The Cage Rearing of Rainbow Trout in a Brackish Water Pond in Newfoundland, 1978

A. Jamieson

Research and Resource Services Directorate
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland
A1C 5X1

May 1980

Canadian Industry Report of Fisheries and Aquatic Sciences No. 115

Government of Canada
Fisheries and Oceans
Gouvernement du Canada
Pêches et Océans

Canadian Industry Report of Fisheries and Aquatic Sciences

These reports contain the results of research and development that are useful to industry for either immediate or future application. Industry Reports are directed primarily towards individuals in the primary and secondary sectors of the fishing and marine industries. No restriction is placed on subject matter and the series reflects the board interests and policies of the Department of Fisheries and Oceans, namely, fisheries management, technology and development, ocean sciences, and aquatic environments relevent to Canada.

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

Numbers 1-91 in this series were issued as Project Reports of the Industrial Development Branch, Technical Reports of the Industrial Development Branch, and Technical Reports of the Fisherman's Service Branch. Numbers 92-110 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Industry Reports. The current series name was changed with report number 111.

Details on the availability of Industry Reports in hard copy may be obtained from the issuing establishment on the front cover.

Rapport canadien à l'industrie sur les sciences halieutiques et aquatiques

Ces rapports contiennent les résultats des recherches et des progrès qui peuvent être utiles à l'industrie pour des applications soit immédiates, soit futures. Ils sont préparés à l'intention principalement des membres des secteurs primaire et secondaire de l'industrie des pêches et de la mer. 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, notamment gestion des pêches, techniques et développement, sciences océaniques et environnements aquatiques, au Canada.

Les Rapports destinés à l'industrie peuvent être considérés comme des publications complètes. Le titre exact paraît au haut du résumé de chaque rapport, qui sera publié dans la revue *Aquatic Sciences and Fisheries Abstracts* et qui figurera dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros de 1 à 91 de cette série ont été publiés à titre de rapports sur les travaux de la Direction du développement industriel, de rapports techniques de la Direction du développement industriel, et de rapports techniques de la Direction des services aux pêcheurs. Les numéros 92 à 110 ont été publiés à titre de Rapports à l'industrie du Service des pêches et de la mer, Ministère des Pêches et de l'Environnement. Le nom de la série a été changé à partir du rapport numéro 111.

La page couverture porte le nom de l'établissement auteur où l'on peut se procurer les rapports sous couverture cartonnée.

Canadian Industry Report of

Fisheries and Aquatic Sciences

No. 115

May 1980

THE CAGE REARING OF RAINBOW TROUT IN A BRACKISH WATER POND IN NEWFOUNDLAND, 1978

by

A. Jamieson

Research and Resource Services Directorate
Department of Fisheries and Oceans
P. O. Box 5667
St. John's, Newfoundland
A1C 5X1

This is the second Industry Report from the
Research and Resource Services Directorate, St. John's, Newfoundland

PREFACE

The intent of this report is to describe and discuss a pilot project to rear rainbow trout in net cages in Scotts (Scotch) Pond, Greens Harbour, Trinty Bay during the summer of 1978. This project was carried out under the management of Mr. Fletcher Peach for the Upper Trinity South Regional Development Association (UTSRDA). Mr. Peach also designed and supervised the construction of the locally-made cages and rafts. Technical assistance was provided by Mr. Ron Scaplen of the provincial Department of Fisheries and the author. A brief history of the development of the trout farm and hatchery at Hopeall prior to the cage rearing experiment is presented below.

In 1975, the UTSRDA received funding from the provincial Department of Rural Development for the construction of the Hopeall trout hatchery.

In May of 1976 the first wild brood stock was delivered to the hatchery. These 230 trout (104 female and 126 male) were collected and delivered by Fisheries and Marine Service personnel. These trout, along with another batch delivered in the spring of 1977, provided the basis for the hatchery operation (Jamieson 1978).

The wild brood stock was collected from streams and ponds located in the St. John's east area of the Avalon Peninsula.

The concept for the project had evolved at that stage to include two main points:

(1) To develop (from wild stock) a local brood stock of rainbow trout to provide young fish for growing to market size.

(2) To test the biological and economic feasibility of rearing rainbow trout from eggs to market size (approx. 250 g) in 18 months in Newfoundland.

The financial input for the 3-year pilot project was:

Phase I	$43,906.00
Phase II	$22,530.00
Phase III	$25,780.00

A Canada Works project in the summer of 1977 provided another $50,000.00. Extra funding from the Department of Rural Development for cage culture work was - $33,540.00.

The provincial Department of Fisheries provided capital funds to improve the facilities which amounted to approximately $39,000.00 up to March 1979. This made a grand total of $214,756.00 from all sources over the 3 years of operation.

Cat. no. Fs 97-14/115 ISSN 0704-3694

CONTENTS

ABSTRACT

Jamieson, A. 1980. The cage rearing of rainbow trout in a brackish water pond in Newfoundland, 1978. Can. Ind. Rep. Fish. Aquat. Sci. 115: iv + 18 p.

An experiment designed to evaluate the feasibility of cage rearing rainbow trout in a brackish water pond in Newfoundland was carried out in Scotts Pond (Scotch Pond) Trinity Bay in 1978.

Rainbow trout (1-yr-old), averaging 11.5 g in June reached a final average weight of 270 g by November. Two-yr-old trout averaging 68.7 g initial weight in June reached a final average weight of 337.8 g by November.

The major constituent of the diet was marine fish and fish offal.

The results demonstrated the biological feasibility of the cage culture method to rear rainbow trout to market weight in a 6-month growing season in a Newfoundland brackish water habitat.

Key words: cage rearing, rainbow trout, brackish water, Newfoundland, feed (marine fish and fish offal)

RÉSUMÉ

Jamieson, A. 1980. The cage rearing of rainbow trout in a brackish water pond in Newfoundland, 1978. Can. Ind. Rep. Fish. Aquat. Sci. 115: iv + 18 p.

Une expérience destinée à évaluer la faisabilité de l'élevage en cage de truite arc-en-ciel dans un étang d'eau saumâtre à Terre-Neuve a été réalisée en 1978 à l'étang Scotts (lac Scotch), baie de la Trinité.

Les truites arc-en-ciel (âgées d'un an), pesant en moyenne 11,5 g, en Juin ont atteint un poids final moyen de 270 g en novembre. Les truites âgées de deux ans, pesant en moyenne 68,7 g de poids initial, ont atteint un poids final moyen de 337,8 g en november. L'alimentation était constituée pour l'essentiel de poisson de mer et d'issues de poisson.

Les résultats ont démontré la faisabilité biologique de la méthode d'élevage en cage pour amener des truites arc-en-ciel à une taille commercialisable au cours d'une période de croissance de six mois, dans un habitat d'eau saumâtre de Terre-Neuve.

Mots clés: élevage en cage, truite arc-en-ciel, eau saumâtre, Terre-Neuve, nourriture (poisson de mer et issues de poisson)

INTRODUCTION

The cage rearing of rainbow trout and other salmonids is now an established business in parts of Europe, Asia and North America. A project was conducted in Scotts Pond, Greens Harbour, Trinity Bay, during the summer of 1978, to test the practicality of this cultural technique in a Newfoundland brackish water habitat. The main objective of the experiment was to determine if artificially-fed rainbow trout would grow from approximately 11 g to 250 g in the 6-month Newfoundland growing season.

The intent in this experiment was to use as much as possible locally available fish scraps and other low cost marine fishes as the major source of feed. The types of fish scraps and marine fishes varied throughout the experiment and depended on what was available. Appendices 2 and 3 give the amounts and kinds of feed used throughout the test period.

This pilot project has served to give the necessary experience to handle a much larger, full scale commercial operation.

MATERIALS AND METHODS

Beginning in the last week of May 1978 and continuing into the first week of June, rainbow trout reared at the Hopeall hatchery were placed in net cages, located in Scotts Pond, Greens Harbour, Trinity Bay (Fig. 1).

Scotts Pond, Lat. 47°37'53", Long. 53°30'08" is a brackish water pond located in the town of Greens Harbour, Trinity Bay. Fig. 2 shows the depth contours and that the pond lies in a general northwest-southeast direction. The morphometry of the pond, Appendix 1, shows that about 7.7% of the depth extends to 3 m, for a total of 2.4 ha. These are the areas that would provide the cage rearing sites within the pond.

The cages measured 6.1 m x 9.1 m and had a maximum depth of 4.8 m, but were used at 3.0 m. Four of these cages were suspended from the railing on a locally-constructed wooden raft.

Nineteen millimeter (19 mm) knotless nylon netting was used in the construction of the cages and in the covering for the top of the cages that was installed to protect against predators (gulls, etc.).

The raft was constructed from 5 cm x 10 cm lumber in the framing and railing, with 2.5 cm board being used in the walkways. The outside dimensions of the raft were 15.8 m x 21.9 m, with 1.2 m wide walkways (see Fig. 3). Flotation was provided by 5 cm styrofoam under all walkways.

Two groups of experimental fish (Table 1) were used in the experiment to compare the growth rate of 1- and 2-yr-old trout.

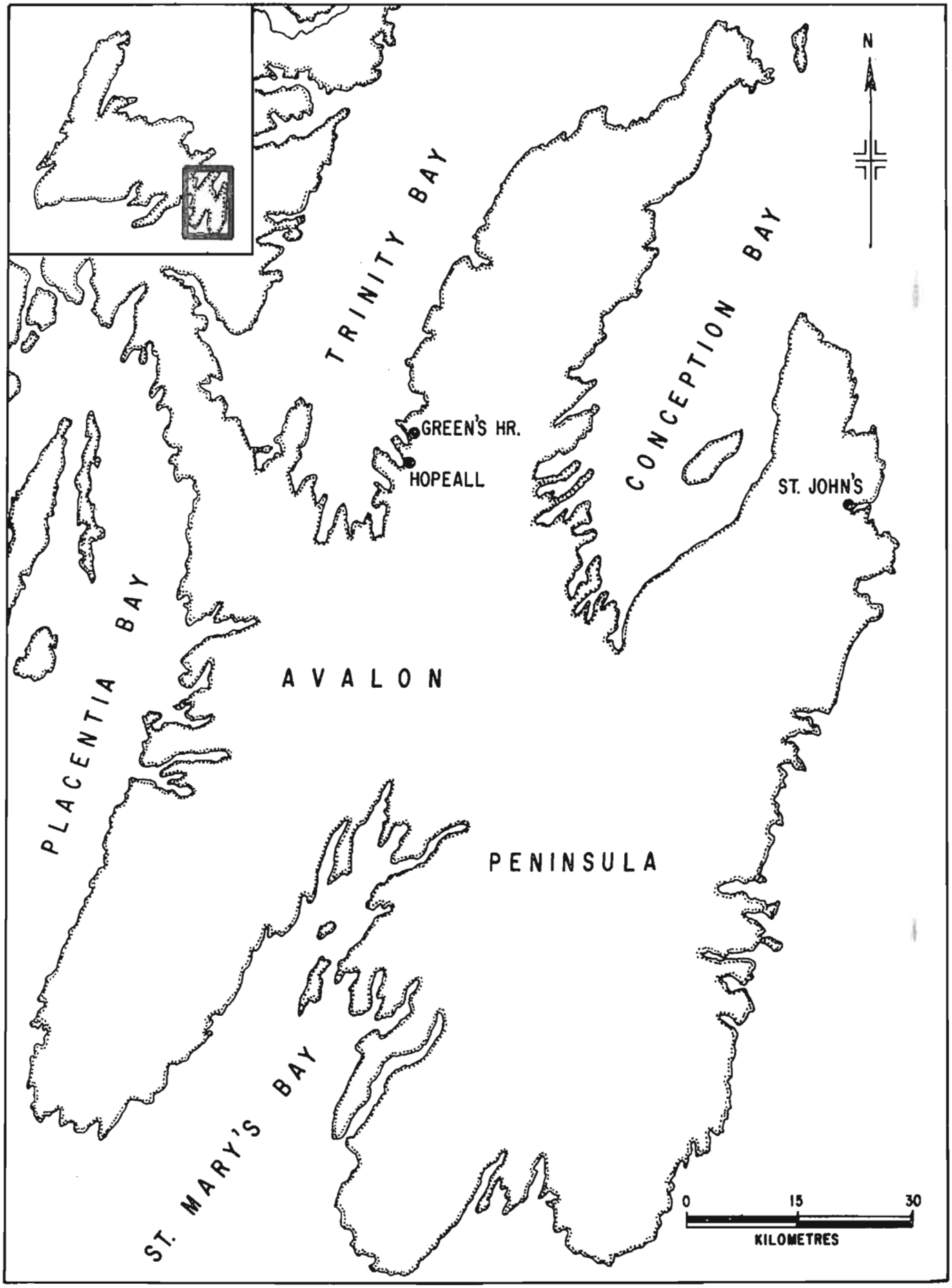


Fig. 1. Location map.

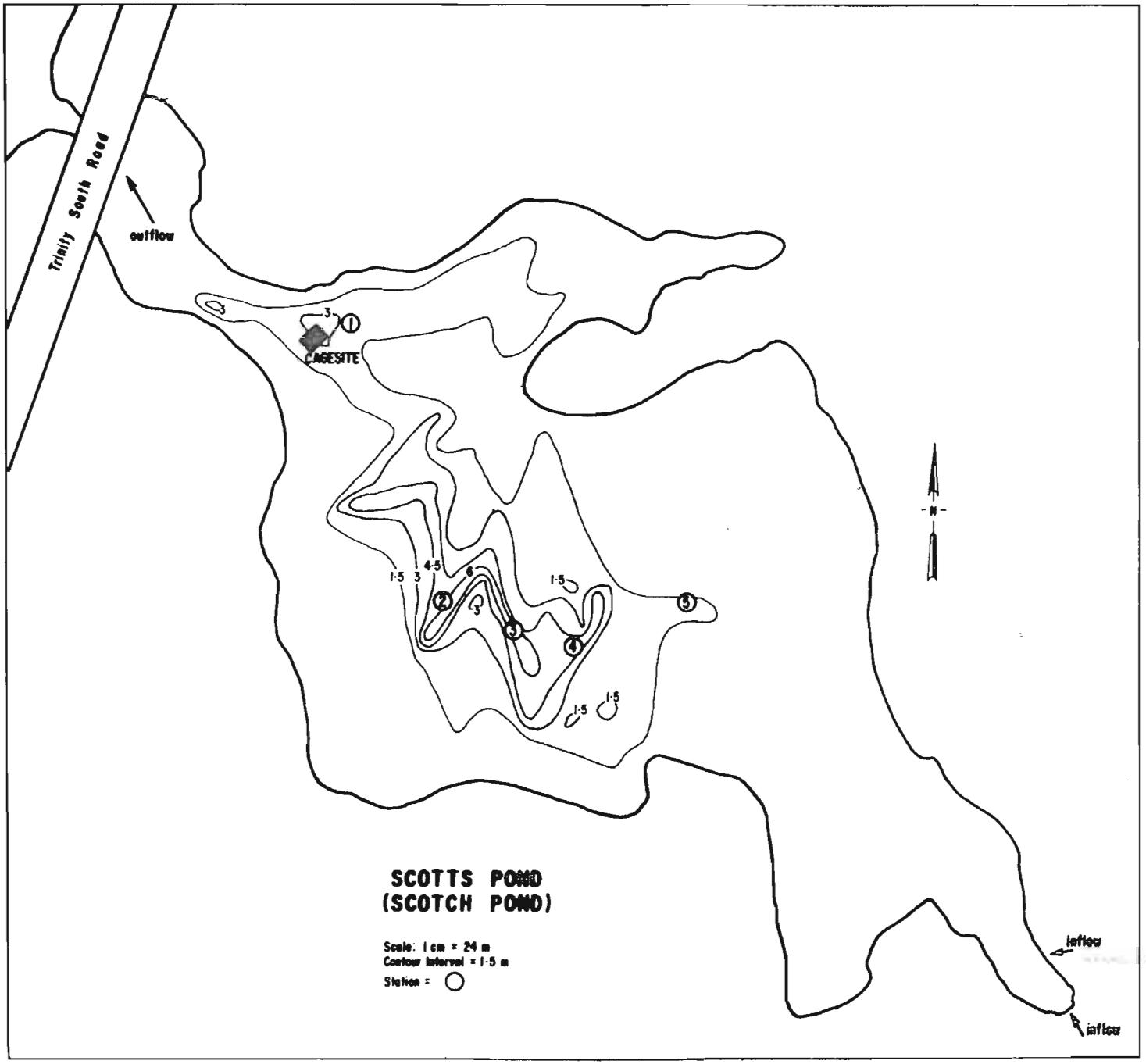


Fig. 2. Scotts Pond.

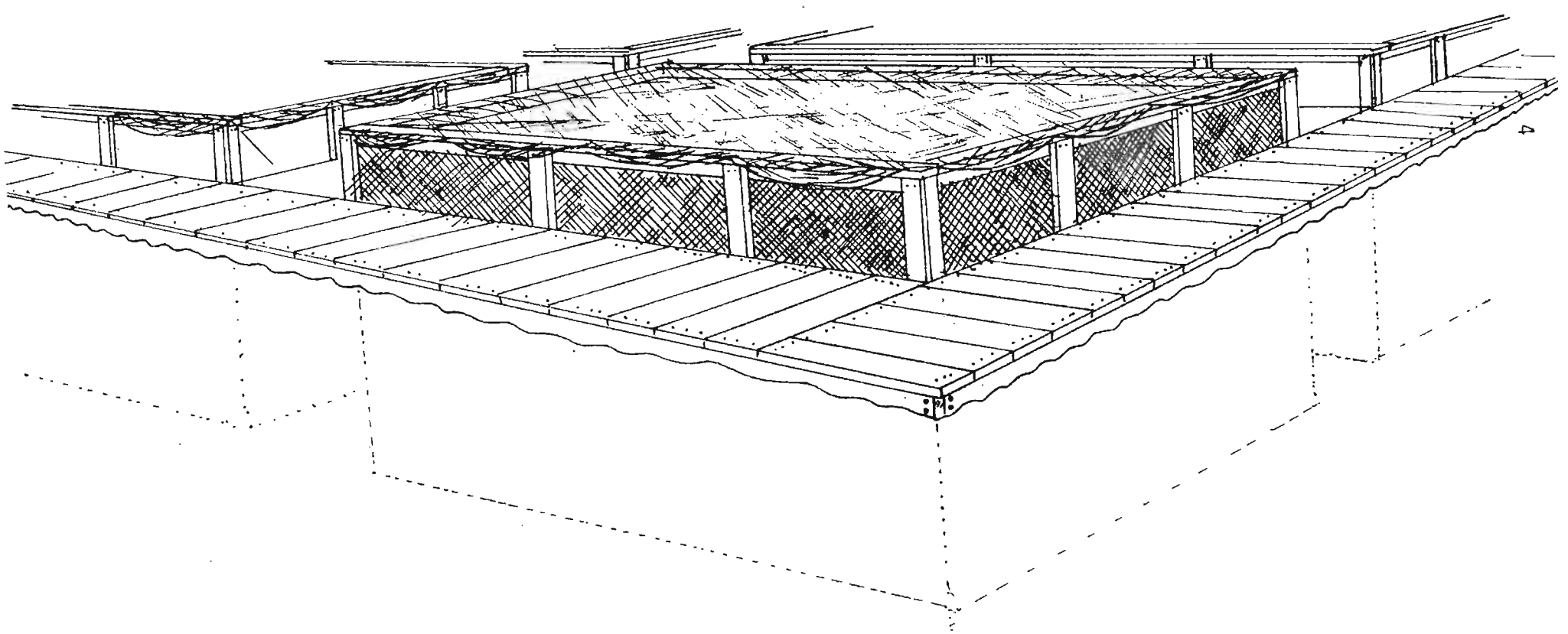


Fig. 3. Raft and net cages with predation covers.

The trout were acclimated over a 10-day period by gradually lowering the net cage into the deeper salt water layer. The surface water down to about 1.5-2 m was fresh.

Table 1. Number and size of trout stocked.

Cage no.	Number stocked	Average length (cm)	Average weight (g)
I	2188	9.8	11.5
II	2516	17.3	68.7

Trout comparable to those in Cage I were reared in raceways at the hatchery and fed the same ration at the same rate as the cage reared group. This was to provide a method of comparison between raceway reared trout and cage reared trout.

Two types of food were used in the feeding program, a commercial dry pellet (EWOS 5 P crumbles) was fed in conjunction with the wet mix. The wet mix consisted of marine fish and fish offal. This was ground in a food grinder, mixed with a 10% binder meal and pigmentation food.

Every effort was made to maintain a feeding frequency of three times per day and it was only because of bad weather or equipment malfunction that this schedule was not followed.

Temperature and oxygen content were measured in the experimental cages from July 5 to October 25. These two parameters, plus salinity, were also measured from the raft outside the cages and throughout the brackish water area of Scotts Pond (Fig. 2). This information was needed to make comparisons of oxygen levels inside and outside the cages, and to check variations in these parameters with changes in depth.

As an adjunct to the main experiment some processing and test marketing were done in co-operation with a fish processor in the area.

RESULTS

FEEDING

The food ration, and particularly the wet mix, was readily accepted by the trout. There was, however, less vigorous feeding when the water temperatures rose in mid-summer.

Appendix 2 gives a listing of the various ingredients used in the food, and Appendix 3 gives the feeding rate. These particular food mixes appeared to provide all the necessary requirements for trout growth as shown by the conversion rate (Table 2). The conversion rate gives the amount of food used (in kg) to produce a kilogram of trout. This is expressed as a ratio. Three different ratios are given for each cage, as explained in the note accompanying Table 2.

GROWTH

Table 3 shows the weight gain for both 1-yr-old (Cage I) and 2-yr-old (Cage II) trout. The most significant growth increment was for the 1-yr-olds which went from 11.5 g to 270 g, a gain of just over 258 g in 180 days. Comparable trout reared in raceways in the Hopeall hatchery displayed a weight increase of just over 65 g for the same time period (Table 3).

The growth in cages was about four times that of the trout reared in raceways in the Hopeall hatchery.

The weight gain on the 2-yr-old trout (Cage II) was an average 269 g or a gain of just under 4 times the starting weight of 68.7 g. By comparison the weight gain on the 1-yr-old trout (Cage I) was just over 22 times the starting weight.

CAGES AND PLATFORM

The cages functioned well. The large size of the raft structure provided a good working platform; however, it presented some difficulties in moving and in mooring because of its large size. The bottom of the pond in the study area was mud, and provided poor anchorage. Shorefasts were used to hold the raft on site, after it had been moved several times by high winds. The netting became fouled with marine growth and waste food as the summer progressed, making it rather difficult and unpleasant to haul. However, it did not cause any difficulties to the trout due to low stocking densities.

Table 2. Conversion rates.

	*Wet food converted 3 to 1 (dry food equivalent)	Wet food converted 3.5 to 1 (dry food equivalent)	Wet food converted 4 to 1 (dry food equivalent)
Cage I	2.4	2.1	1.9
Cage II	2.0	1.9	1.7

* It is general practice in aquaculture to convert wet food to dry food equivalents, so that comparisons may be made. The moisture content of the wet food is a variable factor that changes with processing, season, and species of fish, etc. To overcome this variability (and not having had moisture content analysis done on the food used), the standard ratios of 3 to 1, 3.5 to 1, and 4 to 1 were considered in this case to be fairly realistic for use in calculating the conversion rate.

An overall conversion of 1.5 to 1 is considered to be very good.

Table 3. Growth.

	Initial average weight (g)	Initial average length (cm)	Final* average weight (g)	Final average length (cm)	Average weight gain (g)
Cage I	11.5	9.8	270.0	25.2	258.5
Cage II	68.7	17.3	337.8	33.3	269.1
Raceway	11.5	9.8	76.7	17.2	65.2

* See Appendix 4a, b and c.

SURVIVAL

Survival at harvest of 87% and 89% for 1- and 2-yr-old trout, respectively, shows that mortality rate was not a problem with the low stocking density used (Table 4). It is interesting to note that 30% of the Cage I mortality and 70% of the Cage II mortality occurred within a week to 10 days of being placed in the cages, and was possibly due to an inability to acclimate to cage conditions.

Table 4. Stocking rate and mortality.

Cage no.	Number stocked	Stocking density*	Mortality	Percent survival
I	2188	*31 g per m^3	277	87
II	2516	*45 g per m^3	279	89
Totals	4704		556	88

* Based on harvest weight and number.

ENVIRONMENTAL CONDITIONS

Scotts Pond exhibits a lot of the characteristics of a still-water salt gradient pond. Fig. 4 shows that, in the cooler months, temperature increases with increased depth and salinity. These conditions are the reverse of what is normally found in brackish water ponds where there is mixing caused by wind and tides.

The shape and configuration of Scotts Pond (deep trench with a sill at the outlet) allow for little mixing of the fresh surface water and the deeper salt water. This appears to allow the solar energy entering the salt water to be retained there, thus raising the temperature.

Oxygen levels (Fig. 5) at Station 3, which are similar to the other stations, show an increase with higher temperatures and increasing depth and salinity. However, it will be noted at the 4.9 m depth that dissolved oxygen levels are low from February to June.

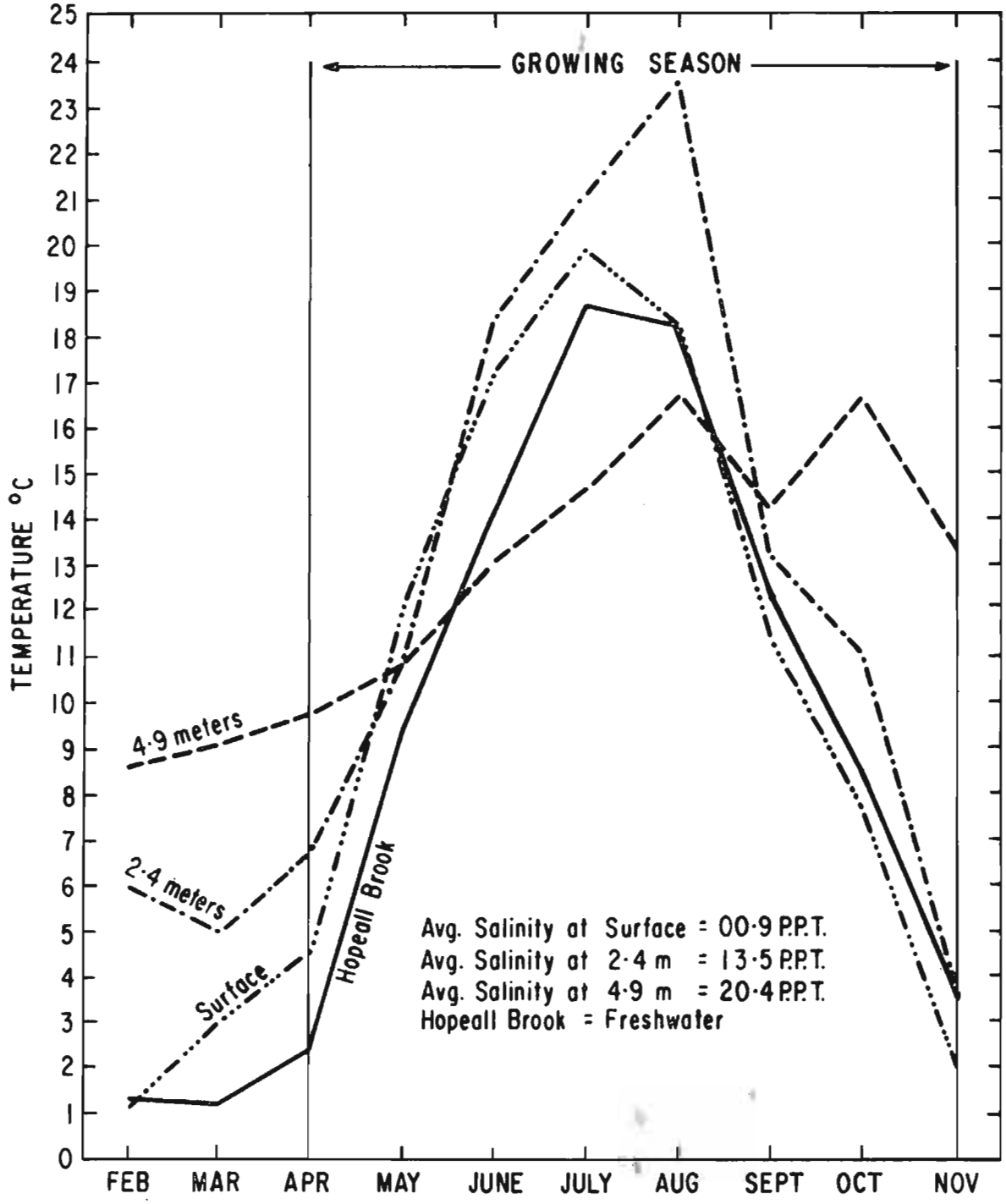


Fig. 4. Average monthly water temperatures for station 3, Scotts Pond, at various depths and a comparison with Hopeall Brook.

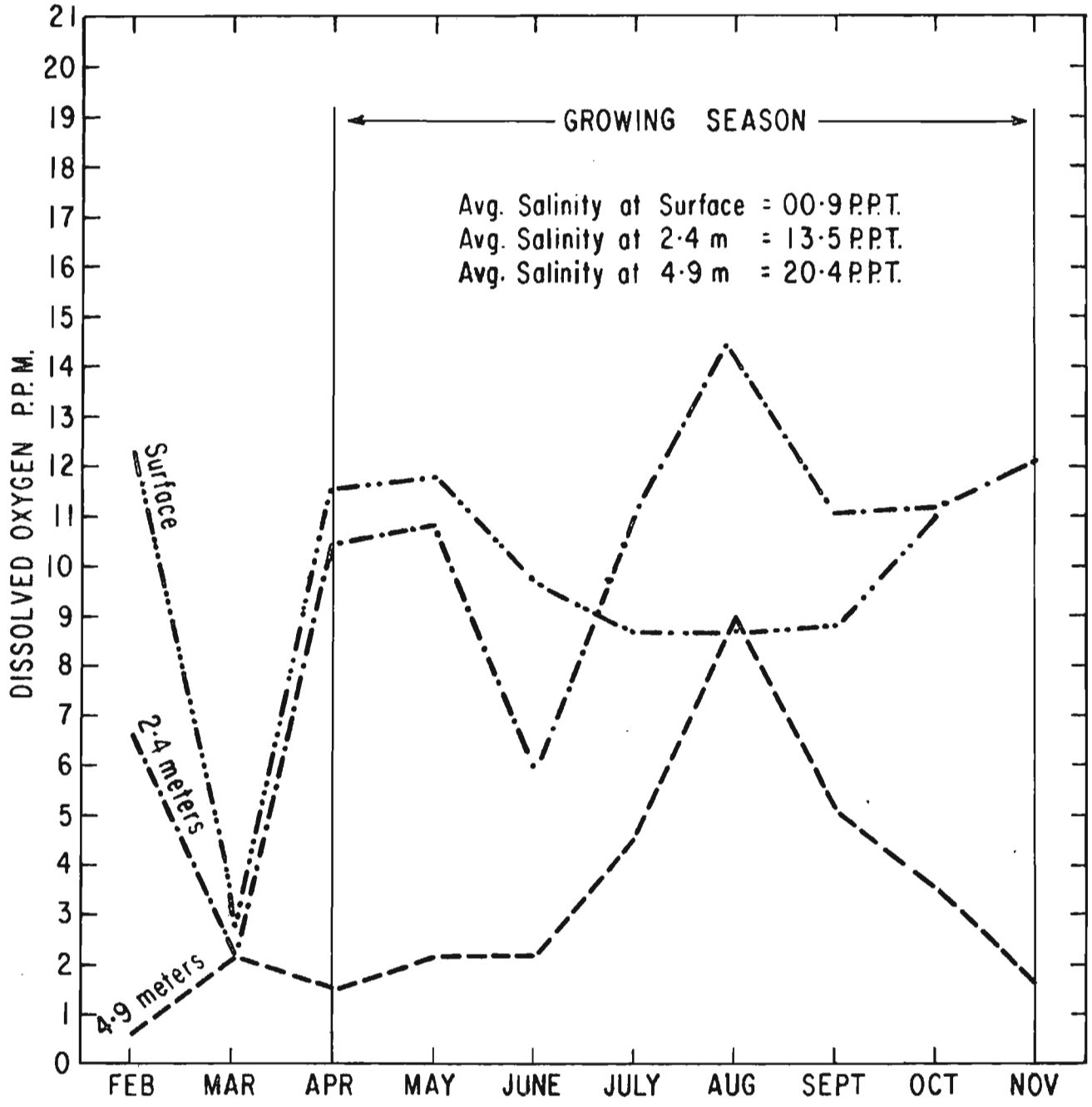


Fig. 5. Average monthly dissolved oxygen content for station 3, at various depths.

These higher oxygen levels (except near the bottom) in the deeper water during the warmer months could be caused by plankton photosynthesis in the salt water layer.

Oxygen measurements taken in the cages and outside the cages did not show an appreciable difference at the 1.2 m depth during the warm temperature period, June-August. In the deeper water (near the bottom 3.1 m) oxygen levels did go to very low levels (<2.0 ppm) both inside and outside the cages. Also it was noted that, at the 2.4 m depth, oxygen levels were lower inside the cages during the same period.

PROMOTION AND TEST MARKETING

A promotional "taste panel" was sponsored by the provincial Department of Rural Development in October 1978. Rainbow trout from the cage rearing experiment was the main course and were prepared in about seven different ways. There were about 100 invited guests. Included among the guests were restaurant and hotel people, fish processors and members of the press.

This taste panel received very good press coverage and stimulated public interest in rainbow trout and the Hopeall hatchery operation.

In November 1978 the cage reared trout were harvested (see photos 1 and 2) and transported to P. Janes & Sons Ltd., in Hants Harbour, Trinity Bay, for processing.

The small number of trout produced in the pilot project operation were also test marketed through P. Janes & Sons Ltd., and went to local restaurants and supermarkets with some small shipments to mainland markets.

The response of the consumer was generally positive. The most-voiced negative comment was that people would like to have seen deeper pink color in the trout flesh.

DISCUSSION AND RECOMMENDATIONS

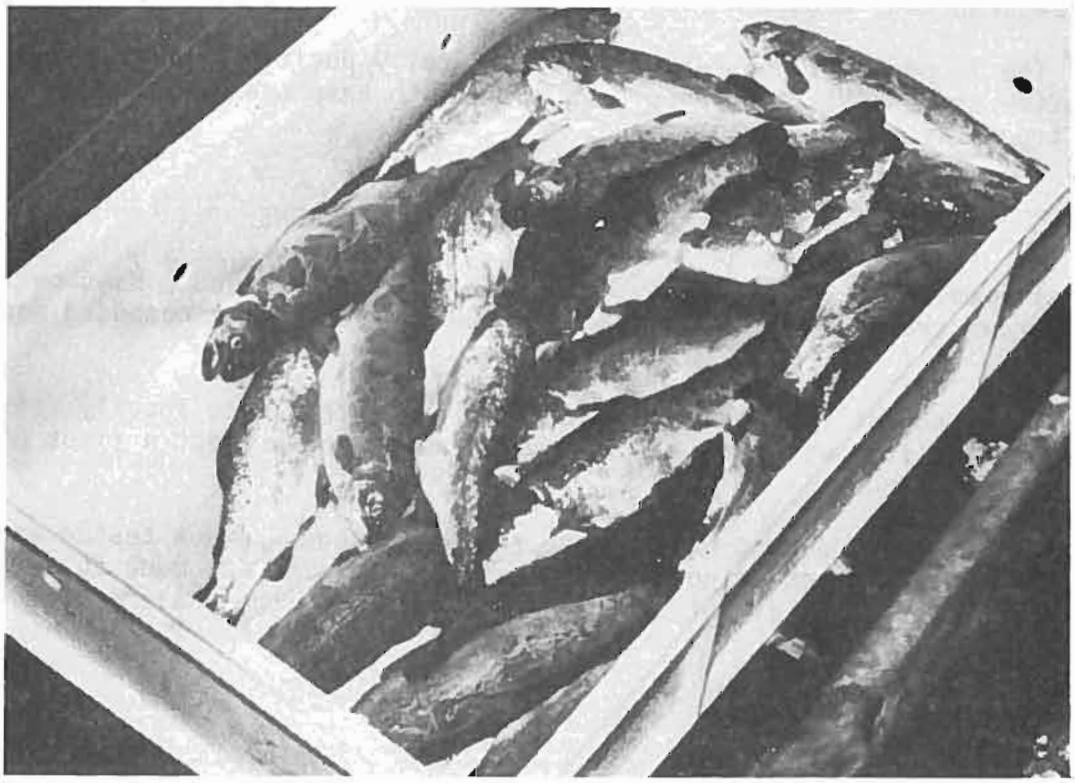
The main aim of the cage rearing project was achieved. Rainbow trout were grown from about 11 g to 270 g in 180 days on a diet composed mostly of local marine fishes and fish waste.

These objectives were achieved using trout that were locally reared from eggs derived from wild brood stock. This marks the project a first of a kind for Newfoundland.

The economic aspect of the cage rearing method was not tested as part of the experiment in achieving this success. No attempt was made to demonstrate the economic feasibility of the project, because of the scale of the operation

Photo 1. Harvesting trout from cages.

Photo 2. Trout after harvesting.



(small number of trout) and the large capital and operating cost in relation to the amount of end product. The UTSRDA felt, however, that based on projection of the growth rate, food conversion, cost of feed, capital requirements and manpower cost a large scale commercial operation of this type would be financially viable.

Most of the recommendations that are put forth have been discussed (some implemented for 1979) at a meeting of the UTSRDA Fish Farm Management Advisory Committee.

FOOD AND FEEDING

The economic future of a commercial cage culture operation will depend very much on the use of inexpensive marine fish and fish waste as a major ingredient in the feed.

The pilot project demonstrated that marine fish and fish waste can be used to achieve good growth on trout grown in cages in Newfoundland. It also brought out that there are difficulties involved in handling the raw material for the feed.

There will have to be considerable "gearing up" to handle the large volume of feed that will be required, as the scale of the operation grows to commercial size, and 100,000 or 200,000 trout or more have to be fed.

A moist pellet[1] type of feed should be used to facilitate greater ease of handling of the mixed feed.

There should also be some experimentation with feeding frequency to achieve the best utilization of the feed by trout.

GROWTH

Although the growth attained in this project was very good there is opportunity for improvement. The trout were not transferred to the cages until the end of May. If the water temperature in the pond is suitable, more growth might be obtained if the transfer were done by the first week of May. Also if larger size (more than 11 g) 1-yr-old trout can be grown at Hopeall hatchery, this would improve the size of the final product.

CAGES

The main difficulty associated with the operation of cages and rafts was the insecurity of the moorings. This was due to the large size of the raft and the mud bottom at the cage site.

[1] This type of feed was tested as a small scale project (summer 1979). The composition of the feed is much like that used by Sutterlin in 1976 at St. Andrews, N.B. (Sutterlin et al. 1976).

Future operations in Scotts Pond will be twenty times larger, and it is recommended that a good system of shorefasts be worked out to secure the rafts and cages.

SURVIVAL AND ENVIRONMENTAL CONDITIONS

Survival under cage conditions in Scotts Pond did not present any difficulties in the summer of 1978.

Densities (Table 4) were kept low to avoid the type of difficulties encountered by some other workers in studies of this type because of high temperatures and high density (Whitaker and Martin 1974). In a commercial operation, stocking densities would need to be much higher. In commercial operations with rainbow trout in cages on Norwegian marine farms, a density of 9-10 kg/m^3 is used (Sutterlin and Merrill 1978).

High stocking densities at high temperatures, similar to those encountered in 1978, could well cause some problems for trout survival in a future commercial-size operation.

It is recommended that a water quality monitoring program be established by the operators (UTSRDA), and that temperature, oxygen content and salinities be measured at stations in various parts of the pond. These three parameters should be regularly checked in the cages during operation.

PRODUCT PROCESSING

There is a need in the planning of the commercial operation to consider the development of techniques for fish grading, killing, handling, and processing. It will be very important for a good quality product and the development of reliable markets that the packaging, freezing and shipping be well thought out beforehand.

PROMOTION AND MARKETING

Now that the technical and management problems have been recognized and overcome, the next major area to be challenged is that of marketing. Marketing of up to 100,000 270 g rainbow trout in the fall of 1980, and up to 200,000-400,000 each year thereafter is an important aspect of a commercial-scale trout-rearing operation.

It is with this in mind that the operators (UTSRDA) should, with the help of various government agencies, move forward to find and organize markets and promote their product.

ACKNOWLEDGMENTS

I thank the following for their help with the report. F. Peach for collection and compilation of the data on feed and feeding, hatchery and cage temperatures and drawing of cages. D. Riche for work on morphometry; G. Whalen for temperature, oxygen and salinity data; H. Mullett and G. King for drafting and photography; M. Locke and J. Y. Lannon for typing. For reviewing the manuscript, I thank W. J. Bruce, V. R. Taylor, P. Downton, F. Burfitt.

REFERENCES

Jamieson, A. 1978. A report on the establishment and operation (18 months) of a rainbow trout hatchery farm at Hopeall, Trinity Bay, Newfoundland. Fish. Mar. Serv. Internal Rept., 56 p.

Sutterlin, A. M., P. Harmon, and H. Barchard. 1976. The culture of brook trout in salt water. Fish. Mar. Serv. Tech. Rep. 636: 21 p.

Sutterlin, A. M., and S. P. Merrill. 1978. Norwegian salmonid farming. Fish. Mar. Serv. Tech. Rep. 779: 47 p.

Whitaker, J., and J. Martin. 1974. The cage rearing of rainbow trout in precambrian lakes. Fish. Res. Board Can. Tech. Rep. 446: 13 p.

Appendix 1

Scotts Pond (Scotch Pond) Morphometry

Area - 28.14 hectares

Perimeter - 3.6 km

Maximum length - 1.13 km

Maximum effective length - 1.11 km

Maximum width - 0.56 km

Maximum effective width - 0.56 km

Mean width - 0.24 km

Mean depth - 1.31 m

Maximum depth - 6.1 m

Depth	Area	Percent
m	(m^2)	
0-1.51	210,817	74.9
1.52-3.01	48,959	17.4
3.04-4.57	13,048	4.6
4.57-6.09	6,914	2.5
6.09	1,672	0.6

Appendix 2. Food type and amount fed.

Food type	Weight fed Cage I (kg)	Weight fed Cage II (kg)
Wet mix*	3071	3338
Shrimp offal (incl. in wet mix)	193	193
Dry mix (5P crumbles)	62.6	80
Pigmentation food	90.8	90.8

* Overall percentages used in wet mix: mackerel - 45%, capelin - 29%, squid - 12%, shrimp offal - 8%. The remaining 6% consisted of pork liver, herring, whale meat, billfish, and cod offal.

Appendix 3. Feeding rates.

Feeding period	Wet mix*		Dry feed (5P crumbles)	
	Cage I (kg)	Cage II (kg)	Cage I (kg)	Cage II (kg)
May 25-June 27	181	204		
June 28-July 27	433	426	18.6	18.6
July 28-Aug. 27	527	599	23.1	20.9
Aug. 28-Sept. 27	793	885	19.9	39.0
Sept. 28-Oct. 27	835	874	0.9	1.4
Oct. 28-Nov. 20	302	350		
Total	3071	3338	62.6	80.0

* Wet mix includes shrimp offal

Appendix 4. Percent average weight (g) distribution of harvested rainbow trout.