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A REPORT ON THE ESTABLISHMENT AND OPERATION
(18 MONTHS)

OF A RAINBOW TROUT HATCHERY-FARM
AT HOPEALL, TRINITY BAY, NEWFOUNDLAND

by A. JAMIESON



FRESHWATER AND ANADROMOUS FISHERIES
MANAGEMENT PROGRAM
RESEARCH AND RESOURCE SERVICES

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Freshwater and Anadromous Fisheries Management Program,
Research and Resource Services,
Fisheries and Marine Service,
Newfoundland Region

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I would like to thank the following people who helped in the preparation of this report: Fletcher Peach; who compiled most of the data on feeding and growth and who did the original drawings for the hatchery lay-out. Also, we used his article to the "Rounder" and other written material; Sylvia Kearsey who did all the typing and helped with the arrangement of the tables; Bob Wiseman who critically reviewed the report; Dave Greening and Eric Greening who did the drafting.

INTRODUCTION

The purpose of this report is to bring together the information generated from the setting up and preliminary operation of the rainbow trout hatchery at Hopeall, Trinity Bay. The report will attempt to address the following questions:

1. History of the development at Hopeall.
2. The original objectives as well as objectives formulated after it started.
3. Approaches taken to attain these objectives.
4. Financial investments.
5. Amount and utilization of FMS resources invested in the project to date.
6. Detailed description of the facility both current and at different stages of construction.
7. Detailed account of separate experiments conducted within the project (including feeding regimes, growth rates and environmental conditions).
8. Appraisal of all experiments made.
9. Recommendations on the future course of the venture and in particular, an outline of future FMS involvement.

To give a feeling for the original concepts and history of the development of the project, I have included an article written by Fletcher Peach, Upper Trinity South Development Co-ordinator, published in the spring of 1976 in the *Rounder*, a tabloid publication of the Rural Development Council of Newfoundland and Labrador.

This article explains most of the pre-construction work and negotiation, plus an outline of the original objectives and how they were modified by F & M S regulations.

"What about fish farming for a development project? Let's start a rainbow trout fish farm. We could bring in fingerlings from Ontario and grow them to market size and sell them to local restaurants; develop a packaged product, may be can, smoke or put them into snack-packs. We could set up a fish pond and charge people a fee to fish; and another possibility since we have plenty of raw material is to future fish food production.

That sounds interesting; now all we need is some technical information, financing for the project and a suitable location to set up.

You could image that this was how the Upper Trinity South Regional Development Association Rainbow Trout fish farm pilot project got started in November, 1974, as an idea of the Green's Harbour Development Committee. However, a lot of water has passed under the bridge since then. The original idea was fairly simple, bring in fingerlings from an Ontario hatchery in the spring and rear them in raceways to 6-8 oz. size by fall.

As this project was to be the first commercial fish farm in the Province, and therefore could be laying the groundwork for a future Provincial industry, the first move was to contact the Department of Rural Development for pilot project financing, second to build a proposal to support the application for funds.

This included visiting Federal Fisheries & Marine Service, Provincial Department of Fisheries, Marine Research Lab at Logy Bay, Crown Lands, Information Canada, and Libraries.

Letters were written to Department of Tourism & Renewable Resources in Saskatchewan for information on fish farming, also to manufacturers of fish farm equipment and fish food from Ontario to Texas, and studying information on long established fish farms in Britain, Europe and North America.

During this period the Department of Rural Development did a market study and it was determined that a local market existed, primarily in the restaurant trade.

The selection of a suitable location for the project was very important and assistance was provided by the Federal Fisheries & Marine Service, FAFMP included checking water temperatures, water analysis, watershed annual run-off and a suitable location for cage culture. A site was chosen on Hopeall River, T. Bay; however, before the Association could apply for the use of land and water, public notices were required to be run in the Newfoundland Gazette and one other newspaper in the area, as per Section 107 of the Crown Lands Act.

When this was done the people of Hopeall decided to call a public meeting to find out what effect fish farming would have on the River; this meeting was attended by representatives of the Regional Development Association, the project was outlined and met with approval.

The first estimate for a three phase (3 year) project was submitted to the Department of Rural Development in February, 1975 to cost \$61,400.00. After submitting this proposal for the pilot project, we were informed that we were not permitted to transfer live fish between Provinces, because of possible transfer of fish disease. This would have finished the project right there, but the Federal Fisheries & Marine Service agreed to provide a breeder stock from Rainbow trout in the Province and also to provide the technical knowledge required to set up a hatchery. This would include capture and transfer of live fish to

the hatchery site before spawning time and supervising stripping and fertilization of the eggs. Several types of hatchery equipment needed to be checked out so as to assure the highest survival rate possible. The whole proposal was reviewed, rewritten and submitted to the Department of Rural Development for pilot project financing again in August, 1975. This was also for a three phase (3 year) project, and taking into consideration the added expense of setting up a hatchery, the cost of the proposal was \$92,216.00. This amount would cover capital cost, hatchery equipment, fish food, salaries, etc.

The proposal was finally approved in principle on October 7, 1975 for the amount of phase 1 (\$43,906.00); funding for phases 2 and 3 would be contingent on the success of phase 1. The approval in principle was subject to the following conditions; that the Development Association secure and present to the Department of Rural Development a lease from Crown Lands, written results of the proposed site evaluation, and water analysis from Federal Fisheries, also a projection of the fourth year operation, with documentation from Federal Fisheries concerning the capacity of the proposed facilities.

The next step was to approach Crown Lands regarding the lease and discuss the requirements for applying for the land to set up the project. So, instead of applying to Crown Lands and waiting for them to process the application, the Association, with the assistance of the Department of Rural Development, secured approvals from the Department of Highways, Department of Health, Department of Tourism, and Department of the Environment and also with help of the Department of Rural Development had the proposed site surveyed; all these approvals and the survey were presented to the Department of Crown Lands along with the application for the land.

The Federal Fisheries & Marine Service submitted, with the assistance of the Association, a fourth year projection and the required documentation on

facilities.

In summary, the Association has a project manager ready to be hired as soon as the funds become available, and as Rainbow trout spawn in the spring, the Association hopes to take advantage of this spring to get the project into operation. Beginning with a brood stock of 200 female and 100 male fish with a potential for 70,000 eggs, and selecting a brood stock over a three-year period, the fourth year projection was for a potential of 1,400,000 eggs.

Before the beginning of construction, the Association hopes to send the project manager to the mainland to have a first-hand look at an established fish farm. At the time of this publication, we expect to be ready to begin construction of the project; a project the Upper Trinity South Regional Development Association hopes will become an asset to the area and the Province as a whole".

The foregoing article mentioned several pieces of written material that were prepared for support and explanation of the pilot project. I have included some of these in the main body of the report.

WORKING CONCEPT AND OBJECTIVES FOR A 3-YEAR PROGRAM

The overall concept for the 3-year program, with some reference to the intent for the fourth and fifth years.

The 3-year program had two main purposes. The first was to develop from wild stock, provided by the Federal Fisheries and Marine Service, a local brood stock of Rainbow trout. The second objective was to determine the economic feasibility and biological possibility of rearing Rainbow trout from eggs to market size 225 g (one-half lb) in 18 months.

If the 3-year pilot project proved to be successful, the intent for the fourth year was to use the brood stock that had been developed to provide eggs and fry in sufficient quantities to begin a commercial operation in the fifth year.

A description of the methods and materials to be used during the 3-year pilot project.

In the spring of the first year, the Federal Fisheries and Marine Service was to provide approximately 300 mature wild Rainbow trout, (200 female and 100 male trout). Much of the same procedure would be followed in each of the two following years.

These trout would be delivered to the site at Hopeall River by Fisheries and Marine Service workers. The trout would be held in several 2274 L fiberglass tanks, which would have flow through water systems. The trout, as they become ready to spawn, would be taken from the tanks to have the eggs stripped and fertilized. This work would be done by Fisheries and Marine Service and hatchery workers.

The eggs after fertilization and water hardening would be transferred to one or the other of the following hatching devices:

(a) Commercially produced incubation system such as that made by the E.W.O.S. people. The capacity of the one to be purchased would be between 40,000 and 64,000 eggs.

(b) The remainder of the eggs (6,000-20,000) would be incubated in trays in the fry rearing troughs, which would be made of fiberglass covered plywood.

Much of the same procedure would be followed during each of the next 2 years. With the experience gained during the first 2 or 3 years, a decision would be made as how best to handle the 1.4 million eggs expected to be available in the spring of the fourth year. Facilities would then be provided to handle this number of eggs and the resulting fry.

The fry during the early stage, up to above 5 cm (2 inches) would be reared in fiberglass troughs. After this stage, they would be moved to earthen raceways, where they could be reared (it was hoped to a length of 10 cm (4 inches) by the end of the first growing season). It was hoped to carry most of these fingerlings overwinter in the raceways during the first year; some fish would be overwintered in cages in fresh water ponds to test this method for the following year's operations. Much of the same procedure would be followed during each of the next 2 years.

A considerable increase in the size of the facility would be required to handle the fry and fingerlings of the fourth and fifth years.

To start the second growing season, fertilization and hatching would proceed as in year one. On hand also would be approximately 40,000 fingerlings.

It was intended to rear the majority of these fish to market size in cages, held in fresh water ponds. The number of cages could be increased to handle the fish as they increase in size. A level of 7.4 kg of fish per cu m of water (one-half lb per cu ft) would have to be maintained in the cages.

The capacity of the raceways would allow only for the holding of all the fry from the second year's hatch up to 7 cm (3 inches) fingerling size. After this stage in growth, most of the fish would be transferred to cages.

Without any increase in the raceway capacity, the situation going into the second winter would be as follows:

Fish on hand and their disposition during the second winter:

30,000 - 225 gm fish for market

In raceways and tanks at hatchery:

approximately 20,000 - 10 cm fingerlings

300 or 400 - 225 gm brood fish.

Held in floating cages, anchored near shore in pre-selected sites and fed during the winter:

approximately 25,000 - 10 cm fingerlings

8,000 - 225 gm brood fish.

During the third season each step would again be repeated, as per outline. If all went well in the fall of the third year, 30,000 - 225 gm trout will be available for market. Also, another 8,000 - 225 gm fish for brood stock, plus 5,000 - 450 gm (1 lb) fish from the previous year, for brood stock. There will be about 45,000 - 50,000 - 10 cm fingerlings.

During the third winter the disposition of the fish would be as follows:

In raceways and tanks at the hatchery and fed during the winter:

approximately 20,000 - 10 cm fingerlings

200 or 300 - 225 gm brood trout

100 or 200 450 gm brood trout.

Held in floating cages anchored near shore in pre-selected sites and fed during the winter:

approximately 25,000 - 10 cm fingerlings

8,000 - 225 gm brood trout

5,000 - 450 gm brood trout

To handle the production of eggs (approximately 1.4 million) and fry (approximately 790 thousand) in the fourth year, there would have to be a 20-fold increase in the capacity of the hatchery. It was anticipated that funding for this expansion would be made available by the Department of Rural Development.

FINANCIAL INVESTMENTS

Up to the end of November, 1977 the financial input into the Hopeall pilot project was as follows:

Funding through the Provincial Department of Rural Development

Phase I - Total \$43,906.00

Phase II - Total 22,530.00

The Phase III funding has not as yet (December 1977), been received.

Funds received through a Canada Works Project during the summer of 1977, amounted to \$50,000.00. This was for a 26-week works program that provided aside from salaries, an amount of about \$40.00 per week per man in materials. The approximate figures for the Canada Works Project were broken down as follows:

\$34,000	-	Salaries
11,000	-	Materials
5,000	-	Worker benefits, etc.

I have included at this point, a copy of the original, detailed proposal of expenditures as submitted with the project proposal to the Provincial Department of Rural Development. This was the original intent for spending but was not necessarily followed to the letter (Tables 1-4).

As no income was realized during the period of operation under review, the income section (which was included in the original proposal) has been deleted from this version.

Table 1. Proposed expenditures for the Upper Trinity South Regional Development Association, Rainbow trout fish farm pilot project, Phase I.

1.	Raceways ----- 8' x 40' x 3' (inside) -----1	\$ 350.00
2.	Raceways -----10' x 50' x 4' (outside) -----4	1800.00
3.	Road -----200 yds (see #21)	
4.	Shed -----20' x 70'	4000.00
5.	Tanks ----- Ewos, fiberglass ---- #2019 ----10	580.00
6.	Tanks ----- Ewos, fiberglass ---- #2014 ----10	1350.00
7.	Hatchery equipment Ewos, fiberglass ---- #2001----- 4	1196.00
8.	Plastic pipe, connections, assorted sizes -----	750.00
9.	Fencing, chain link, (for raceways) -----	1200.00
10.	Furnace, installed -----	1000.00
11.	Generator -----	400.00
12.	Wiring -----	550.00
13.	Fish food -----5000 lbs. -----	1500.00
14.	Lease and Survey -----	650.00
15.	Gathering and transportation of fish (breeders)	500.00
16.	Operating expenses (gas and oil) -----	480.00
17.	Bookkeeper (part-time) -----	2500.00
18.	Misc. -----	1000.00
19.	Management -----12 months -----	9600.00
20.	Help ----- 10 -----	6000.00
21.	Preparing site, road, raceways -----(dozer, trucker fill)	2500.00
22.	Labour (shed, inside raceway, preparing outside raceways and installing equipment -----	6000.00
	Total -----	\$ 43,906.00

Table 2. Proposed expenditures for the Upper Trinity South Regional Development Association, Rainbow trout fish farm pilot project, Phase II.

1.	Cage materials ----- construction -----	\$ 1,400.00
2.	Fish food ----- 12,000.00 lbs -----	3,600.00
3.	Boat ----- 10 ft -----	450.00
4.	Management ----- 12 months -----	9,600.00
5.	Help ----- 10 months -----	6,000.00
6.	Operating expenses (gas, oil) -----	480.00
7.	Misc. -----	1,000.00
	Total -----	\$ 22,530.00

Table 3. Proposed expenditures for the Upper Trinity South Regional Development Association, Rainbow trout fish farm pilot project, Phase III.

1.	Food (fish) ----- 25,000 lbs. -----	\$ 7,500.00
2.	Management ----- 12 months -----	9,600.00
3.	Help ----- 12 months -----	7,200.00
4.	Misc. -----	1,000.00
5.	Operating expenses (gas, oil) -----	480.00
	Total -----	\$ 25,780.00

Table 4. Summary of proposed expenditures for the Upper Trinity South Regional Development Association, Rainbow trout fish farm pilot project, Phases I-III.

Phase I	-	\$43,906.00
Phase II	-	22,530.00
Phase III	-	25,780.00
Grand total	-	\$92,216.00

FISHERIES & MARINE SERVICE RESOURCE CONTRIBUTIONS

The manpower, material, and moral support provided by F & M S through various staff members has been made available from the early stages of the Hopeall project in 1974 to date.

The initial approach to Fisheries & Marine Service was made to the writer by Mr. Fletcher Peach in 1974. The discussion at that time related to the possibilities of a trout farming project and the providing of literature references on fish farming and the setting up of a meeting with Mr. V.R. Taylor and other Service people.

As the project began to take form in 1975, the Service provided technical advice and assistance on site selection, project evaluation and water quality analysis. Mr. V.R. Taylor, during this period, spent considerable time in the compilation of a feeding table and material on pond configuration and volumes, flow requirements and rearing capacities. These were used for guidelines during the early stages of the development. The writer's own effort with the hatchery project amounted to about 10 percent of his working time during 1975.

In 1976, F & M S (FAFMP) provided, on loan, some fiberglass tanks, water pumps, egg incubators, chemicals, and laboratory glassware. During the spring of 1976, W.G. Whelan and his term staff collected wild Rainbow trout using the following manpower and gear:

April 20-May 10

15 days trapping fish for three men (or 45 man days) using 17' Boston Whaler, 85 HP motor, six live traps, a truck, holding box, and transfer tank to move fish to Hopeall from Great Pond, Bauline Line.

4 days capturing fish for three men in Great Pond Brook (or 12 man days) using dip nets, a truck, holding box, and transfer tank.

The article in the *Rounder* by Fletcher Peach mentions that arrangements were hoped to be made for a visit to hatcheries on the Mainland. These arrangements were made in 1976 and during the first week of April, Lewis March, hatchery manager at that time, Brian Trainer of the Department of Rural Development and myself visited four hatcheries and a sea cage operation in Nova Scotia. Travel was by Fisheries & Marine Service vehicle and all arrangements were made by Fisheries & Marine Service people in the Maritimes Region. As for the writer's involvement in the Hopeall hatchery, I would estimate that throughout that year I devoted about 15 to 20 percent of my working time in assisting the operation. Most of this effort would have been during the stripping, spawning, and incubation periods.

In 1977, our Service's effort was again concentrated in the spring (April, May, June) period. Wild trout were again collected and the eggs stripped and set in incubators.

W.G. Whelan and crew provided the following manpower and gear:

April 29-May 12

10 days trapping fish for three men (or 30 man days) using 17' Boston Whaler, 85 HP motor, six live traps, a truck, holding box, and a transfer tank to move fish to Hopeall from Great Pond.

5 days capturing fish (or 10 man days) in Great Pond Brook using dip nets, holding box, a truck, and transfer tank.

During the spawning period, L.J. Cole also provided help in the stripping process, and other aspects of the hatchery operation.

As there was during this year, three groups of trout at the hatchery (brood stock, yearlings and fry), and work was begun on cage culture, I would estimate the contribution of my working time involved over 20 percent.

In the period June 28-30, 1977, Dr. R.M. MacKelvie and Mr. J.W. Cornick of the Service's Fish Health Laboratory at Halifax, examined a sample of trout eggs and trout from the Hopeall hatchery. This study was in response to a request by the Upper Trinity South Development Association, for the hatchery to receive disease-free certification to enable shipping live trout out of the Province. This was to be done to comply with the new Fish Health Protection regulations of this Service and administered in this Region by Dr. J.H.C. Pippy, Program Head.

The complete results of these tests appear as an appendix of internal copies of this report.

A DESCRIPTION OF THE PHYSICAL LAYOUT OF THE HOPEALL HATCHERY FROM BEGINNING
OF CONSTRUCTION IN MID-FEBRUARY, 1976 TO CURRENT FACILITIES

The site of the Hopeall hatchery is on the northeast side of the Hopeall River, Trinity Bay (Fig. 1), approximately 228 m below the old Trinity South Road (Fig. 2). The area granted by Crown Lands is 6.9 ha, most of which is still forested. The first construction effort at the site was to clear an area of land and to build a road from the old Trinity South Road (Photos 1-3). A frame structure was erected and a 455 m-diameter black polyethylene water supply pipeline was laid to the building from Island Pond on Hopeall River. The building, which was 21.3 m long by 5.5 m wide, housed an inside concrete raceway measuring 12.2 m long by 2.4 m wide (Fig. 2 & 3). This was the facility status in May 1976 when the first Rainbow trout were stripped and the eggs set to incubate in a Heath incubator. At this time, the piped (gravity-feed) water supply was not operational and water pumped from the River was used.

Construction on the site continued throughout 1976. This put the hatchery building and the site generally in a more finished condition (Photo 4). A start was also made on excavating the river run-around to prepare it for use as an outside raceway (Photos 7 & 8).

Inside the hatchery building, in addition to the concrete raceway, there were 4-2700 ℓ capacity fiberglass tanks (Fig. 3), and four plywood troughs measuring 1.3 m by 2.5 m (not shown in Fig. 3). An area was enclosed and used as an incubation room (shown in Fig. 3 as storeroom "D").

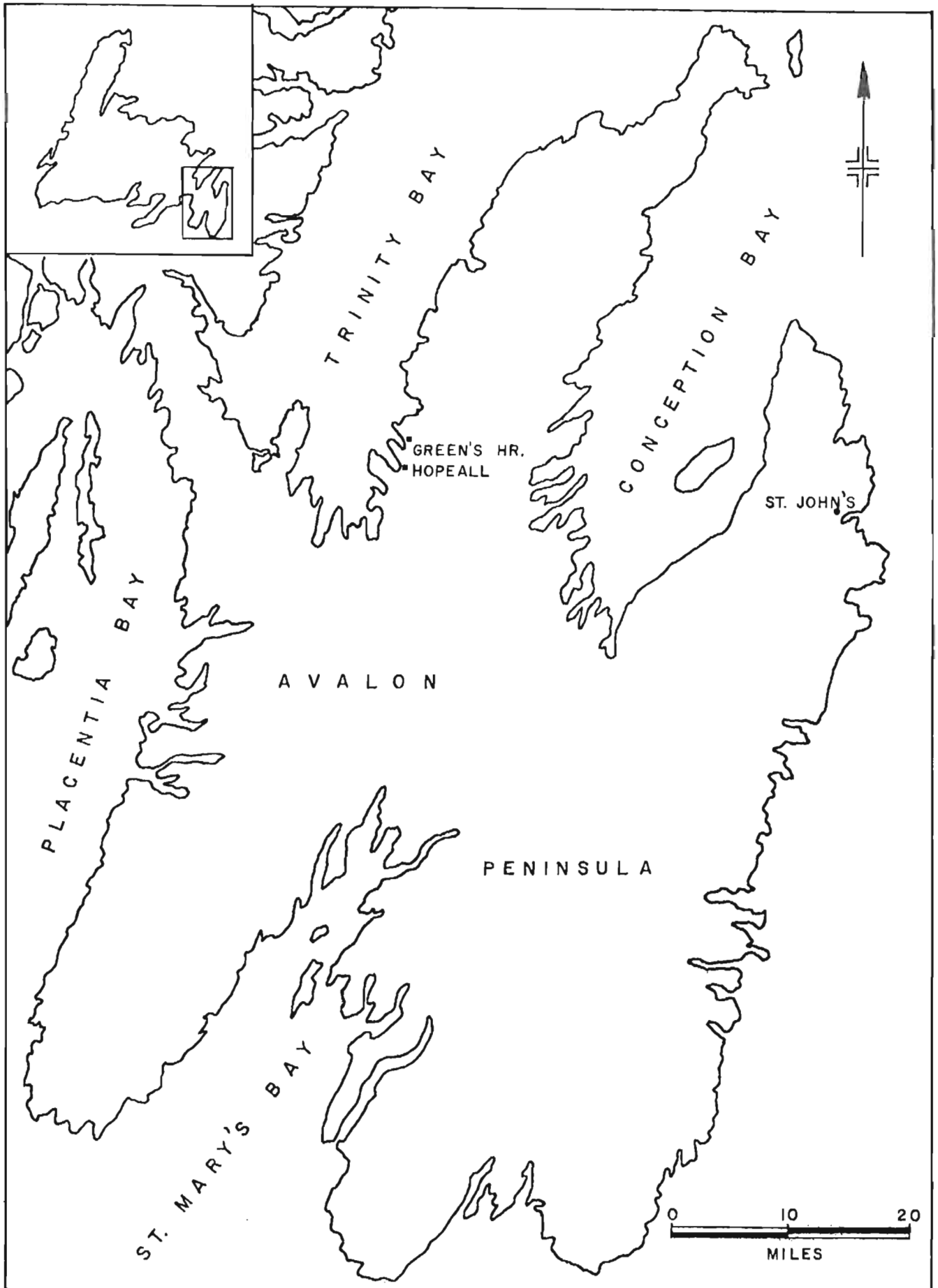
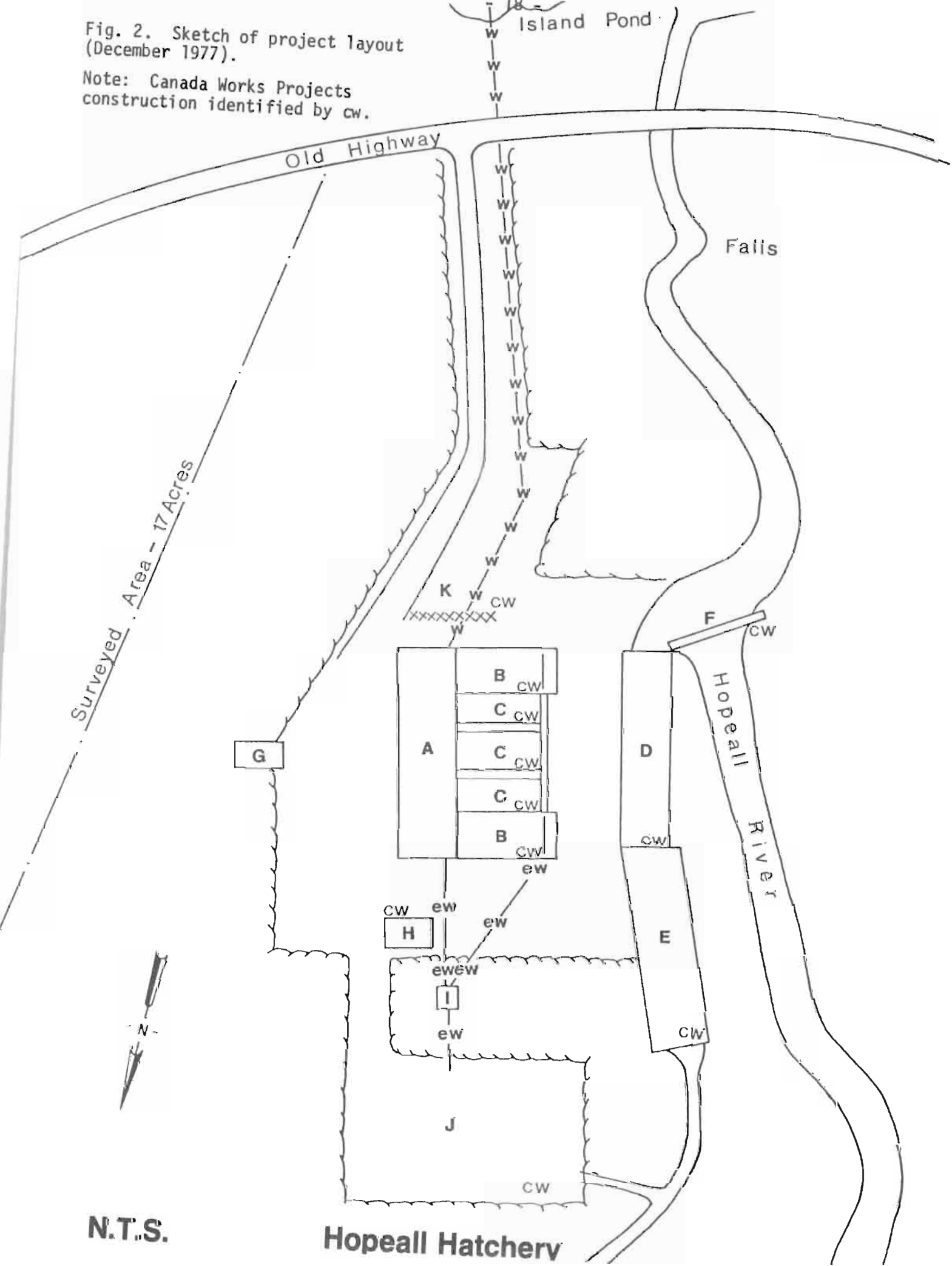


Fig. 1. Location map.

Fig. 2. Sketch of project layout (December 1977).

Note: Canada Works Projects construction identified by cw.



N.T.S.

Hopeall Hatchery

Table 5. Key for sketch of project (Fig. 2).

A	-	original shed	-	21.3 m x 5.5 m
B	-	shed extensions	-	15.2 m x 5.5 m
C	-	raceways	-	14.0 m x 2.7 m
D	-	raceway	-	21.3 m x 4.6 m
E	-	raceway	-	27.4 m x 5.5 m
F	-	adjustable flow control		
G	-	feed shed		
H	-	tool shed		
I	-	outflow settlement pool		
J	-	proposed pond .203 ha - surfaced stripped		
K	-	grassed-in area xxxxxxxxxxxx Rock		
		edge of woods		
		pipeline - water inflow		
		water outflow		

Photo No. 1 - Sign giving directions to hatchery site.



Photo No. 2 - Early road construction to site.

Photo No. 3 - Site preparations for main hatchery building.



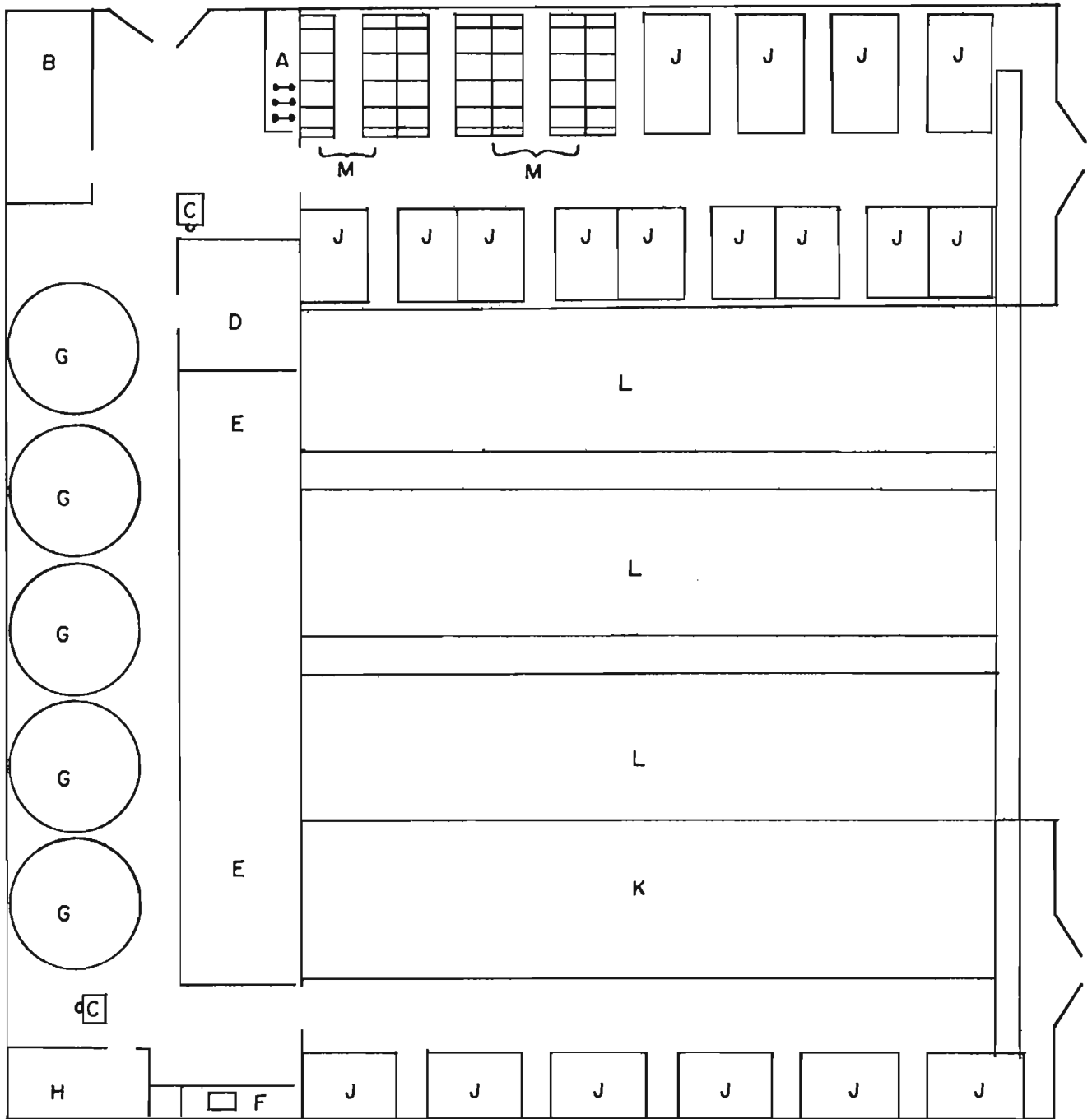


FIG. 3 LAYOUT-TROUT HATCHERY Scale: 1cm=1.22m
RACEWAYS-TANKS-TROUGHS. (Water distribution not shown)

Table 6. Key for sketch of hatchery layout (Fig. 3).

A	-----	Water supply hookup at main.
B	-----	Dry feed storage room.
C	-----	Oil fired space heaters.
D	-----	Storage room.
E	-----	Inside concrete block raceway.
F	-----	Wet food preparation area.
G	-----	Fiberglass tanks (2700 l capacity).
H	-----	Washroom.
M	-----	Trout eggs incubators.
J	-----	Rearing troughs (wooden).
K	-----	Inside concrete raceway.
L	-----	Outside concrete raceways.

Photo No. 4 -
Hatchery building,
Fall, 1976.



Photo No. 5 -
Hatchery building,
Spring, 1977.

Photo No. 6.
Construction of one of
the hatchery building
additions. See Fig. 1B
and Fig. 2A.



During the summer of 1977 a considerable amount of construction work was accomplished. At the conclusion of this work the following facilities had been completed: (1) Two outside raceways (Photos 10 & 12) in the river run-around. One of these has concrete sides and bottom, measures 21.3 x 4.6 m and is covered; the other measures 27.4 x 5.5 m, has concrete sides, a gravel bottom and is not yet covered (Fig. 2). (2) Two additions were added to the S.W. side of the hatchery. The additions measured 15.2 x 5.5 m and enclosed on two sides, three additional outside concrete raceways which measure 14.0 x 2.7 m each side (Fig. 2 & 3). (3) In an area just north of the hatchery, an area was cleared for future use as a small, 0.2 ha pond (area "J" in Fig. 2) to be used for a trout holding area. The cleared area around the hatchery was levelled, enlarged and landscaped.

Fig. 2 shows the additions as compared with the original building and Fig. 3 shows the layout of hatchery raceway, tanks and troughs for construction work done in 1977.



Photo No. 7 - River
run-around before
construction.

Photo No. 8 - River
run-around during early
construction.



Photo No. 9 - River
run-around with the foundation
of the first outside raceway.



Photo No. 10.
First outside raceway
covered and fenced,
summer of 1977.

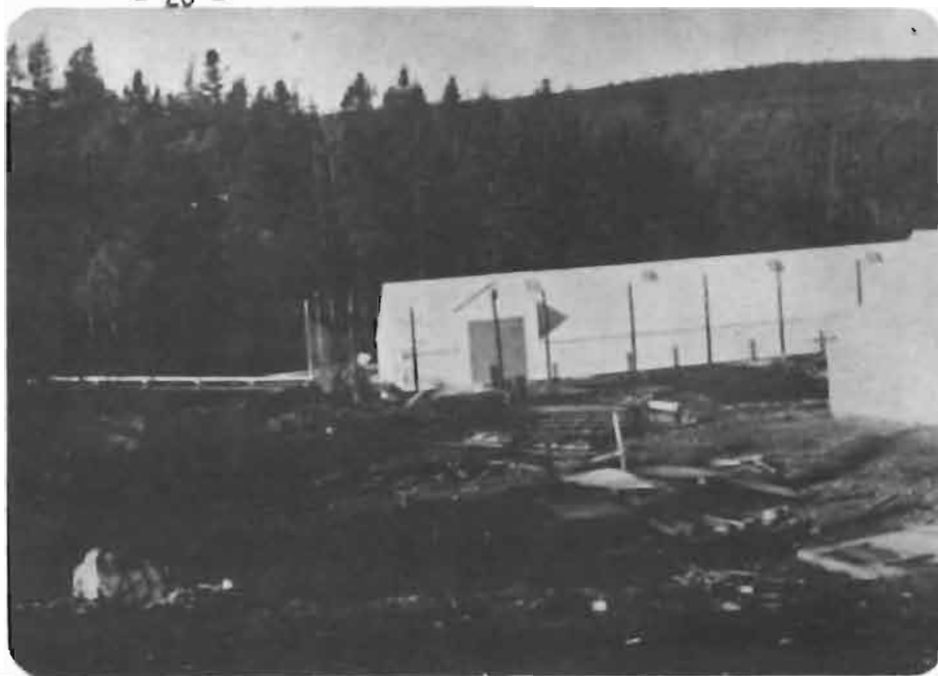


Photo No. 11.
Hatchery site,
summer of 1977.

Photo No. 12.
Some detail of
first and second
outside raceways,
summer of 1977.





Photo No. 13. Overall view of the hatchery, summer, 1977.

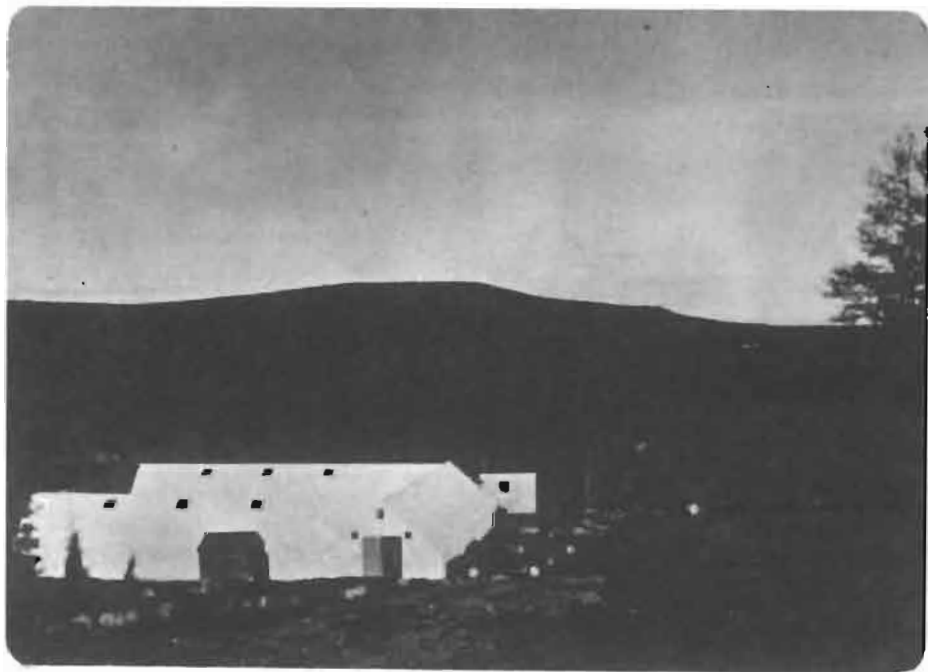


Photo No. 14. Overall view of hatchery at the conclusion of construction, fall, 1977.

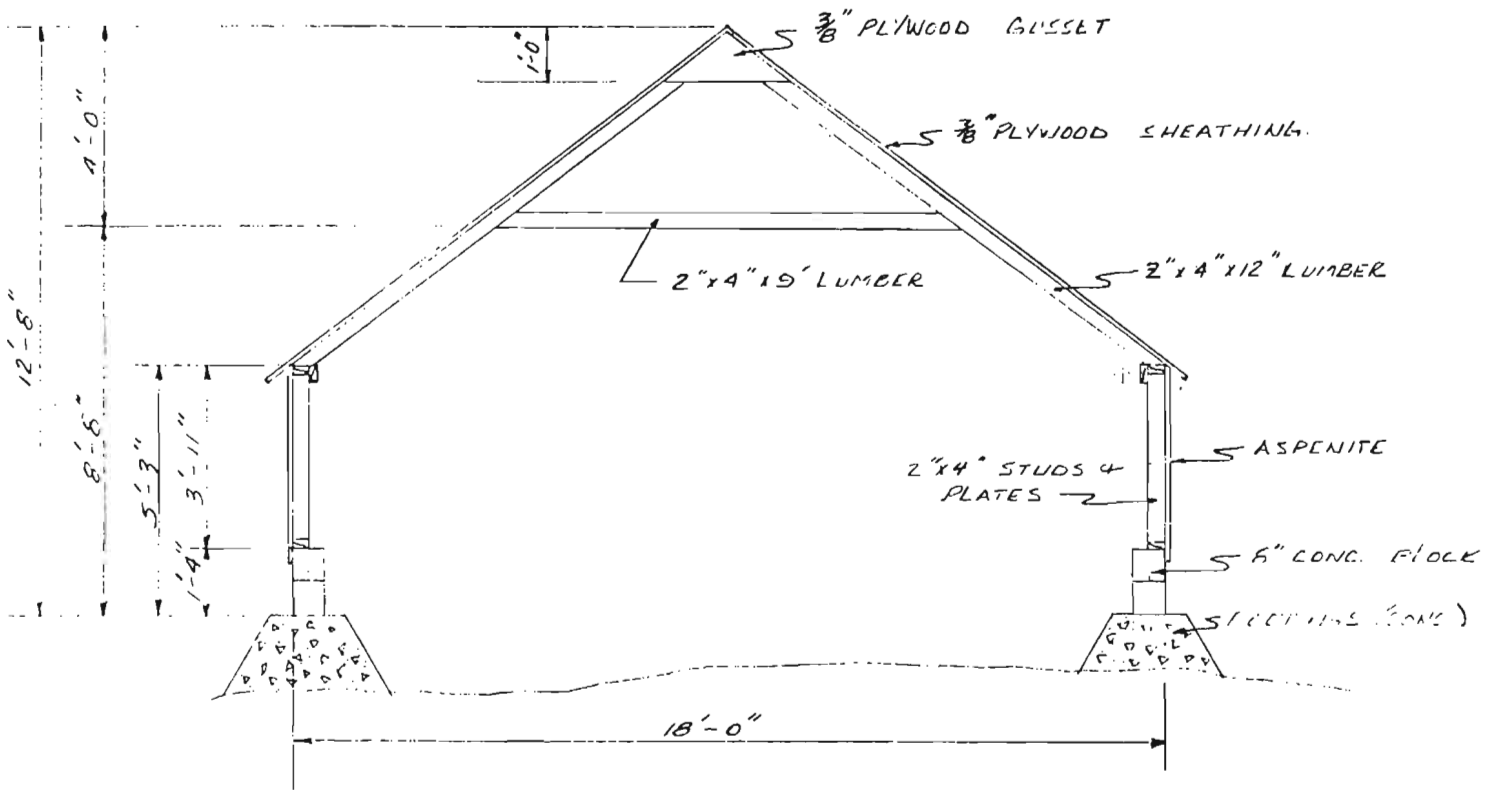


Fig. 4. TYPICAL BUILDING CONSTRUCTION
SCALE $\frac{1}{4}"=1'-0"$

HOPEALL' TROUT HATCHERY

AN ACCOUNT OF THE EXPERIMENTS CONDUCTED WITHIN THE PROJECT

The two basic aims of the pilot project at the Hopeall hatchery are: (1) to develop from a wild stock of Rainbow trout, a brood stock to provide a basis for a commercial fish farming operation; and (2) to test the biological and economic feasibility of rearing trout to market size in 18 months.

A list of the various experiments conducted within the project is as follows:

- To collect, transport, and to hold in captivity 300 wild Rainbow trout (200 female and 100 male), in 2 successive years.
- To strip the female fish as they become ready to spawn and fertilize with milt from males; incubate the fertilized eggs; and hatch 75-85 percent of the eggs.
- Feed the fry commercially-prepared trout food and bring them to 7-12 cm in length by the end of the first growing season.
- Using various rearing areas (raceways, cages, etc.), grow trout to approximately 25 cm (225 gm) by the end of the next growing season. During this growing season, use was to be made of locally available caplin, squid, fish scraps, etc., mixed with suitable commercial fish feed.

Collection of brood stock

The collection of wild Rainbow trout for brood stock was undertaken in April and May of 1976 and 1977. The reasons Fisheries and Marine Service performed this service for the Upper Trinity South Regional Development Association were as follows:

In the formative stages of the Hopeall hatchery, new regulations on the importation of live trout from outside the Province were invoked. These regulations would have made impossible the operation of the proposed pilot project. Not wishing however to stop the project, and wanting only to avoid the importation of trout that might have diseases not present in the fresh waters of the Province, F & M S decided to provide local wild brood stock.

This work was carried out in the months of April and May during the last 2 years. The project involved the capture of Rainbow trout from several streams and one lake (Great Pond) in the area of St. John's east (Bauline Line). The methods employed were to use live traps in the lake and dipnetting in streams where the trout gathered to spawn. The fish were held in holding boxes until moved to Hopeall by truck in transfer tanks. At Hopeall, the fish were sexed by external examination and held in 2275 ℓ fiberglass tanks.

Egg fertilization and incubation and fry hatch

The eggs in 1976 amounted to approximately 60,000 and these were incubated in a Heath incubator on loan from F & M S, Maritimes Region. Table 7 shows the survival rates of brood stock, eggs and fry during 1976. In 1977 about 40,000 eggs were obtained. These were incubated in a locally-made wooden incubator which proved to be fairly successful. Table 8 shows the survival rates of brood stock, eggs and fry for the 1977 operation.

Table 7. 1976 brood stock particulars, their status throughout the year, and status of fry produced.

	<u>Brood fish</u>		
Count as of May 1976	-	230 fish	126 Males 104 Females
Count as of June 1976	-	160 fish	
Mortality from June 1976 to October 24, 1976	-		13 Males 13 Females
On hand as of October 24, 1976	-	134 fish	
(Effects of stripping and internal parasites probable cause of mortalities).			
No. of viable eggs produced, 1976	-	60,000	
			<u>Fry</u>
Egg to fry survival	-	50%	
Fry count as of July 23, 1976	-	28,627	
Mortality from June 23-October 24, 1976	-	5,687	
Fry on hand as of October 24, 1976	-	22,940	
Survival of fry July 23 to October 24	-	80%	

Table 8. 1977 brood stock particulars, their status throughout the year and status of fry produced.

	<u>Brood fish</u>		
Count as of May 1977	-	247 fish	153 Males 94 Females*
Count as of June 27, 1977	-	217 fish	137 Males 80 Females
Mortality from June 28, 1977 - October 31, 1977	-		32 Males** 15 Females
On hand as of October 31, 1977	-	180 fish	
No. of viable eggs produced, 1977	-	40,000	
	<u>Fry</u>		
Egg to fry survival	-	68%	
Fry count as of June 23, 1977	-	27,250	
Mortality from June to September	-	6,394	
Mortality from September to November	-	1,049	
Total mortality from June to November	-	7,443	
Survival of fry, June to November	-	73%	

* A combination of wild stock collected in 1977 and as well brood fish held-over from 1976. Although 94 females were present, eggs were obtained from only 80 fish. The other 14 were either immature or did not produce viable eggs.

** Includes 20 used for fish Health Inspection on June 28.

Tables 9 & 10 show the areas where deviations from the original project objectives occurred in each year. It must be noted that the original project objectives were to be guidelines only, for it is impossible to be explicit in planning and operation where so many of the factors can be affected by the whims of nature.

Table 9. Accomplishments in 1976 in relation to pre-set objectives.

Factor	Proposed	Actual accomplishment - 1976
Female brood fish	200	104
Male brood fish	100	126
Viable eggs	45,000-85,000	60,000
Survival egg to fry	75%-85%	Approx. 50%
Swim-up fry	35,000-75,000	Approx. 30,000
Survival through summer	75%	80%
Number of fry (fingerlings) to overwinter	20,000-40,000	Approx. 23,000

Fry had increased from an average size of 2.5 cm in July to an average size of 7.5 cm as of October 24, 1976. However the size of fry ranged from 4 cm to over 10 cm.

Table 10. Accomplishments in 1977 in relation to pre-set objectives.

Factor	Proposed	Actual accomplishment - 1977
Female brood fish	200	80
Male brood fish	100	157
Viable eggs	45,000-85,000	40,000
Survival egg to fry	75%-85%	68%
Swim-up fry	35,000-75,000	27,250
Survival through summer	75%	73%
Number of fry (fingerlings) to overwinter	20,000-40,000	19,807

Fry had increased from an average of about 2.5 cm in July, 1977 to an average size of 5.9 cm by November 1977 which was less than growth over a comparable period in 1976. The range of size was from about 3.1 cm to 9.3 cm.

Feeding schedules and food conversion

The fry feeding schedule at the hatchery was a modification of that proposed by V.R. Taylor and from other data available in aquaculture literature. The basic approach was to feed small amounts at half-hour to one hour intervals in the early weeks after hatching. This regime continued into late summer and early fall when the fish were fed only two to three times a day. Table 11 shows the amount fed on a weekly basis throughout the hatchery operation.

During the very early post-hatch period in 1976, while the fry still retained some yolk sac, very finely ground beef liver was fed to them. This was to help the fry to begin the feeding regime. The feeding of liver plus a size #0 commercial feed was continued from the time when the yolk sac was absorbed up to July 3. Table 11 shows where the other changes in feed size and combinations occurred. It will be noted in Table 11 that beginning on April 10, 1977 ground meat and then ground fish was mixed with the commercial feed and used in the feeding program. The amounts by weight, and some of the types of fish used, are noted at the bottom of Table 11. Tables 12 & 13 compare monthly consumption in the first growing season, of dry feed plus liver and other food fed to 1976 and 1977 fry.

The growth of trout during the experiment is tabulated in Tables 14 & 15, and an appraisal of these are given in the next section.

As will be noted in Table 14, the trout were reared in different locations and concentrations. All of these moves to the outside raceways were made later in the growing season because the outside space did not become available until late summer. In the middle section of the outside raceway there were 1150 fish designated "best trout"; these were graded for size earlier from the larger trout reared in the inside tanks.

A conversion table is included (Table 16) which shows the efficiency of the conversion of feed to trout flesh obtained in the hatchery operation.

The conversion rate is attained by calculating the ratio between the total amount of food fed and the calculated total weight of all the trout.

Table 11. The total amount of food used in the hatchery during the period June 6, 1976 to November 19, 1977.

Month	Week	Dry feed size	Amount (lbs)	Liver	Fish & Squid	Meat
June, 1976	6-12	#0	1.7	1.2		
June	13-19	0	1.7	1.2		
June	20-26	0	1.7	1.2		
June	27- 3	0	1.7	1.2		
July	4-10	0	1.7			
July	11-17	0-1	2.0			
July	18-24	0-1	2.8			
July	25-31	0-1	3.2			
August	1- 7	0-1	6.7			
August	8-14	0-1	6.6			
August	15-21	0-1	7.9			
August	22-28	1-2	9.0			
August	29- 4	1-2	13.3			
September	5-11	1-2	9.5			
September	12-18	2-3	6.8			
September	19-25	2-3	34.3			
September	26- 2	2-3	33.0			
October	3- 9	2-3	43.2			
October	10-16	2-3	40.5			
October	17-23	2-3	42.6			
October	24-30	2-3	41.5			
October	31- 6	2-3	32.7			
November	7-13	2-3	13.9			
November	14-20	2-3	11.7			
November	21-27	2-3	13.9			
November	28- 4	2-3	11.7			
December	5-11	2-3	9.7			
December	12-18	2-3	12.9			
December	19-25	2-3	9.7			
December	26- 1	2-3	7.5			
January, 1977	2- 8	2-3	7.5			
January	9-15	3	10.2			
January	16-22	3	9.1			
January	23-29	3	6.2			
January	30- 5	3	8.3			
February	6-12	3	9.7			
February	13-19	3	10.7			
February	20-26	3	10.7			
February	27- 5	3	15.3			
March	6-12	3	15.3			
March	13-19	3	16.4			
March	20-26	3	24.1			

Table 11 cont'd.

Month	Week	Dry feed size	Amount (lbs)	Liver	Fish & Squid	Meat
March	27- 2	3	21.7			
April	3- 9	3	18.2			
April	10-16	3	25.7			1.7
April	17-23	3	33.2			12.3
April	24-30	3	48.2			14.8
May	1- 7	3	47.0			11.4
May	8-14	3	50.0			6.5
May	15-21	3	68.6		6.6	
May	22-28	3	74.0		11.4	
May	29- 4	3	80.1		58.1	
June	5-11	3	79.3		73.7	
June	12-18	3	89.8		171.8	
*June	19-25	1	13.4		285.9	
June	26- 2	1	93.8		287.3	
July	3- 9	1	140.7		245.6	
July	10-16	1	97.0		302.8	
July	17-23	1	67.9		343.9	
July	24-30	1 & 5P	67.9		343.9	
July	31- 6	1 & 5P	87.4		233.7	
August	7-13	1 & 5P	77.6		337.3	
August	14-20	1 & 5P	77.6		343.9	
August	21-27	1	67.9		343.9	
August	28- 3	1	67.9		343.9	
September	4-10	1	67.9		343.9	
September	11-17	1	67.9		343.9	
September	18-24	1 & 5P	140.7		212.9	
September	25- 1	1 & 5P	140.7		24.5	
October	2- 8	5P	67.0		12.2	
October	9-15	5P	49.6		131.0	
October	16-22	5P	65.7		81.8	
October	23-29	5P	25.5		180.0	
October	31- 5	5P	28.0		196.5	
November	6-12	5P	13.4		261.9	
November	13-19	5P	30.8		204.4	

Food size: #0, 1, 2, 3, 5P (Pellets)

*from June 19, 1977, #1 & 5P was mixed with shredded fish, mainly caplin, cod, squid.

Dry feed: 2778 lbs cost \$1389.00
 Caplin & cod offal: 5000 lbs. 400.00
 Squid: 780 lbs. Nil

Total cost \$1789.00

Table 12. Amount of food used for 1976 - fry - June 6, 1976 - September 27, 1976.

Month	Dry feed size	Amount (lbs)	Other	Amount (lbs)
June	#0	6.0	Beef Liver	4.8
July	#0-1	10.4		
August	#0-1-2	40.2		
September	#1-2-3	80.9	Beef Liver	1.2
October	#2-3	209.0		
November	#2-3	50.0		
		397.0		5.0
Total weight of feed -----				402 lbs.
Cost -----				\$200.00
Dry feed, including freight -----				50¢ per lb (average)

Table 13. Amount of food used for 1977 - fry - June 23, 1977 - November 21, 1977.

Month	Dry feed size	Amount (lbs)	Other	Amount (lbs)
June	#0	2.2	Liver	1.4
July	#0-2	14.6	-	-
August	#1-2	85.2	Caplin Spawn	0.2
September	#2-3	86.4	-	-
October	#2-4	75.9	-	-
November	#2-4	42.4	Squid	1.4
		306.0		3.0
Total weight of feed -----				309 lbs.
Cost -----				\$155.00
Dry feed, including freight -----				50¢ per lb (average)

Table 14. Hatch of June, 1976. (Numbers, weights, and lengths taken November 24-25, 1977.

Tank No. 3.	- Total number of trout - 1362	- Average length - 17.5 cm
	Total weight of trout 104 kg	Average weight - 76.1 gm
	Length - 42% are 18.0 cm or over 23% are 19.0 cm or over	
Inside Raceway	- Total number of trout - 7300	- Average length - 13.1 cm
	Total weight of trout - 210 kg	Average weight - 28.8 gm
	Length - no trout over 18.0 cm - 34% 14 cm or over	
Outside Raceway	- Middle section - best trout - No. of trout - 1150	
	Total weight of trout - 112 kg	- Average length - 19.7 cm
		Average weight - 97.5 gm (November 25, 1977)
		Average weight - 108.9 gm (January 6, 1978)
	Length - 42% are 20 cm or over 30% are 21 cm or over	
Outside Raceway	- Lower section - No. of trout - 4149	
	Total weight of trout - 219 kg	- Average length - 16.5 cm
		Average weight - 59.8 gm (November 25, 1977)
	Length - 41% are 17 cm or over 16% are 18 cm or over	

Overall average - length - 16.6 cm
Overall average - weight - 67.0 gm

Table 15. Hatch of June, 1977. (Numbers, weights, and lengths taken November 24-25, 1977).

Trough No. 1	-	Total fry	- 2640	- Average length	- 5.9 cm
		Total weight of fry	- 5.4 kg	Average weight	- 2.8 gm
		Length	- 58% are 6 cm or over		
			15% are 7 cm or over		
Trough No. 2	-	Total fry	- 4320	- Average length	- 5.8 cm
		Total weight of fry	- 10.4 kg	Average weight	- 2.4 gm
		Length	- 43% are 6 cm or over		
			13% are 7 cm or over		
Trough No. 3	-	Total fry	- 3845	- Average length	- 5.0 cm
		Total weight of fry	- 11.2 kg	Average weight	- 2.9 gm
		Length	- 58% are 6 cm or over		
			12% are 7 cm or over		
Trough No. 4	-	Total fry	- 2640	- Average length	- 6.2 cm
		Total weight of fry	- 8.7 kg	Average weight	- 3.3 gm
		Length	- 72% are 6 cm or over		
			24% are 7 cm or over		
Trough No. 5	-	Total fry	- 3393	- Average length	- 6.0 cm
		Total weight of fry	- 10.5 kg	Average weight	- 3.1 gm
		Length	- 55% are 6 cm or over		
			12% are 7 cm or over		
Trough No. 6	-	Total fry	- 1769	- Average length	- 6.4 cm
		Total weight of fry	- 6.9 kg	Average weight	- 3.9 gm
		Length	- 67% are 6 cm or over		
			25% are 7 cm or over		

Overall average length - 5.9 cm
Overall average weight - 3.1 gm

Table 16. Food conversion rates for the 1976 and 1977 hatch.

The hatch of 1976

From June 1976 to November, 1977

* the overall conversion is 2.3 to 1 when wet feed (caplin, cod offal, etc.) is made equivalent to the dry feed by a ratio of 3 to 1 or such that 3 lbs of wet feed will equal 1 lb of dry feed.

The overall conversion is 2.0 to 1 when wet feed is made equivalent to the dry feed by a ratio of 4 to 1.

When the above wet to dry feed equivalents are used for the "best trout" (see Table 12), the conversion rates are:

1.5 to 1 when the ratio is 3 to 1
and 1.3 to 1 when the ratio is 4 to 1.

The hatch of 1977

From June, 1977 to November, 1977

the overall conversion is 2.2 to 1; this was using dry feed almost exclusively.

*It is a general practice in aquaculture to convert wet feed to dry feed equivalents, so that comparisons may be made. The moisture content of the wet feed 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 feed used), the standard ratios of 3 to 1 and 4 to 1 were considered in this case to be fairly realistic for use in calculating the conversion rates. These are the generally used ratios mentioned in the literature available on aquaculture.

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

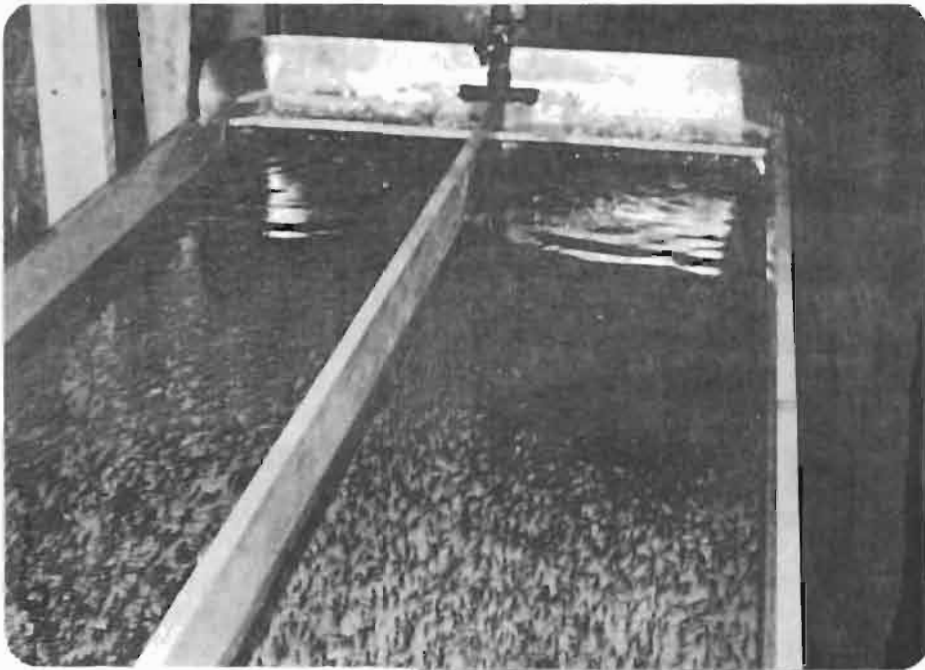


Photo No. 15. Fry
late spring of 1976.
(Just after hatching).

Photo No. 16.
Fry - early summer
1976.

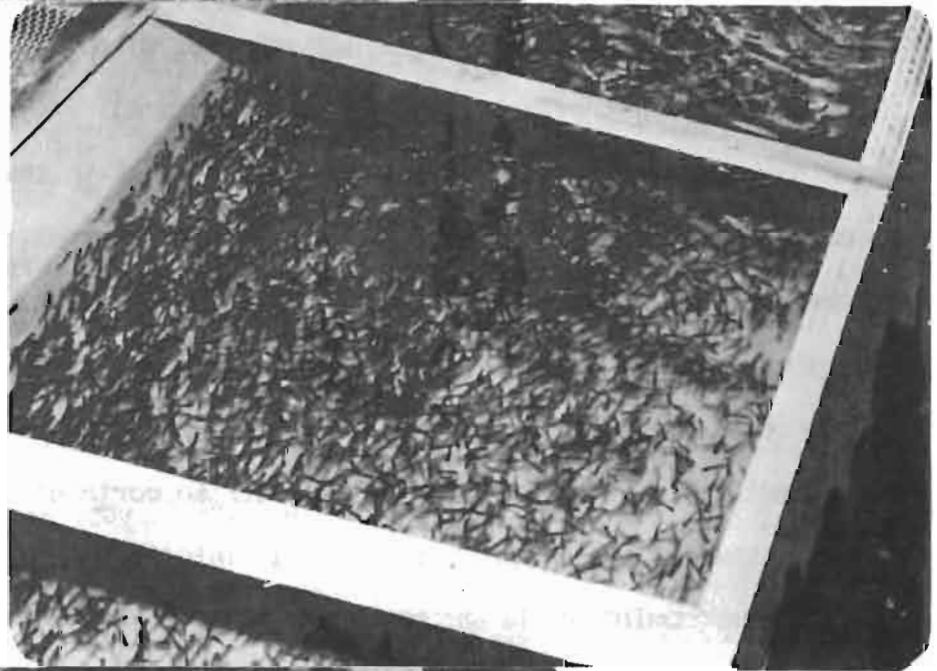


Photo No. 16. Fry -
late summer, 1976.

Cage rearing

A cage culture experiment was conducted on a limited scale during the summer of 1977. Cage culture, which is the growing of fingerlings to a marketable size, in net enclosures in natural waters (both fresh and salt) is a method that has been successful in other areas.

The intent of this summer's experiment was to test netting materials, cage structures, and the survival potential of Rainbow trout in fresh and salt water. The net cage that was used was locally made, and measured 2.4 x 3 x 2.4 m deep, outside dimensions. Inside of this 18.8 mm outer mesh-net a shallower 1.2 m deep smaller mesh (6mm) net was secured which was divided into two sections. A small number of trout (eight hundred) from the hatch of 1976 were placed in the two sections of the inside net in the cage. One section contained five hundred "regular run" trout which were taken from the inside raceway. The second section held three hundred selected larger trout, which had previously been graded, and held at lower densities in 2700 l tanks.

This experiment was carried out in a brackish water pond (Scotts Pond) in Green's Harbour which is only about 4.7 km north of the hatchery.

It was hoped to get the trout out into the cage early in the spring. This however could not be accomplished. It was not until late June that the cage was ready and installed in the pond.

The intent was initially to hold the trout in the upper compartment of the cage in the freshwater layer by the use of the inner small mesh (6mm) liner. This was to be done for only a week or two. It was then intended to let them, with the use of the deeper (2.4 m) net, seek their own level in the water column, which at about 1.8 to 2.4 m below the surface was brackish. Salinities in March were from less than one part per thousand at the surface to seventeen parts per thousand at 2.4 m.

However the workload and lack of time did not permit the making of the deeper (2.4 m) inside net, which would have allowed the trout access to the deeper water. The trout were therefore held all summer, and continue to be held, in the upper fresh water layer. Because of the high temperatures during the late summer, mortalities were somewhat high at about 25%. The remaining trout were sampled in early winter and appear to be in very good condition, as to health, flesh texture and vigor. There was no apparent damage to the cage, and it is intended to overwinter the trout in the cage in Scotts Pond.

The information gained with this small scale experiment will be very useful in any large scale work in the future.

APPRAISAL OF EXPERIMENTS

Brood stock development and egg to fry survival

The first experiment, the collection of a fairly large number of mature wild Rainbow trout, was begun in April and May of 1976 and repeated in 1977. It was hoped that this part of the project would not cause any particular difficulties. However, because of lingering winter conditions (ice on lakes, etc.) and then the sudden arrival of spring conditions, some difficulties were encountered.

It was intended to gather the spawners as they began their movement into the rivers. To this end live traps were placed in Great Pond on the Bauline Line. These were checked daily and the trout were removed and held in holding cages. As the number of trout being captured in the live traps did not come up to expectations, we had to resort to dipnetting in streams in the St. John's East area.

The transfer of the trout to Hopeall went very well, with no mortalities occurring.

The numbers and sex ratios of the trout did not come up to our original plans. To obtain larger numbers of Rainbow trout at spawning time in this area, the scale of the operation would have to be greatly increased, and involved fishing a number of ponds. This was not possible at the time.

The egg stripping and fertilization was carried out in accordance with procedures described in the most recent fish culture literature. We attempted the dry method in our first efforts but as water from the fish and our gloved hands got in with the eggs, we resorted to the wet method. In the wet method, eggs are stripped gently from the female into a plastic pan containing water.

At the same time milt from a male is added, the sex products are then gently mixed and set aside to water-harden. After about 1 hour or so, the eggs were rinsed and set in the incubator trays. During the first spring (1976) the stripping was done without an anesthetic; however it was felt that this procedure may have caused some damage to both the brood stock and eggs. In 1977, to avoid any such possible damage, all fish (male and female) were anesthetized using MS 222. Using the anesthetic helps to ease the strain to both the trout and those stripping them, and hopefully results in less damage to the eggs. Much valuable experience has been gained in the 2 years that this procedure has been done and the people at the Hopeall hatchery have now a good capability in this area of operation.

As the data indicate, there is room for improvement in the egg to fry survival rates. It is hoped as the hatchery operation progresses, eggs from their own selected and developed brood stock will produce better returns in this regard. This is an area of any hatchery operation where much care is an absolute necessity and I feel that this is understood by the hatchery management at Hopeall.

Feeding and growth of fry

The feeding schedule adopted at the Hopeall hatchery in the first year of operation produced a trout that averaged about 7.5 cm at the end of the growing season.

In the second year of operation, the average length that the 1977 fry attained was about 5.9 cm at the end of the growing season.

The growth in 1976 was reasonably good, given that all construction at the hatchery was not completed and this was the first year of operation. However, a larger fingerling of about 10 to 13 cm would provide a better chance

to produce a marketable fish by the end of the second growing season.

The growth of 1977 fry was to me a little disappointing as the fish only reached an average size of 5.9 cm. This perhaps can be accounted for by the fact that much of the rearing space in the hatchery was occupied by fingerlings from the previous year's hatch and additional rearing area had not been constructed. The 1977 fry were held for the duration of the growing season at fairly high densities in the wooden troughs. These conditions were unavoidable as the nature of the financing at the project did not allow for work on the outside raceways to proceed any faster. It is anticipated that in the coming season, with the expanded facilities, that much better growth rates can be realized.

Growth rates of fingerlings

The overall average round weight of the trout grown during the first 18-month period was 67.0 gm. This weight is less than half of what is considered the minimum marketable-size, which is a round weight of 173 gm. However, when we consider that this was attained under very much less than ideal conditions, there is a good possibility that this growth rate can be achieved in the operation. This was demonstrated to a small degree with a limited number of selected fish (a little less than 8 percent of total) that were grown under less crowded conditions for part of the 1977 growing season. These fish attained an average weight of 97.5 gm by November 25, 1977 and 108.9 gm by January 6, 1978.

It is anticipated that with utilization of the additional and better rearing areas that were constructed during 1977 and the more extensive use of cage culture, a larger trout product will be grown in 1978.

When all the various difficulties and delays that occurred because of normal operating restraints or governmental inertia are considered, I feel that the overall operation could be rated a qualified success up to this stage.

RECOMMENDATIONS

Hatching and early rearing capacity

The current hatching capacity at the facility is estimated to be between 80,000 and 100,000 eggs. This should be adequate for this spring's effort. However in the spring of 1979, if all goes well, the hatchery should have the brood stock to produce from 500,000 to 1,500,000 eggs. This far exceeds both the hatching and fry rearing capacity now available at Hopeall. I therefore recommend that in order to be in the position to handle the anticipated output of eggs and fry that construction of expanded facilities and the purchase of more incubation equipment must be seriously considered.

With regard to the growth rate from swim-up fry stage to the end of the first season, it is imperative that the environmental factors, feeding, and grading practices be optimized to produce a fish that is 8-10 cm in length. This requirement is prerequisite to producing a marketable size trout in cages by the end of the second growing season. This can be accomplished by improving water temperatures in the early spring and possibly late fall. If available spring water were used in a mix with surface water, a few degrees increase in temperature would extend the growing season. The expanded facilities anticipated to be available this spring (1978) will allow for the grading of the fry at regular intervals so that larger size feed can be supplied to the faster growing fry and the smaller fry will have less competition for feed. Also these facilities will allow for lower stocking densities in the raceways, which also promotes faster growth.

It is apparent that because of the nature of the present brood stock (wild and unselected) much work will have to be devoted to good selection practices. This is necessary in order to produce a trout with characteristics conducive to a good profitable aquaculture industry. The techniques and practice relating to

these breeding programs are available in various publications. These programs will also help to develop a trout with the capacity to produce offspring with the rapid growing potential so necessary in this type of operation.

Cage culture

The small scale cage culture experiment conducted this past summer in Scott's Pond in Green's Harbour demonstrated the feasibility of the method to rear trout in this area. It is therefore recommended that this work be expanded for the 1978 growing season. In conjunction with the cage culture program, it would be advisable to develop a feed storage and processing capability at or near the cage site to provide food (groundfish waste, etc.) for the caged trout. As many of the procedures for the monitoring of the environmental parameters and resulting trout condition in a cage rearing program are unfamiliar to the hatchery staff, it would be advisable that FAFMP provide this service to the project. Also, if support is not forthcoming from other sources, help should be provided in designing a program to evaluate the cage culture experiment.

There is a possibility that eggs and milt may be available from a good percentage of hatchery reared two-year-old stock. The trout will be examined in early spring to ascertain the number of sexually mature individuals that will be available. However, (depending on Fish Health Protection Regulations) if there are not enough mature trout, some help may be requested of FAFMP to provide more wild brood stock.

Appendix I. Hatch of 1976, mortality.

Month	Week	Number
July, 1976	24-30	2273
July	31- 6	1351
August	7-13	515
August	14-20	238
August	21-27	139
August	28- 3	107
September	4-10	164
September	11-17	-
September	18-24	93
September	25- 1	126
October	2- 8	39
October	9-15	11
October	16-22	8
October	24-30	6
October	31- 6	14
November	7-13	5
November	14-20	5
November	21-27	8
November	28- 4	6
December	5-11	10
December	12-18	11
December	19-25	7
December	26- 1	3
January, 1977	2- 8	4
January	9-15	5
January	16-22	4
January	23-29	49
January	30- 5	5
January	30- 5	5
February	6-12	4
February	13-19	1
February	20-26	3
February	27- 5	6
March	6-12	2
March	13-19	9
March	20-26	2
March	27- 2	4
April	3- 9	4
April	10-16	5
April	17-23	24
April	24-30	4

Appendix I Cont'd.

Month	Week	Number
May	1- 7	10
May	8-14	19
May	15-21	35
May	22-28	48
May	29- 4	58
June	5-11	209
June	12-18	26
June	19-25	28
June	26- 2	7
July	3- 9	1
July	10-16	7
July	17-23	9
July	24-30	3
July	31- 6	2
August	7-13	2
August	14-20	10
August	21-27	10
August	28- 3	21
September	4-10	84
September	11-17	73
September	18-24	91
September	25- 1	83
October	2- 8	177
October	9-15	89
October	16-22	118
October	23-29	66
October	30- 5	39
November	6-12	39
November	13-19	15
		<hr/>
Total		6653

Appendix II. Summary of mortality for hatch of 1976 (July 24, 1976 to November 19, 1977).

Period	Number	Explanation
From July 24/76 to October 1/76	5006	Handling mortality and weak non-feeding fry accounted for 95% of mortality.
From October 2/76 to January 22/77	146	Normal expected mortality
From January 23/77 to April 16/77	94	Normal expected mortality
From April 17/77 to June 4/77	198	Normal expected mortality
From June 5/77 to September 3/77	336	Insufficient water flow for transferred fish - low oxygen resulted.
From September 4/77 to November 19, 1977	874	High temperatures and inadequate cleaning practices causing stress among fish contributed to high loss during this period.

Appendix III. Weekly mortality of hatch of 1977.

Month	Week	Number
June	23-25	251
June	26- 2	1513
July	3- 9	1620
July	10-16	816
July	17-23	467
July	24-30	442
July	31- 6	387
August	7-13	271
August	14-20	193
August	21-27	212
August	28- 3	140
September	4-10	55
September	11-17	39
September	18-24	25
September	25- 1	19
October	2- 8	21
October	9-15	11
October	16-22	13
October	23-29	21
October	30- 5	15
November	6-12	15
November	13-19	37
		6583
	Disease inpection	+ 120
	Total	6703

*See reference for explanation of similar mortalities for 1976 hatch.

Appendix IV. Average water temperature (°C) at hatchery inflow (June 9, 1976 weekly November 19, 1977.

Month	Week	Average water temperature
June	9-12	11.0
June	13-19	10.3
June	20-26	15.4
June	27- 3	14.2
July	4-10	17.9
July	11-17	17.6
July	18-24	19.5
July	25-31	16.9
August	1- 7	23.5
August	8-14	21.0
August	15-21	18.3
August	22-28	18.7
August	29- 4	18.7
September	5-11	17.8
September	12-18	16.2
September	19-25	16.4
September	26- 2	14.0
October	3- 9	11.6
October	10-16	10.3
October	17-23	7.8
October	24-30	6.6
October	31- 6	6.2
November	7-13	3.7
November	14-20	2.6
November	21-27	1.9
November	28 -4	2.2
December	5-11	1.7
December	12-18	2.8
December	19-25	2.6
December	26- 1	1.8
January	2- 8	2.5
January	9-15	1.8
January	16-22	2.7
January	23-29	2.0
January	30- 5	2.7
February	6-12	2.0
February	13-19	1.6
February	20-26	1.7
February	27- 5	3.1
March	6-12	2.8
March	13-19	4.1
March	20-26	3.5
March	27- 2	4.0
April	3- 9	3.4
April	10-16	4.1

Appendix IV Cont'd.

Month	Week	Average water temperature
April	17-23	6.5
April	24-30	8.1
May	1- 7	9.7
May	8-14	8.1
May	15-21	9.6
May	22-28	10.8
May	29- 4	13.6
June	5-11	15.8
June	12-18	16.8
June	19-25	14.3
June	26- 2	17.8
July	3- 9	18.0
July	10-16	19.5
July	17-23	19.5
July	24-30	19.0
July	31- 6	20.0
August	7-13	19.5
August	14-20	19.0
August	21-27	18.0
August	28- 3	18.0
September	4-10	15.0
September	11-17	13.5
September	18-24	10.0
September	25- 1	11.5
October	2- 8	12.5
October	9-15	9.5
October	16-22	8.0
October	23-29	7.0
October	30- 5	7.0
November	6-12	5.5
November	13-19	8.5
