	10.65	36	7676.5	213.2	3.38	720.8
	76	8.85	3	1024.0	341.3	0.34	115.7
	89	2.96	6	1263.0	210.5	2.03	426.7
	19-89	50.31	267[a]	24400.5[b]	91.4	5.31	485.0
Oct 5-6, 1978	19	1.50	1	115.0	115.0	6.67	76.7
	25	4.50	16	663.0	41.4	3.56	147.3
	38	4.50	43	2848.0	66.2	9.56	632.9
	51	3.00	26	4650.0	178.9	8.67	1550.0
	64	6.98	18	4335.0	240.8	2.58	621.1
	76	Not used	-	-	-	-	-
	89	1.50	2	855.0	427.5	1.33	570.0
	19-89	21.98	106	13466.0	127.0	4.82	612.7
Sept 4-7, 1979	19	3.00	0	0	0	0	0
	25	9.00	15	380.0	25.3	1.67	42.2
	38	10.00	62	4794.0	77.3	6.20	479.4
	51	6.00	46	9010.0	195.9	7.67	1501.7
	64	9.00	11	4605.0	418.6	1.22	511.7
	76	Not used	-	-	-	-	-
	89	5.40	8	4124.0	515.5	1.48	763.7
	19-89	42.40	144 (142)	23235.7	161.4	3.40	548.0
Sept 9-11, 1980	19	1.50	0	0	0	0	0
	25	4.50	4	117	29.3	0.89	26.0
	38	4.50	48	3627.0	75.6	10.67	806.0
	51	3.00	19	3895.0	205.0	6.33	1298.3
	64	5.40	21	4870.0	231.9	3.89	901.9
	76	Not used	-	-	-	-	-
	89	2.70	2	581.0	290.5	0.74	215.2
	19-89	21.60	98 (94)	13647.0	139.3	4.54	631.8

Table 4a (cont'd)

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Brook trout Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
All years combined[c]	19	8.96	1	115.0	115.0	0.11	12.8
	25	26.88	72	3087.0	42.9	2.68	114.8
	38	27.88	333	23209.5	69.7	11.94	832.5
	51	19.13	96	18124.5	188.8	5.02	947.4
	64	32.03	86	21486.5	249.8	2.68	670.8
	76	8.85	3	1024.0	341.3	0.34	115.7
	89	12.56	18	6823.0	379.1	1.43	543.2
	19-89	136.29	615	74749.2	121.5	4.51	548.5

[a]Eel damage noted. Numbers in total catch and in individual mesh sizes include damaged fish.

[b]Weights corrected for eel damage in individual mesh sizes.

[c]Corrected for eel damage as above.

Table 4b. Effort and catch statistics by mesh size for Atlantic salmon from Wigwam Pond, Gros Morne National Park, 1977-80. Statistics for individual mesh sizes refer to undamaged fish except where indicated. Weights for combined mesh sizes are corrected for eel damage (product of mean weight of undamaged fish and total number captured). Bracketed ( ) numerals indicate the known number of undamaged fish in catches containing damaged fish.

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Atlantic salmon Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Sept 12-16, 1977	19	2.96	0	0	0	0	0
	25	8.88	15	407.0	27.1	1.69	45.8
	38	8.88	20	3332.5	166.6	2.25	375.3
	51	7.13	1	1231.0	1231.0	0.14	172.7
	64	10.65	2	72.0	36.0	0.19	6.8
	76	8.85	1	1064.5	1064.5	0.11	120.3
	89	2.96	0	0	0	0	0
	19-89	50.31	39[a,c]	6107.0[b]	156.6	0.78	121.4
Oct 5-6, 1978	19	1.50	0	0	0	0	0
	25	4.50	3	66.0	22.0	0.67	14.7
	38	4.50	3	115.0	38.3	0.67	25.6
	51	3.00	0	0	0	0	0
	64	6.98	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	1.50	0	0	0	0	0
	19-89	21.98	6	181.0	30.2	0.27	8.2
Sept 4-7, 1979	19	3.00	0	0	0	0	0
	25	9.00	9	280.0	31.1	1.00	31.1
	38	10.00	9	413.0	45.9	0.90	41.3
	51	6.00	1	1018.0	1018.0	0.17	169.7
	64	9.00	3	2890.0	963.3	0.33	321.1
	76	Not used	-	-	-	-	-
	89	5.40	2	1338.0	669.0	0.37	247.8
	19-89	42.40	24[d]	5939.0	247.5	0.57	140.1
Sept 9-11, 1980	19	1.50	0	0	0	0	0
	25	4.50	1	16.0	16.0	0.22	3.6
	38	4.50	9	2233.0	248.1	2.00	496.2
	51	3.00	1	1306.0	1306.0	0.33	435.3
	64	5.40	4	5359.0	1339.8	0.74	992.4
	76	Not used	-	-	-	-	-
	89	2.70	0	0	0	0	0
	19-89	21.60	15[e]	8914.0	594.3	0.69	412.7

Table 4b (cont'd)

Date	Mesh size (mm)	Units of effort (15 m•24 h^{-1})	Atlantic salmon Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
All years combined[f]	19	8.96	0	0	0	0	0
	25	26.88	28	769.0	27.5	1.04	28.6
	38	27.88	41	6093.5	148.6	1.47	218.6
	51	19.13	3	3555.0	1185.0	0.16	185.8
	64	32.03	9	8321.0	924.6	0.28	259.8
	76	8.85	1	1064.5	1064.5	0.11	120.3
	89	12.56	2	1338.0	669.0	0.16	106.5
	19-89	136.29	84	21141.0	251.7	0.62	155.1

[a]Eel damage noted. Numbers in total catch and in individual mesh sizes include damaged fish.

[b]Weights corrected for eel damage in individual mesh sizes.

[c]Includes 4 adult sea-run salmon with a total weight of 4956.0 g.

[d]Includes 6 adult sea-run salmon with a total weight of 5246.0 g.

[e]Includes 6 adult sea-run salmon with a total weight of 8519.0 g.

[f]Corrected for eel damage as above.

Table 4c. Effort and catch statistics by mesh size for Arctic charr from Wigwam Pond, Gros Morne National Park, 1977-80. Statistics for individual mesh sizes refer to undamaged fish except where indicated. Weights for combined mesh sizes are corrected for eel damage (product of mean weight of undamaged fish and total number captured). Bracketed ( ) numerals indicate the known number of undamaged fish in catches containing damaged fish.

			Arctic charr				
Date	Mesh size (mm)	Units of effort ($15\ m \cdot 24\ h^{-1}$)	Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Sept 12-16, 1977	19	2.96	4	270.5	67.6	1.35	91.4
	25	8.88	19	2214.0	116.5	2.14	249.3
	38	8.88	20	1458.5	72.9	2.25	164.3
	51	7.13	60	11619.0	193.7	8.42	1629.6
	64	10.65	14	2975.0	212.5	1.31	279.3
	76	8.85	21	3983.0	189.7	2.37	450.1
	89	2.96	8	1441.0	180.1	2.70	486.8
	19-89	50.31	146[a]	23961.0[b]	164.1	2.90	476.3
Oct 5-6, 1978	19	1.50	0	0	0	0	0
	25	4.50	1	130.0	130.0	0.22	28.9
	38	4.50	10	999.0	99.9	2.22	222.0
	51	3.00	4	639.0	159.8	1.33	213.0
	64	6.98	17	5090.0	299.4	2.44	729.2
	76	Not used	-	-	-	-	-
	89	1.50	0	0	0	0	0
	19-89	21.98	32	6858.0	214.3	1.46	312.0
Sept 4-7, 1979	19	3.00	0	0	0	0	0
	25	9.00	1	340	340	0.11	37.8
	38	10.00	15	1536.0	102.4	1.50	153.6
	51	6.00	2	363.0	181.5	0.33	60.5
	64	9.00	14	3613.0	258.1	1.56	401.4
	76	Not used	-	-	-	-	-
	89	5.40	0	0	0	0	0
	19-89	42.40	32[a]	5852.0[b]	182.9	0.75	138.0
Sept 9-11, 1980	19	1.50	0	0	0	0	0
	25	4.50	0	0	0	0	0
	38	4.50	0	0	0	0	0
	51	3.00	0	0	0	0	0
	64	5.40	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	2.70	0	0	0	0	0
	19-89	21.60	0	0	0	0	0

Table 4c (cont'd)

Date	Mesh size (mm)	Units of effort (15 m•24 h^{-1})	Arctic charr Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
All years combined[c]	19	8.96	4	270.5	67.6	0.45	30.2
	25	26.88	21	2684.0	127.8	0.78	99.9
	38	27.88	45	3993.5	88.7	1.61	143.2
	51	19.13	66	12621.0	191.2	3.45	659.8
	64	32.03	45	11678.0	259.5	1.40	364.6
	76	8.85	21	3983.0	189.7	2.37	450.1
	89	12.56	8	1441.0	180.1	0.64	114.7
	19-89	136.29	210	36671.0	174.6	1.54	269.1

[a]Eel damage noted. Numbers in total catch and in individual mesh sizes include damaged fish.

[b]Weights corrected for eel damage in individual mesh sizes.

[c]Corrected for eel damage as above.

Table 4d. Effort and catch statistics by mesh size for rainbow smelt from Wigwam Pond, Gros Morne National Park, 1977-80. Statistics for individual mesh sizes refer to undamaged fish except where indicated. Weights for combined mesh sizes are corrected for eel damage (product of mean weight of undamaged fish and total number captured).

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Rainbow smelt: Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Sept 12-16, 1977	19	2.96	4	29.5	7.4	1.35	10.0
	25	8.88	0	0	0	0	0
	38	8.88	0	0	0	0	0
	51	7.13	4	23.5	5.9	0.56	3.3
	64	10.65	0	0	0	0	0
	76	8.85	1	30.0	30.0	0.11	3.4
	89	2.96	0	0	0	0	0
	19-89	50.31	9[a]	83.0[b]	9.2	0.18	1.7
Oct 5-6, 1978	19	1.50	2	16.0	8.0	1.33	10.7
	25	4.50	0	0	0	0	0
	38	4.50	0	0	0	0	0
	51	3.00	0	0	0	0	0
	64	6.98	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	1.50	0	0	0	0	0
	19-89	21.98	2	16.0	8.0	0.09	0.7
Sept 4-7, 1979	19	3.00	0	0	0	0	0
	25	9.00	0	0	0	0	0
	38	10.00	0	0	0	0	0
	51	6.00	0	0	0	0	0
	64	9.00	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	5.40	0	0	0	0	0
	19-89	42.40	0	0	0	0	0
Sept 9-11, 1980	19	1.50	0	0	0	0	0
	25	4.50	0	0	0	0	0
	38	4.50	0	0	0	0	0
	51	3.00	0	0	0	0	0
	64	5.40	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	2.70	0	0	0	0	0
	19-89	21.60	0	0	0	0	0

Table 4d (cont'd)

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Rainbow smelt Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
All years combined[c]	19	8.96	6	45.5	7.6	0.67	5.1
	25	26.88	0	0	0	0	0
	38	27.88	0	0	0	0	0
	51	19.13	4	23.5	5.9	0.21	1.2
	64	32.03	0	0	0	0	0
	76	8.85	1	30.0	30.0	0.11	3.4
	89	12.56	0	0	0	0	0
	19-89	136.29	11	99.0	9.0	0.08	0.7

[a]Eel damage noted. Numbers in total catch and in individual mesh sizes include damaged fish.

[b]Weights corrected for eel damage in individual mesh sizes.

[c]Corrected for eel damage as above.

Table 4e. Effort and catch statistics by mesh size for all salmonids from Wigwam Pond, Gros Morne National Park, 1977-80. Weights are corrected for eel damage as indicated in Tables 4a-4d. Bracketed ( ) numerals indicate the known number of undamaged fish in catches containing damaged fish.

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	All salmonids: Number	Weight (g)	No. per net effort	Wt. per net effort (g)
Sept 12-16, 1977	19	2.96	4	270.5	1.35	91.4
	25	8.88	71	4548.0	8.00	512.2
	38	8.88	220	16731.5	24.77	1884.2
	51	7.13	66	13419.5	9.26	1882.1
	64	10.65	52	10723.5	4.88	1006.9
	76	8.85	25	6071.5	2.82	686.1
	89	2.96	14	2704.0	4.73	913.5
	19-89	50.31	452[a]	54468.5	8.98	1082.7
Oct 5-6, 1978	19	1.50	1	115.0	0.67	76.7
	25	4.50	20	859.0	4.44	190.9
	38	4.50	56	3962.0	12.44	880.4
	51	3.00	30	5289.0	10.00	1763.0
	64	6.98	35	9425.0	5.01	1350.3
	76	Not used	-	-	-	-
	89	1.50	2	855.0	1.33	570.0
	19-89	21.98	144	20505.0	6.55	932.9
Sept 4-7, 1979	19	3.00	0	0	0	0
	25	9.00	25	1000.0	2.78	111.1
	38	10.00	86	6743.0	8.60	674.3
	51	6.00	49	10391.0	8.17	1731.8
	64	9.00	28	11108.0	3.11	1234.2
	76	Not used	-	-	-	-
	89	5.40	10	5462.0	1.85	1011.5
	19-89	42.40	200[a] (198)	35026.7	4.72	826.1
Sept 9-11, 1980	19	1.50	0	0	0	0
	25	4.50	5	133.0	1.11	30.0
	38	4.50	57	5860.0	12.67	1302.2
	51	3.00	20	5201.0	6.67	1733.7
	64	5.40	25	10229.0	4.63	1894.3
	76	Not used	-	-	-	-
	89	2.70	2	581.0	0.74	215.2
	19-89	21.60	113 (109)	22561.0	5.23	1044.5

Table 4e (cont'd)

Date	Mesh size (mm)	Units of effort (15 m•24 h^{-1})	All salmonids: Number	All salmonids: Weight (g)	All salmonids: No. per net effort	All salmonids: Wt. per net effort (g)
All years combined	19	8.96	5	385.5	0.56	43.0
	25	26.88	121	6540.0	4.50	243.3
	38	27.88	419	29334.5	15.03	1052.2
	51	19.13	165	34300.5	8.63	1793.0
	64	32.03	140	41485.5	4.37	1295.2
	76	8.85	25	6071.5	2.82	686.1
	89	12.56	28	9602.0	2.23	764.5
	19-89	136.29	909[a] (903)	132561.2	6.67	972.6

[a]Includes unknown incidence of eel-damaged fish.

Table 5a. Effort and catch statistics by mesh size for brook trout from Half Moon Pond, Gros Morne National Park, 1975-79. Statistics for individual mesh sizes refer to undamaged fish except where indicated. Weights for combined mesh sizes are corrected for eel damage (product of mean weight of undamaged fish and total number captured). Bracketed ( ) numerals indicate the known number of undamaged fish in catches containing damaged fish.

			Brook trout				
Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Sept 18-20, 1975	19	1.95	0	0	0	0	0
	25	3.90	6	374.0	62.3	1.54	95.9
	38	5.85	38	1903.0	50.1	6.50	325.3
	51	3.51	3	315.0	105.0	0.85	89.7
	64	7.01	5	1145.0	229.0	0.71	163.3
	76	7.01	26	2972.0	114.3	3.71	424.0
	89	1.95	1	158.0	158.0	0.51	81.0
	19-89	31.18	103 (79)	8953.2	86.9	3.30	287.2
Sept 20-23, 1976	19	2.90	0	0	0	0	0
	25	13.35	5	171.0	34.2	0.37	12.8
	38	8.69	38	2859.0	75.2	4.37	329.0
	51	9.63	26	3425.0	131.7	2.70	355.7
	64	8.88	18	3400.5	188.9	2.03	382.9
	76	5.21	2	579.0	289.5	0.38	111.1
	89	4.45	4	1322.0	330.5	0.90	297.1
	19-89	53.11	128 (93)	16181.0	126.4	2.41	304.7
Sept 26-29, 1977	19	2.94	2	99.0	49.5	0.68	33.7
	25	8.81	19	969.5	51.0	2.16	110.1
	38	8.81	69	4950.0	71.7	7.83	561.9
	51	5.29	36	4980.0	138.0	6.81	941.4
	64	15.86	10	2419.0	241.9	0.63	152.5
	76	5.29	6	1682.0	280.3	1.13	318.0
	89	2.94	2	241.0	120.5	0.68	82.0
	19-89	49.94	144[a]	15340.5[b]	106.5	2.88	307.2
Sept 27-30, 1978	19	3.50	0	0	0	0	0
	25	10.50	2	201.0	100.5	0.19	19.1
	38	10.50	61	4997.0	81.9	5.81	475.9
	51	7.00	26	3573.0	137.4	3.71	510.4
	64	12.60	7	1694.0	242.0	0.56	134.4
	76	Not used	-	-	-	-	-
	89	3.50	0	0	0	0	0
	19-89	47.60	96	10465.0	109.0	2.02	219.9

Table 5a (cont'd)

Date	Mesh size (mm)	Units of effort (15 m•24 h^{-1})	Brook trout Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Oct 2-5, 1979	19	7.00	1	158.0	158.0	0.14	22.6
	25	16.00	1	24.0	24.0	0.06	1.5
	38	17.00	48	3406.0	71.0	2.82	200.4
	51	8.00	21	2738.0	130.0	2.63	342.3
	64	10.80	11	2412.0	219.3	1.02	223.3
	76	Not used	-	-	-	-	-
	89	9.00	3	1713.0	571.0	0.33	190.3
	19-89	67.80	85	10451.0	123.0	1.25	154.1
All years combined[c]	19	18.29	3	257.0	85.7	0.16	14.0
	25	52.56	33	1739.5	52.7	0.63	33.1
	38	50.85	254	18115.0	71.3	5.00	356.2
	51	33.43	112	15031.0	134.2	3.35	449.6
	64	55.15	51	11070.5	217.1	0.92	200.7
	76	17.51	34	5233.0	153.9	1.94	298.9
	89	21.84	10	3434.0	343.4	0.46	157.2
	19-89	249.63	556	61390.7	110.4	2.23	245.9

[a]Eel damage noted. Numbers in total catch and in individual mesh sizes include damaged fish.

[b]Weights corrected for eel damage in individual mesh sizes.

[c]Corrected for eel damage as above.

Table 5b. Effort and catch statistics by mesh size for Atlantic salmon from Half Moon Pond, Gros Morne National Park, 1975-79. No eel damage was reported.

Date	Mesh size (mm)	Units of effort ($15\ m \cdot 24\ h^{-1}$)	Atlantic salmon Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Sept 18-20, 1975	19	1.95	3	23.0	8.0	1.54	11.8
	25	3.90	5	110.0	22.0	1.28	28.2
	38	5.85	22	1045.0	47.5	3.76	178.6
	51	3.51	0	0	0	0	0
	64	7.01	0	0	0	0	0
	76	7.01	4	208.0	52.0	0.57	29.7
	89	1.95	0	0	0	0	0
	19-89	31.18	34	1386.0	40.8	1.09	44.5
Sept 20-23, 1976	19	2.90	3	83.0	27.7	1.03	28.6
	25	13.35	23	601.5	26.2	1.72	45.1
	38	8.69	36	1954.5	54.3	4.14	224.9
	51	9.63	9	464.5	51.6	0.93	48.2
	64	8.88	10	423.5	42.4	1.13	47.7
	76	5.21	2	112.5	56.3	0.38	21.6
	89	4.45	3	174.0	58.0	0.67	39.1
	19-89	53.11	86[a]	3813.5	44.3	1.81	71.8
Sept 26-29, 1977	19	2.94	6	137.0	22.8	2.04	46.6
	25	8.81	27	590.5	21.9	3.06	67.0
	38	8.81	19	964.0	50.7	2.16	109.4
	51	5.29	1	55.0	55.0	0.19	10.4
	64	15.86	2	92.0	46.0	0.13	5.8
	76	5.29	5	242.0	48.4	0.95	45.8
	89	2.94	0	0	0	0	0
	19-89	49.94	60	2080.5	34.7	1.20	41.7
Sept 27-30, 1978	19	3.50	0	0	0	0	0
	25	10.50	16	367.0	22.9	1.52	35.0
	38	10.50	7[b]	2386.5	340.9	0.67	227.3
	51	7.00	0	0	0	0	0
	64	12.60	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	3.50	0	0	0	0	0
	19-89	47.60	23	2753.5	119.7	0.48	57.9

Table 5b (cont'd)

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Atlantic salmon Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Oct 2-5, 1979	19	7.00	1	12.0	12.0	0.14	1.7
	25	16.00	9	195.0	21.7	0.56	12.2
	38	17.00	19	931.0	49.0	1.12	54.8
	51	8.00	5	258.0	51.6	0.63	32.3
	64	10.80	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	9.00	1[c]	1260.0	1260.0	0.11	140.0
	19-89	67.80	35	2656.0	75.9	0.52	39.2
All years combined	19	18.29	13	255.0	19.6	0.71	13.9
	25	52.56	80	1864.0	23.3	1.52	35.5
	38	50.85	103	7281.0	70.7	2.03	143.2
	51	33.43	15	777.5	51.8	0.45	23.3
	64	55.15	12	515.5	43.0	0.22	9.4
	76	17.51	11	562.5	51.1	0.63	32.1
	89	21.84	4	1434.0	358.5	0.18	65.7
	19-89	249.63	238	12689.5	53.3	0.95	50.8

[a]One adult salmon of approximately 1800 g escaped alive (not included here).

[b]Includes one sea-run salmon of 2117.5 g.

[c]Adult sea-run salmon.

Table 5c. Effort and catch statistics by mesh size for Arctic charr from Half Moon Pond, Gros Morne National Park, 1975-79. Statistics for individual mesh sizes refer to undamaged fish except where indicated.

			Arctic charr				
Date	Mesh size (mm)	Units of effort ($15\ m \cdot 24\ h^{-1}$)	Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Sept 18-20, 1975	19	1.95	1	9.0	9.0	0.51	4.6
	25	3.90	12	225.0	18.8	3.08	57.7
	38	5.85	0	0	0	0	0
	51	3.51	0	0	0	0	0
	64	7.01	0	0	0	0	0
	76	7.01	0	0	0	0	0
	89	1.95	0	0	0	0	0
	19-89	31.18	13	234.0	18.0	0.42	7.5
Sept 20-23, 1976	19	2.90	1	6.5	6.5	0.34	2.24
	25	13.35	28	494.0	17.6	2.10	37.0
	38	8.69	8	376.5	47.1	0.92	43.3
	51	9.63	9	244.0	27.1	0.93	25.3
	64	8.88	1	16.5	16.5	0.11	1.9
	76	5.21	2	50.5	25.3	0.38	9.7
	89	4.45	0	0	0	0	0
	19-89	53.11	49	1188.0	24.2	0.92	22.4
Sept 26-29, 1977	19	2.94	7	51.0	7.3	2.38	17.4
	25	8.81	342	5152.0	15.1	38.82	584.8
	38	8.81	1	16.0	16.0	0.11	1.8
	51	5.29	0	0	0	0	0
	64	15.86	0	0	0	0	0
	76	5.29	1	16.0	16	0.19	3.0
	89	2.94	0	0	0	0	0
	19-89	49.94	351[a]	5235.0[b]	14.9	7.03	104.8
Sept 27-30, 1978	19	3.50	1	6.0	6.0	0.29	1.7
	25	10.50	233	3118.0	13.4	22.19	297.0
	38	10.50	0	0	0	0	0
	51	7.00	0	0	0	0	0
	64	12.60	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	3.50	0	0	0	0	0
	19-89	47.60	234	3124.0	13.4	4.92	65.6

Table 5c (cont'd)

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Arctic charr Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Oct 2-5, 1979	19	7.00	19	345.0	18.2	2.71	49.3
	25	16.00	101	1585.0	15.7	6.31	99.1
	38	17.00	1	41.0	41.0	0.06	2.4
	51	8.00	0	0	0	0	0
	64	10.80	0	0	0	0	0
	76	Not used	-	-	-	-	-
	89	9.00	0	0	0	0	0
	19-89	67.80	121	1971.0	16.3	1.78	29.1
All years combined[c]	19	18.29	29	417.5	14.4	1.59	22.8
	25	52.56	716	10574.0	14.8	13.62	201.2
	38	50.85	10	433.5	43.4	0.20	8.5
	51	33.43	9	244.0	27.1	0.27	7.3
	64	55.15	1	16.5	16.5	0.02	0.3
	76	17.51	3	66.5	22.2	0.17	3.8
	89	21.84	0	0	0	0	0
	19-89	249.63	768[a]	11752.0[b]	15.3	3.08	47.1

[a]Eel damage noted. Numbers in total catch and in individual mesh sizes include damaged fish.

[b]Weights corrected for eel damage in individual mesh sizes.

[c]Corrected for eel damage as above.

Table 5d. Effort and catch statistics by mesh size for all salmonids from Half Moon Pond, Gros Morne National Park, 1975-79. Weights are corrected for eel damage as indicated in Tables 5a-5c. Bracketed ( ) numerals indicate the known number of undamaged fish in catches containing damaged fish.

			All salmonids			
Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Number	Weight (g)	No. per net effort	Wt. per net effort (g)
Sept 18-20, 1975	19	1.95	4	32.0	2.05	16.4
	25	3.90	23	709.0	5.90	181.8
	38	5.85	60	2948.0	10.26	503.9
	51	3.51	3	315.0	0.85	89.7
	64	7.01	5	1145.0	0.71	163.3
	76	7.01	30	3180.0	4.28	453.6
	89	1.95	1	158.0	0.51	81.0
	19-89	31.18	150 (126)	10573.2	4.81	339.1
Sept 20-23, 1976	19	2.90	4	89.5	1.38	30.9
	25	13.35	56	1266.5	4.19	94.9
	38	8.69	82	5190.0	9.44	597.2
	51	9.63	44	4133.5	4.57	429.2
	64	8.88	29	3840.5	3.27	432.5
	76	5.21	6	742.0	1.15	142.4
	89	4.45	7	1496.0	1.57	336.2
	19-89	53.11	263 (228)	21182.5	4.95	398.8
Sept 26-29, 1977	19	2.94	15	287.0	5.10	97.6
	25	8.81	388	6712.0	44.04	761.9
	38	8.81	89	5930.0	10.10	673.1
	51	5.29	37	5035.0	6.99	951.8
	64	15.86	12	2511.0	0.76	158.3
	76	5.29	12	1940.0	2.27	366.7
	89	2.94	2	241.0	0.68	82.0
	19-89	49.94	555[a]	22656.0	11.11	453.7
Sept 27-30, 1978	19	3.50	1	6.0	0.29	1.7
	25	10.50	251	3686.0	23.90	351.1
	38	10.50	68	7383.5	6.48	703.2
	51	7.00	26	3573.0	3.71	510.4
	64	12.60	7	1694.0	0.56	134.4
	76	Not used	-	-	-	-
	89	3.50	0	0	0	0
	19-89	47.60	353	16342.5	7.42	343.3

Table 5d (cont'd)

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	All salmonids Number	Weight (g)	No. per net effort	Wt. per net effort (g)
Oct 2-5, 1979	19	7.00	21	515.0	3.00	73.6
	25	16.00	111	1804.0	6.94	112.8
	38	17.00	68	4378.0	4.00	257.5
	51	8.00	26	2996.0	3.25	374.5
	64	10.80	11	2412.0	1.02	223.3
	76	Not used	-	-	-	-
	89	9.00	4	2973.0	0.44	330.3
	19-89	67.80	241	15078.0	3.55	222.4
All years combined	19	18.29	45	929.5	2.46	50.8
	25	52.56	829	14177.5	15.80	269.7
	38	50.85	367	25829.5	7.22	508.0
	51	33.43	136	16052.5	4.07	480.2
	64	55.15	64	11602.5	1.16	210.4
	76	17.51	48	5862.0	2.74	334.8
	89	21.84	14	4868.0	0.64	222.9
	19-89	249.63	1562[a](1503)	85832.2	6.26	343.8

[a]Includes unknown incidence of eel-damaged fish.

Table 6. Effort and catch statistics by mesh size for brook trout from North Narrows Pond, Gros Morne National Park, 1975-79. Statistics for individual mesh sizes refer to undamaged fish except where indicated. Weights for combined mesh sizes are corrected for eel damage (product of mean weight of undamaged fish and total number captured). Bracketed ( ) numerals indicate the known number of undamaged fish in catches containing damaged fish.

Date	Mesh size (mm)	Units of effort (15 m$\cdot$24 h^{-1})	Brook trout Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Sept 20-23, 1975	19	2.92	1	83.0	83.0	0.34	28.4
	25	5.83	3	134.0	44.7	0.51	23.0
	38	8.75	37	2594.0	70.1	4.23	296.5
	51	10.50	18	2233.0	124.1	1.71	212.7
	64	10.50	5	737.0	147.4	0.48	70.2
	76	5.25	6	894.0	149.0	1.14	170.3
	89	2.92	1	122.0	122.0	0.34	41.8
	19-89	46.67	98 (71)	9381.8	95.7	2.10	201.0
Sept 13-16, 1976	19	2.92	0	0	0	0	0
	25	8.75	5	369.5	73.9	0.57	42.2
	38	8.75	55	3707.5	67.4	6.29	423.7
	51	10.50	23	2845.0	123.7	2.19	271.0
	64	10.50	11	1754.0	159.5	1.05	167.0
	76	10.50	7	2387.0	341.0	0.67	227.3
	89	2.91	1	123.5	123.5	0.34	42.4
	19-89	54.83	120 (102)	13160.6	109.7	2.19	240.0
Sept 19-24, 1977	19	4.88	1	83.0	83.0	0.20	17.0
	25	14.69	59	1454.0	24.6	4.02	99.0
	38	14.69	117	10310.0	88.1	7.96	701.8
	51	8.81	46	5450.0	118.5	5.22	618.6
	64	26.44	25	6088.0	243.5	0.95	230.3
	76	8.81	7	1529.5	218.5	0.79	173.6
	89	4.90	1	381.5	318.5	0.20	77.9
	19-89	83.22	256[a]	25296.0[b]	98.8	3.08	304.0
Sept 13, 14, 18, 21, 22, 25, 1978	19	6.50	0	0	0	0	0
	25	19.50	16	621.0	38.8	0.82	31.9
	38	19.50	72	4852.0	67.4	3.69	248.8
	51	13.00	69	9579.0	138.8	5.31	736.9
	64	23.40	21	4539.0	216.1	0.90	194.0
	76	Not used	-	-	-	-	-
	89	6.50	1	383.0	383.0	0.15	58.9
	19-89	88.40	179	19974.0	111.6	2.02	226.0

Table 6 (cont'd)

Date	Mesh size (mm)	Units of effort (15 m·24 h^{-1})	Brook trout Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Sept 12-15, 1979	19	5.00	0	0	0	0	0
	25	15.00	5	267.0	53.4	0.33	17.8
	38	15.00	73	4625.0	63.4	4.87	308.3
	51	10.00	31	4644.0	149.8	3.10	464.4
	64	18.00	15	3106.0	207.1	0.83	172.6
	76	Not used	-	-	-	-	-
	89	9.00	1	407.0	407.0	0.11	45.2
	19-89	72.00	131 (125)	13675.4	104.4	1.82	189.9
All years combined[c]	19	22.22	2	166.0	83.0	0.09	7.5
	25	63.77	88	2845.5	32.3	1.38	44.6
	38	66.69	354	26088.5	73.7	5.31	391.2
	51	52.81	187	24751.0	132.4	3.54	468.7
	64	88.84	77	16224.0	210.7	0.87	182.6
	76	24.56	20	4810.5	240.5	0.81	195.9
	89	26.24	5	1417.0	283.4	0.19	54.0
	19-89	345.13	784	81487.8	103.9	2.27	236.1

[a]Eel damage noted. Numbers in total catch and in individual mesh sizes include damaged fish.

[b]Weights corrected for eel damage in individual mesh sizes.

[c]Corrected for eel damage as above.

Appendix 2 -- Effort and Catch Statistics with Separation by Species, Lake, and Year of Capture from Six Experimentally Fished Lakes of Gros Morne National Park, 1975-80. Weight data are corrected for eel damage, where required, as detailed in Appendix 1.

Table 1a. Effort and catch statistics for brook trout from six experimentally fished lakes of Gros Morne National Park, 1975-80.

Lake Name	Date	Units of effort (15 m$\cdot$24 h^{-1})	Brook trout Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Pond Point	Sept 8-9, 1975	10.78	55	5355.8	97.4	5.10	496.8
Big Pond	Sept 2-3, 1976	11.34	59	5862.2	99.4	5.20	517.0
	Aug 29-30, 1977	12.15	59	4679.5	79.3	4.86	385.1
	1975-77	34.27	173	15897.5	91.9	5.05	463.9
Candlestick	Aug 4-7, 1975	34.93	55	2772.0	50.4	1.57	79.4
Pond	Aug 18-20, 1976	35.89	85	5077.0	59.7	2.37	141.5
	June 18-21, 1977	39.99	55	4351.5	79.1	1.38	108.8
	July 29-31, 1978	12.48	19	1338.0	70.4	1.52	107.2
	1975-78	123.29	214	13538.5	63.3	1.74	109.8
Sandy	Aug 30-Sept 1, 1975	23.42	219	23270.0	106.3	9.35	993.6
Pond	Sept 23-26, 1976	53.18	358	33091.6	92.4	6.73	622.3
	Aug 19-21, 1977	33.09	268	25706.0	95.9	8.10	776.9
	Sept 5-7, 1978	27.20	143	17096.0	119.6	5.26	628.5
	Sept 18-21, 1979	63.63	238	32850.0	138.0	3.74	516.3
	1975-79	200.52	1226	132013.6	107.7	6.11	658.4
Wigwam	Sept 12-16, 1977	50.31	267	24400.5	91.4	5.31	485.0
Pond	Oct 5-6, 1978	21.98	106	13466.0	127.0	4.82	612.7
	Sept 4-7, 1979	42.40	144	23235.7	161.4	3.40	548.0
	Sept 9-11, 1980	21.60	98	13647.0	139.3	4.54	631.8
	1977-80	136.29	615	74749.2	121.5	4.51	548.5
Half	Sept 18-20, 1975	31.18	103	8953.2	86.9	3.30	287.2
Moon	Sept 20-23, 1976	53.11	128	16181.0	126.4	2.41	304.7
Pond	Sept 26-29, 1977	49.94	144	15340.5	106.5	2.88	307.2
	Sept 27-30, 1978	47.60	96	10465.0	109.0	2.02	219.9
	Oct 2-5, 1979	67.80	85	10451.0	123.0	1.25	154.1
	1975-79	249.63	556	61390.7	110.4	2.23	245.9
North	Sept 20-23, 1975	46.67	98	9381.7	95.7	2.10	201.0
Narrows	Sept 13-16, 1976	54.83	120	13160.6	109.7	2.19	240.0
Pond	Sept 19-24, 1977	83.22	256	25296.0	98.8	3.08	304.0
	Sept 13-25, 1978	88.40	179	19974.0	111.6	2.02	226.0
	Sept 12-15, 1979	72.00	131	13675.4	104.4	1.82	189.9
	1975-79	345.13	784	81487.8	103.9	2.27	236.1

Table 1b. Effort and catch statistics for Atlantic salmon from six experimentally fished lakes of Gros Morne National Park, 1975-80.

Lake Name	Date	Units of effort (15 m·24 h^{-1})	Atlantic salmon: Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Pond Point	Sept 8-9, 1975	10.78	0	0	0	0	0
Big Pond	Sept 2-3, 1976	11.34	0	0	0	0	0
	Aug 29-30, 1977	12.15	0	0	0	0	0
	1975-77	34.27	0	0	0	0	0
Candlestick	Aug 4-7, 1975	34.93	28	2244.0	80.1	0.80	64.2
Pond	Aug 18-20, 1976	35.89	39	3858.6	98.9	1.09	107.5
	June 18-21, 1977	39.99	33	2502.5	75.8	0.83	62.6
	July 29-31, 1978	12.48	3	339.0	113.0	0.24	27.2
	1975-78	123.29	103	8944.1	86.8	0.84	72.6
Sandy	Aug 30-Sept 1, 1975	23.42	0	0	0	0	0
Pond	Sept 23-26, 1976	53.18	0	0	0	0	0
	Aug 19-21, 1977	33.09	0	0	0	0	0
	Sept 5-7, 1978	27.20	0	0	0	0	0
	Sept 18-21, 1979	63.63	0	0	0	0	0
	1975-79	200.52	0	0	0	0	0
Wigwam	Sept 12-16, 1977	50.31	39[a]	6107.0	156.6	0.78	121.4
Pond	Oct 5-6, 1978	21.98	6	181.0	30.2	0.27	8.2
	Sept 4-7, 1979	42.40	24[b]	5939.0	247.5	0.57	140.1
	Sept 9-11, 1980	21.60	15[c]	8914.0	594.3	0.69	412.7
	1977-80	136.29	84	21141.0	251.7	0.62	155.1
Half	Sept 18-20, 1975	31.18	34	1386.0	40.8	1.09	44.5
Moon	Sept 20-23, 1976	53.11	86[d]	3813.5	44.3	1.81	71.8
Pond	Sept 26-29, 1977	49.94	60	1080.5	34.7	1.20	41.7
	Sept 27-30, 1978	47.60	23[e]	2753.5	119.7	0.48	57.9
	Oct 2-5, 1979	67.80	35[f]	2656.0	75.9	0.52	39.2
	1975-79	249.63	238	12689.5	53.3	0.95	50.8

Table 1b (cont'd)

Lake Name	Date	Units of effort (15 m·24 h^{-1})	Atlantic salmon Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
North	Sept 20-23, 1975	46.67	0	0	0	0	0
Narrows	Sept 13-16, 1976	54.83	0	0	0	0	0
Pond	Sept 19-24, 1977	83.22	0	0	0	0	0
	Sept 13-25, 1978	88.40	0	0	0	0	0
	Sept 12-15, 1979	72.00	0	0	0	0	0
	1975-79	345.13	0	0	0	0	0

[a]Includes 4 adult sea-run salmon with a total weight of 4956.0 g.

[b]Includes 6 adult sea-run salmon with a total weight of 5246.0 g.

[c]Includes 6 adult sea-run salmon with a total weight of 8519.0 g.

[d]One Atlantic salmon of approximately 1800 g escaped alive from net (not included here).

[e]Includes 1 adult sea-run salmon with a total weight of 2117.5 g.

[f]Includes 1 adult sea-run salmon with a total weight of 1260.0 g.

Table 1c. Effort and catch statistics for Arctic charr from six experimentally fished lakes of Gros Morne National Park, 1975-80.

Lake Name	Date	Units of effort (15 m$\cdot$24 h^{-1})	Arctic charr: Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Pond Point	Sept 8-9, 1975	10.78	0	0	0	0	0
Big Pond	Sept 2-3, 1976	11.34	0	0	0	0	0
	Aug 29-30, 1977	12.15	0	0	0	0	0
	1975-77	34.27	0	0	0	0	0
Candlestick	Aug 4-7, 1975	34.93	115	2021.0	17.6	3.29	57.9
Pond	Aug 18-20, 1976	35.89	40	727.6	18.2	1.11	20.3
	June 18-21, 1977	39.99	41	755.0	18.4	1.03	18.9
	July 29-31, 1978	12.48	9	144.1	16.0	0.72	11.6
	1975-78	123.29	205	3647.7	17.6	1.66	29.6
Sandy	Aug 30-Sept 1, 1975	23.42	0	0	0	0	0
Pond	Sept 23-26, 1976	53.18	0	0	0	0	0
	Aug 19-21, 1977	33.09	0	0	0	0	0
	Sept 5-7, 1978	27.20	0	0	0	0	0
	Sept 18-21, 1979	63.63	0	0	0	0	0
	1975-79	200.52	0	0	0	0	0
Wigwam	Sept 12-16, 1977	50.31	146	23961.0	164.1	2.90	476.3
Pond	Oct 5-6, 1978	21.98	32	6858.0	214.3	1.46	312.0
	Sept 4-7, 1979	42.40	32	5852.0	182.9	0.75	138.0
	Sept 9-11, 1980	21.60	0	0	0	0	0
	1977-80	136.29	210	36671.0	174.6	1.54	269.1
Half	Sept 18-20, 1975	31.18	13	234.0	18.0	0.42	7.5
Moon	Sept 20-23, 1976	53.11	49	1188.0	24.2	0.92	22.4
Pond	Sept 26-29, 1977	49.94	351	5235.0	14.9	7.03	104.8
	Sept 27-30, 1978	47.60	234	3124.0	13.4	4.92	65.6
	Oct 2-5, 1979	67.80	121	1971.0	16.3	1.78	29.1
	1975-79	249.63	768	11752.0	15.3	3.08	47.1
North	Sept 20-23, 1975	46.67	0	0	0	0	0
Narrows	Sept 13-16, 1976	54.83	0	0	0	0	0
Pond	Sept 19-24, 1977	83.22	0	0	0	0	0
	Sept 13-25, 1978	88.40	0	0	0	0	0
	Sept 12-15, 1979	72.00	0	0	0	0	0
	1975-79	345.13	0	0	0	0	0

Table 1d. Effort and catch statistics for rainbow smelt from six experimentally fished lakes of Gros Morne National Park, 1975-80.

			Rainbow smelt				
Lake Name	Date	Units of effort (15 m·24 h^{-1})	Number	Weight (g)	Mean weight (g)	No. per net effort	Wt. per net effort (g)
Pond Point	Sept 8-9, 1975	10.78	0	0	0	0	0
Big Pond	Sept 2-3, 1976	11.34	0	0	0	0	0
	Aug 29-30, 1977	12.15	0	0	0	0	0
	1975-77	34.27	0	0	0	0	0
Candlestick Pond	Aug 4-7, 1975	34.93	0	0	0	0	0
	Aug 18-20, 1976	35.89	0	0	0	0	0
	June 18-21, 1977	39.99	0	0	0	0	0
	July 29-31, 1978	12.48	0	0	0	0	0
	1975-78	123.29	0	0	0	0	0
Sandy Pond	Aug 30-Sept 1, 1975	23.42	11	236.0	21.5	0.47	10.1
	Sept 23-26, 1976	53.18	20	387.5	19.4	0.38	7.3
	Aug 19-21, 1977	33.09	2	46.0	23.0	0.06	1.4
	Sept 5-7, 1978	27.20	11	279.0	34.2	0.40	1.3
	Sept 18-21, 1979	63.63	38	995.0	26.2	0.60	15.6
	1975-79	200.52	82	1943.5	23.7	0.41	9.7
Wigwam Pond	Sept 12-16, 1977	50.31	9	83.0	9.2	0.18	1.7
	Oct 5-6, 1978	21.98	2	16.0	8.0	0.09	0.7
	Sept 4-7, 1979	42.40	0	0	0	0	0
	Sept 9-11, 1980	21.60	0	0	0	0	0
	1977-80	136.29	11	99.0	9.0	0.08	0.7
Half Moon Pond	Sept 18-20, 1975	31.18	0	0	0	0	0
	Sept 20-23, 1976	53.11	0	0	0	0	0
	Sept 26-29, 1977	49.94	0	0	0	0	0
	Sept 27-30, 1978	47.60	0	0	0	0	0
	Oct 2-5, 1979	67.80	0	0	0	0	0
	1975-79	249.63	0	0	0.	0	0
North Narrows Pond	Sept 20-23, 1975	46.67	0	0	0	0	0
	Sept 13-16, 1976	54.83	0	0	0	0	0
	Sept 19-24, 1977	83.22	0	0	0	0	0
	Sept 13-25, 1978	88.40	0	0	0	0	0
	Sept 12-15, 1979	72.00	0	0	0	0	0
	1975-79	345.13	0	0	0	0	0

Table le. Effort and catch statistics for all salmonids from six experimentally fished lakes of Gros Morne National Park, 1975-80.

Lake Name	Date	Units of effort (15 m·24 h^{-1})	All salmonids: Number	Weight (g)	No. per net effort	Wt. per net effort (g)
Pond Point	Sept 8-9, 1975	10.78	55	5355.8	5.10	496.8
Big Pond	Sept 2-3, 1976	11.34	59	5862.2	5.20	517.0
	Aug 29-30, 1977	12.15	59	4679.5	4.86	385.1
	1975-77	34.27	173	15897.5	5.05	463.9
Candlestick	Aug 4-7, 1975	34.93	198	7037.0	5.67	201.5
Pond	Aug 18-20, 1976	35.89	164	9663.2	4.57	269.2
	June 18-21, 1977	39.99	129	7609.0	3.23	190.3
	July 29-31, 1978	12.48	31	1821.1	2.48	145.9
	1975-78	123.29	522	26130.3	4.23	211.9
Sandy	Aug 30-Sept 1, 1975	23.42	219	23270.0	9.35	993.6
Pond	Sept 23-26, 1976	53.18	358	33091.6	6.73	622.3
	Aug 19-21, 1977	33.09	268	25706.0	8.10	776.9
	Sept 5-7, 1978	27.20	143	17096.0	5.26	628.5
	Sept 18-21, 1979	63.63	238	32850.0	3.74	516.3
	1975-79	200.52	1226	132013.6	6.11	658.4
Wigwam	Sept 12-16, 1977	50.31	452	54468.5	8.98	1082.7
Pond	Oct 5-6, 1978	21.98	144	20505.0	6.55	932.9
	Sept 4-7, 1979	42.40	200	35026.7	4.72	826.1
	Sept 9-11, 1980	21.60	113	22561.0	5.23	1044.5
	1977-80	136.29	909	132561.2	6.67	972.6
Half	Sept 18-20, 1975	31.18	150	10573.2	4.81	339.1
Moon	Sept 20-23, 1976	53.11	263	21182.5	4.95	398.8
Pond	Sept 26-29, 1977	49.94	555	22656.0	11.11	453.7
	Sept 27-30, 1978	47.60	353	16342.5	7.42	343.3
	Oct 2-5, 1979	67.80	241	15078.0	3.55	222.4
	1975-79	249.63	1562	85832.2	6.26	343.8
North	Sept 20-23, 1975	46.67	98	9381.7	2.10	201.0
Narrows	Sept 13-16, 1976	54.83	120	13160.6	2.19	240.0
Pond	Sept 19-24, 1977	83.22	256	25296.0	3.08	304.0
	Sept 13-25, 1978	88.40	179	19974.0	2.02	226.0
	Sept 12-15, 1979	72.00	131	13675.4	1.82	189.9
	1975-79	345.13	784	81487.8	2.27	236.1

Appendix 3 -- Summary of Data Employed in Comparisons of Growth in Length, the Derivation of Body-scale Relationships, and Resulting Overall Body-scale Relationships Used in the Back-calculation of Lengths at Age of Fishes From Gros Morne National Park

Table 1. Appendix 3 -- Summary of data employed in comparisons of growth in length, the derivation of body-scale relationships, and resulting overall body-scale relationships used in the back-calculation of lengths at age of fishes from Gros Morne National Park. Shown below the species names are the magnifications used for scale reading and measurement (mm) of fish scales. Intercepts, slopes, and correlation coefficients (r values) for body-scale relationships were obtained from regression of $\log_e$ fork length (mm) on $\log_e$ magnified scale radius (mm) for all fish from each species for each magnification.

Lake Name	Year of sample	Trout		Salmon		Charr		Smelt	
		X139	X46	X139	X46	X139	X46	X139	X46
Pond Point	1975	15							
Big Pond	1976	32							
	1977	22							
Candlestick	1975	17					11		
Pond	1976	32							
Sandy	1976	44						15	
Pond	1977	77						2	
	1978		25						5
	1979		44						21
Wigwam	1977	41		16		36		6	
Pond	1978		53				11		
	1979		54		13		10		
	1980		71		4				
Half Moon	1975		11				3		
Pond	1976	38				21			
	1977	7		10		7			
	1978		25		11		13		
	1979		31				25		
North	1975	8							
Narrows Pond	1976	45							
	1977	63							
	1978		46						
	1979		47						
All lakes	1975-80	441	407	26	28	64	73	23	26
Intercept		1.5406	2.8982	0.6236	1.9408	0.2898	2.5122	-1.9526	1.1280
Slope		0.892	0.769	0.896	0.823	1.126	0.816	1.251	0.900
r		0.8236	0.8026	0.9246	0.9214	0.9077	0.8449	0.8855	0.9056

Appendix 4 -- Calculated Lengths at Age of Brook Trout From Six Lakes of Gros Morne National Park With Separation by Year-class and Year of Capture

(See Appendix 3 for a numerical summary of the data employed for comparisons of growth in length and body-scale relationships used for back-calculating lengths at age.)

Table 1a. Calculated lengths at age of the year-classes of brook trout from Pond Point Big Pond. The number of aged fish of each year-class of each age-group is bracketed ( ).

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age				
			1	2	3	4	5
1971	1975-76	3	88.6 (3)	144.5 (3)	185.5 (3)	248.9 (3)	374.5 (1)
1972	1975-76	11	68.1 (11)	125.2 (11)	178.0 (11)	219.1 (7)	
1973	1975-77	17	80.2 (17)	138.8 (17)	183.6 (10)	220.0 (3)	
1974	1975-77	20	70.5 (20)	129.2 (18)	181.9 (5)		
1975	1976-77	15	78.3 (15)	125.8 (11)			
1976	1977	3	67.0 (3)				
Weighted mean			75	131	181	226	375
Number of fish		69	69	60	29	13	1

Table 1b. Calculated lengths at age by year-class and year of capture of brook trout from Pond Point Big Pond.

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age				
			1	2	3	4	5
1971	1975	2	89.7	136.0	170.6	222.7	
	1976	1	86.5	161.6	215.3	301.3	374.5
1972	1975	4	68.5	124.0	180.0		
	1976	7	67.9	125.8	176.8	219.1	
1973	1975	7	88.6	150.5			
	1976	7	76.9	135.9	187.8		
	1977	3	68.5	118.5	173.9	220.0	
1974	1975	2	60.9				
	1976	13	72.0	130.4			
	1977	5	70.5	125.9	181.9		
1975	1976	4	68.0				
	1977	11	82.1	125.8			
1976	1977	3	67.0				
Weighted mean			75	131	181	226	375
Number of fish		69	69	60	29	13	1

Table 2a. Calculated lengths at age of the year-classes of brook trout from Candlestick Pond. The number of aged fish of each year-class of each age-group is bracketed ( ).

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age 1	2	3	4
1972	1976	1	82.8 (1)	154.4 (1)	194.1 (1)	249.4 (1)
1973	1975	11	89.3 (11)	142.3 (11)		
1974	1975-76	25	85.1 (25)	137.6 (19)		
1975	1976	12	79.4 (12)			
Weighted mean			85	140	194	249
Number of fish		49	49	31	1	1

Table 2b. Calculated lengths at age by year-class and year of capture of brook trout from Candlestick Pond.

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age 1	2	3	4
1971	1976	1	82.8	154.4	194.1	249.4
1973	1975	11	89.3	142.3		
1974	1975	6	94.4			
	1976	19	82.1	137.6		
1975	1976	12	79.4			
Weighted mean			85	140	194	249
Number of fish		49	49	31	1	1

Table 3a. Calculated lengths at age of the year-classes of brook trout from Sandy Pond. The number of aged fish of each year-class of each age-group is bracketed ( ).

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age				
			1	2	3	4	5
1972	1976-77	4	97.6 (4)	195.9 (4)	258.0 (4)	312.4 (4)	329.0 (1)
1973	1976	8	94.0 (8)	184.9 (8)	248.9 (8)		
1974	1976-79	33	89.3 (33)	160.5 (33)	222.6 (12)	319.5 (3)	376.2 (1)
1975	1976-79	58	98.6 (58)	168.9 (46)	262.9 (6)	320.7 (2)	
1976	1977-79	51	93.0 (51)	178.2 (24)	250.7 (10)		
1977	1978-79	35	100.7 (35)	177.4 (30)			
1978	1979	1	95.8 (1)				
Weighted mean			96	172	245	317	353
Number of fish		190	190	145	40	9	2

Table 3b. Calculated lengths at age by year-class and year of capture of brook trout from Sandy Pond.

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age				
			1	2	3	4	5
1972	1976	3	103.2	212.3	265.8	321.0	
	1977	1	80.7	146.5	234.6	286.7	329.0
1973	1976	8	94.0	184.9	248.9		
1974	1976	21	85.6	157.5			
	1977	9	88.3	159.2	211.0		
	1978	2	120.8	189.9	257.6	316.8	
	1979	1	111.2	176.7	257.2	324.8	376.2
1975	1976	12	83.0				
	1977	40	101.3	165.6			
	1978	4	115.3	191.4	267.6		
	1979	2	105.6	190.6	253.5	320.7	
1976	1977	27	80.8				
	1978	14	106.1	174.2			
	1979	10	107.6	183.8	250.7		
1977	1978	5	75.8				
	1979	30	104.9	177.4			
1978	1979	1	95.8				
Weighted mean			96	172	245	317	353
Number of fish		190	190	145	40	9	2

Table 4a. Calculated lengths at age of the year-classes of brook trout from Wigwam Pond. The number of aged fish of each year-class of each age-group is bracketed ( ).

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age				
			1	2	3	4	5
1972	1977	2	105.9 (2)	183.2 (2)	256.7 (2)	318.4 (2)	357.5 (2)
1973	1977	4	87.2 (4)	147.7 (4)	205.7 (4)	275.3 (4)	
1974	1977-78	7	88.7 (7)	152.5 (7)	218.4 (7)	231.0 (1)	
1975	1977-79	30	86.7 (30)	145.9 (30)	222.5 (6)	273.6 (1)	
1976	1977-80	76	97.2 (76)	166.1 (71)	230.3 (33)	275.0 (9)	
1977	1978-80	57	92.7 (57)	157.5 (48)	213.8 (19)		
1978	1980	41	85.8 (41)	142.0 (41)			
1979	1980	2	72.9 (2)				
Weighted mean			92	156	227	278	358
Number of fish		219	219	203	70	17	2

Table 4b. Calculated lengths at age by year-class and year of capture of brook trout from Wigwam Pond.

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age				
			1	2	3	4	5
1972	1977	2	105.9	183.2	256.7	318.4	357.5
1973	1977	4	87.2	147.7	205.7	275.3	
1974	1977	6	91.2	158.3	228.4		
	1978	1	73.5	118.0	158.1	231.0	
1975	1977	24	84.6	143.2			
	1978	5	97.6	159.4	224.8		
	1979	1	83.2	143.2	211.2	273.6	
1976	1977	5	71.8				
	1978	38	98.1	164.8			
	1979	24	103.2	172.9	236.0		
	1980	9	91.4	153.1	215.0	175.0	
1977	1978	9	83.6				
	1979	29	98.2	162.9			
	1980	19	88.7	149.2	213.8		
1978	1980	41	85.8	142.0			
1979	1980	2	72.9				
Weighted mean			92	156	227	278	358
Number of fish		219	219	203	70	17	2

Table 5a. Calculated lengths at age of the year-classes of brook trout from Half Moon Pond. The number of aged fish of each year-class of each age-group is bracketed ( ).

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age				
			1	2	3	4	5
1971	1976	1	69.7 (1)	112.0 (1)	198.3 (1)	265.1 (1)	347.0 (1)
1972	1975-76	8	87.6 (8)	154.0 (8)	215.5 (8)	258.4 (3)	
1973	1975-77	19	78.1 (19)	146.8 (19)	208.8 (15)	285.6 (1)	
1974	1975-77	24	73.9 (24)	138.8 (22)	197.9 (5)		
1975	1976-78	11	89.3 (11)	156.0 (8)	216.1 (7)		
1976	1978-79	25	96.3 (25)	162.7 (25)	210.0 (7)		
1977	1979	23	94.2 (23)	156.1 (23)			
1978	1979	1	98.0 (1)				
Weighted mean			87	152	210	265	347
Number of fish		112	112	106	43	5	1

Table 5b. Calculated lengths at age by year-class and year of capture of brook trout from Half Moon Pond.

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age 1	2	3	4	5
1971	1976	1	69.7	112.0	198.3	265.1	347.0
1972	1975	5	96.3	166.0	224.1		
	1976	3	73.2	133.9	201.2	258.4	
1973	1975	4	96.6	153.6			
	1976	14	72.6	144.2	208.9		
	1977	1	81.4	156.0	207.8	285.6	
1974	1975	2	77.9				
	1976	17	73.8	141.3			
	1977	5	72.5	130.2	197.9		
1975	1976	3	80.4				
	1977	1	102.2	152.8			
	1978	7	91.3	156.5	216.1		
1976	1978	18	99.7	168.2			
	1979	7	87.6	148.5	210.0		
1977	1979	23	94.2	156.1			
1978	1979	1	98.0				
Weighted mean			87	152	210	265	347
Number of fish		112	112	106	43	5	1

Table 6a. Calculated lengths at age of the year-classes of brook trout from North Narrows Pond. The number of aged fish of each year-class of each age-group is bracketed ( ).

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age 1	2	3	4	5
1971	1975-76	3	74.8 (3)	129.5 (3)	183.2 (3)	218.1 (3)	267.3 (1)
1972	1975-77	13	79.0 (13)	145.0 (13)	192.6 (13)	235.5 (11)	264.4 (1)
1973	1975-77	27	75.5 (27)	130.4 (27)	181.6 (25)	227.2 (12)	
1974	1975-78	38	86.2 (38)	144.0 (36)	190.5 (20)	239.6 (4)	
1975	1976-79	39	92.1 (39)	148.0 (34)	201.3 (12)	235.0 (2)	
1976	1977-79	57	88.1 (57)	146.9 (45)	193.0 (22)		
1977	1978-79	31	95.6 (31)	156.2 (22)			
1978	1979	1	93.1 (1)				
Weighted mean			87	145	190	231	266
Number of fish		209	209	180	95	32	2

Table 6b. Calculated lengths at age by year-class and year of capture of brook trout from North Narrows Pond.

Year-class	Year of capture	No. of fish	Mean calculated length (mm) at age 1	2	3	4	5
1971	1975	2	78.5	140.3	188.2	221.5	
	1976	1	67.4	108.0	173.1	211.2	267.3
1972	1975	2	80.1	137.1	188.7		
	1976	10	78.6	148.8	195.0	237.6	
	1977	1	81.0	122.8	175.9	214.4	264.4
1973	1975	2	75.9	150.9			
	1976	13	77.1	133.4	180.5		
	1977	12	73.8	123.8	182.7	227.2	
1974	1975	2	84.8				
	1976	16	89.7	149.0			
	1977	16	82.8	138.3	189.2		
	1978	4	86.6	146.8	195.5	239.6	
1975	1976	5	82.9				
	1977	22	94.9	148.5			
	1978	10	92.0	149.1	202.7		
	1979	2	85.6	137.4	194.4	235.0	
1976	1977	12	83.7				
	1978	23	89.3	148.2			
	1979	22	89.3	145.6	193.0		
1977	1978	9	81.3				
	1979	22	101.4	156.2			
1978	1979	1	93.1				
Weighted mean			87	145	190	231	266
Number of fish		209	209	180	95	32	2

Appendix 5 -- Lengths of the Age-groups of Atlantic Salmon from Two Lakes of Gros Morne National Park With Separation by Year-class and Year of Capture

(See Appendix 3 for a numerical summary of the data employed for comparisons of growth in length and calculated body-scale relationships.
See Barbour et al. (1979) for Candlestick Pond data.)

Table 1. Mean empirical lengths in each age-group of the year-classes of Atlantic salmon from Half Moon Pond.

Year-class	Dates of capture	No. of fish	Mean length (mm) in age-group 1	2
1975	Sept 26-29, 1977	4		166.3
1976	Sept 26-29, 1977	6	106.8	
	Sept 27, 1978	9		133.3
1977	Sept 27, 1978	2	110.0	
Weighted mean			107.6	143.5
Number of fish		21	8	13

Table 2. Mean empirical lengths in each age-group of the year-classes of Atlantic salmon from Wigwam Pond. Bracketed figures beside mean lengths indicate freshwater and marine ages, respectively, of sea-run salmon.

Year-class	Dates of capture	No. of fish	Mean length (mm) in age-group 1	2	3	4	5
1973	Sept 12-16, 1977	3				512.7 (3:1)	
1974	Sept 12-16, 1977	1			165.0		
	Sept 5-7, 1979	1					535.0 (4:1)
1975	Sept 12-16, 1977	10		148.4			
	Sept 5-7, 1979	3				506.7 (3:1)	
1976	Sept 12-16, 1977	2	110.5				
	Sept 10-11, 1980	2				545.0 (3:1)	
1977	Sept 5-7, 1979	9		139.4			
1979	Sept 10-11, 1980	2	117.5				
Weighted mean			114.0	144.1	165.0	518.5 (3:1)	535.0 (4:1)
Number of fish		33	4	19	1	8	1

Appendix 6 -- Lengths of the Age-groups of Arctic Charr From Three Lakes of Gros Morne National Park with Separation by Year-class and Year of Capture

(See Appendix 3 for a numerical summary of the data employed for comparisons of growth in length and calculated body-scale relationships.)

Table 1a. Mean empirical lengths in each age-group of the year-classes of Arctic charr aged by otoliths from Candlestick Pond. Data from Rombough et al. (1978).

Year-class	Dates of capture	No. of fish	Mean length (mm) in age-group 1	2	3	4	5	6	7
1970	June 19-21, 1977	1							164.0
1971	Aug 19-20, 1976	2					144.0		
1972	Aug 19-20, 1976	4				132.8			
	June 19-21, 1977	3					132.7		
1973	Aug 19-20, 1976	24			118.6				
	June 19-21, 1977	22				121.1			
1974	Aug 19-20, 1976	1		102.0					
	June 19-21, 1977	9			112.4				
1975	Aug 19-20, 1976	6	85.8						
Weighted Mean			85.8	102.0	116.9	122.9	137.2		164.0
Number of fish		72	6	1	33	26	5		1

Table 1b. Mean empirical length at age of Arctic charr aged by scales from Candlestick Pond.

Year-class	Dates of capture	No. of fish	Mean length (mm) in age-group 1
1974	Aug 6-7, 1975	11	119.4

Table 2. Mean empirical lengths in each age-group of the year-classes of Arctic charr aged by scales from Wigwam Pond.

Year-class	Dates of capture	No. of fish	Mean length (mm) in age-group				
			1	2	3	4	5
1972	Sept 26-29, 1977	1					387.0
1973	Sept 26-29, 1977	5				318.2	
1974	Sept 26-29, 1977	14			283.2		
	Oct 6, 1978	2				270.0	
1975	Sept 26-29, 1977	10		205.6			
	Oct 6, 1978	9			225.6		
	Sept 5-7, 1979	1				280.0	
1976	Sept 26-29, 1977	6	115.7				
	Sept 5-7, 1979	7			251.4		
1977	Sept 5-7, 1979	2		195.0			
Weighted mean			115.7	203.8	258.5	301.4	387.0
Number of fish		57	6	12	30	8	1

Table 3. Mean empirical lengths in each age-group of the year-classes of Arctic charr aged by scales from Half Moon Pond.

Year-class	Dates of capture	No. of fish	Mean length (mm) in age-group				
			1	2	3	4	5
1971	Sept 27-29, 1978	1					158.0
1972	Sept 20-23, 1976	1				192.0	
1973	Sept 19, 1975	3		113.3			
	Sept 20-23, 1976	6			159.7		
1974	Sept 20-23, 1976	12		120.5			
1975	Sept 20-23, 1976	2	86.0				
	Sept 26-29, 1977	7		111.9			
1976	Sept 27-29, 1978	1		170.0			
1977	Sept 27-29, 1978	11	105.9				
	Oct 4, 1979	2		135.0			
1978	Oct 4, 1979	23	127.0				
Weighted mean			118.3	120.4	159.7	192.0	158.0
Number of fish		69	36	25	6	1	1

Appendix 7 -- Lengths of the Age-Groups of Rainbow Smelt from Two Lakes of Gros Morne National Park with Separation by Year-class and Year of Capture

(See Appendix 3 for a numerical summary of the data employed for comparisons of growth in length and calculated body-scale relationships.)

Table 1. Mean empirical lengths in each age-group of the year-classes of rainbow smelt from Sandy Pond.

Year-class	Dates of capture	No. of fish	Mean length (mm) in age-group			
			1	2	3	4
1973	Sept 23-26, 1976	8			161.6	
1974	Sept 23-26, 1976	7		136.0		
	Aug 19-21, 1977	1			180.0	
1975	Aug 19-21, 1977	1		145.0		
	Sept 6-7, 1978	1			160.0	
	Sept 19-23, 1979	2				180.0
1976	Sept 6-7, 1978	3		155.0		
	Sept 19-23, 1979	15			175.0	
1977	Sept 6-7, 1978	1	95.0			
	Sept 19-23, 1979	4		122.5		
Unweighted mean			95.0	136.8	170.3	180.0
Number of fish		43	1	15	25	2

Table 2. Mean empirical lengths at age of rainbow smelt from Wigwam Pond.

Year-class	Dates of capture	No. of fish	Mean length (mm) in age-group 1	Mean length (mm) in age-group 2
1975	Sept 12-16, 1977	6		98.3