



**SALMON ENHANCEMENT
IN
NEWFOUNDLAND & LABRADOR
(SUMMARY)**

**FISHERIES RESEARCH BRANCH
DEPARTMENT OF FISHERIES AND OCEANS
ST. JOHN'S, NEWFOUNDLAND**

**A discussion document prepared by the CORE working
group on Nfld. salmon enhancement**

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SALMON ENHANCEMENT

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OVERVIEW

In the late 1970's it was recognized by many that the Province of Newfoundland and Labrador had the potential to produce far more Atlantic salmon than it currently produces and that the social and economic well-being of the people of the province could be significantly improved by development of that potential. Thus, from 1980 to 1982 eight provincial and federal agencies met to consider the desirability and practicality of launching such an enhancement program.

The ten-year program proposal ultimately developed called primarily for the implementation of a cost-effective scheme, involving low or intermediate level technology, which would almost double the production of salmon in the province. The main thrust of the plan would by its nature maintain the natural genetic diversity and life history patterns of the salmon stocks while at the same time expanding these stocks into previously unused habitat in the province.

The plan would be modular in concept and include a total of 21 projects using one or more enhancement strategies and involving nearly 50 river systems throughout Newfoundland and Labrador. Implementation of colonization, public enhancement, and sea farming projects, along with completion of pond ranching pilot projects would be emphasized during the first two years of the program. The first full scale pond ranching projects would then come on stream in the third year, while refinements to the DFO component of a hatchery project at Bay d'Espoir proceeded on the south coast rivers. In the fourth year hatchery stocking operations would be initiated as would the first research and feasibility investigations into Pacific introductions.

By the end of the ten-year program, salmon landings should expand by nearly 1500 metric tonnes within commercial fisheries or aquaculture facilities and recreational fisheries should increase by another 50,000 adult salmon. Forty-five million dollars would be invested over a decade with the direct employment of an estimated 250 full-time or seasonal employees each year during the start-up phase plus the creation of an additional 200 long-term jobs during the operations phase of the program. The present ten-year program could be expanded so as to contain additional projects to allow even greater increases in salmon production and benefits than outlined in this plan.

A key spin-off benefit of this plan is the coupling of increased catches in Newfoundland's commercial fisheries with a reduction in the *proportion* of mainland origin salmon being taken. This will enable managers to actually increase Newfoundland's overall catch of salmon while decreasing the *number* of mainland salmon taken. Without enhancement, reduction of interception would mean imposition of economic hardships to many fishermen.

SUMMARY

THE ATLANTIC SALMON ENHANCEMENT PLAN

NEWFOUNDLAND-LABRADOR

The Atlantic salmon fisheries in eastern Canada could be returned to the higher production levels of fifty years ago. Proven enhancement included in future management could restore and nurture those important fisheries. Special Planning Groups have now assembled a plan of salmon enhancement for Newfoundland-Labrador as one component of an eventual overall program for Atlantic Canada. The extensive enhancement plan now described would create new economic and social benefits, especially for the fishery users and residents of Newfoundland-Labrador.

The Atlantic salmon

The sea-run salmon resource of the province is found in over 160 scheduled rivers plus several hundred unscheduled rivers which contain an assortment of large and small streams. Upon hatching in the rivers as fry the young salmon spend from 2 to 7 years in fresh water as parr and finally move to sea as smolts. They spend a further 1 to 3 years feeding in the Atlantic Ocean and return as adult salmon return to their natal rivers to spawn as 1 sea-winter salmon (<2.7 kg) or as large salmon (>2.7 kg) multi-sea-winter. It is during their coastal feeding and spawning migration that they encounter the various fisheries.

The fisheries

Commercial, recreational and native people harvest the Atlantic salmon. The native peoples of Labrador harvest them under a system of special food permits and about 5300 other licenced commercial fishermen harvest approximately 2000 metric tonnes of salmon annually within the province's inshore coastal fishery, representing 90% of the total Canadian commercial harvest. More than 40,000 fish, or 30-40% of the total Canadian angling catch, are taken annually in the province by about 40,000 anglers.

Habitat deterioration

During the past century, habitat deterioration and overfishing have stressed the Atlantic salmon in Newfoundland. Pulp and paper and hydro power developments have taken their toll starting in the late 19th century. More recent industrial expansions impacting on the habitat of the salmon began in the 1960's and have included mechanization of the forest industry with increased forest harvesting, the establishment of an island-wide highway system, and a hydroelectric transmission line associated with new generation projects. One of the most aggravating factors for some provincial stocks, however, was overharvest in local fisheries and the development of the West Greenland fishery. This unprecedented pressure nearly led to collapse of certain river stocks.

Shift in salmon management policy

Since the 1970's new aquatic habitat protection legislation, international negotiations toward reduction of the West Greenland harvest together with local restrictive measures on angling and commercial fisheries affected gradual improvements in the Newfoundland stocks. More recently, national task forces and committees have examined the implications of management and harvest problems within eastern Canada and recommended broader coordinated approaches for salmon stocks throughout the five Atlantic provinces. Consequently, major shifts in management policy were announced in 1980; these included provincial fishery restrictions, the most important being to significantly reduce the interception by the Newfoundland commercial fishery of salmon from other provinces' rivers.

Towards increased salmon production

The above shift in policy was recommended in combination with an economic development thrust which would include an extensive long-term enhancement program designed to restore and improve fishery benefits. Proven techniques such as stream remedial, fishways, adult transfers, and swim-up fry stockings were already available for development of river enhancement strategies. Blasting and channelling have already been successful in removing barriers that formerly hampered salmon migrations in 25 streams and marked increases in salmon runs were demonstrated with fishway construction on another five important watersheds. In addition, combining fishway construction with stocking of the newly opened areas using adult transfers or fry plantings greatly accelerated establishment of 35,000 adults in two other major watersheds. Although there are no government salmon hatcheries in Newfoundland, several locations have received consideration as prospective sites and pen rearing pilot projects are showing promise for a future salmonid sea farming industry. It has been recognized that such combined approaches could double the Atlantic salmon production in the province and allow a return to the high fishery yields of the mid-1930's.

Special federal-provincial enhancement planning groups were established in 1980 to design a ten year program for the development of the salmon stocks of Newfoundland. The general technical, economic, and social rationale for the program was assembled and is now ready for consideration.

Enhancement and interception reduction

The new management plan proposes a 25% reduction in interceptions of Maritime-Quebec salmon taken in the Newfoundland commercial salmon fishery. This will improve the salmon supply to Maritime and Quebec fisheries as well as spawning escapements. However, it will result in serious harvest reductions along the southeast and northeast coasts of Newfoundland. The reductions in catches are further influenced by an appreciable loss of harvestable Newfoundland origin salmon which will escape the fisheries into the rivers (including some rivers where they will not be taken in the angling fishery).

Under this revised harvesting regime, it is impractical to modify the existing inshore salmon fishery so as to effectively absorb the harvestable surplus of Newfoundland origin salmon without creating serious economic and social consequences to established inshore fishermen. Application of enhancement

in Newfoundland rivers would compensate for these restrictions by increasing catches of Newfoundland origin salmon; enhancement could also enable the creation of new river mouth and terminal fisheries which would discretely crop those salmon surplus to spawning needs which are released from the traditional inshore fisheries. The proposed management scenario involving 10 major river enhancement projects could remedy most of the major expected negative impacts on the inshore fishery.

The economy: The major beneficiary

The key beneficiaries of an enhancement program will be the commercial, recreational, and native fishermen. Eventually, an additional 1500 metric tonnes would be available annually for commercial salmon interests (Table 1), which is equivalent to an increase in landed value of over \$6 million (1981 dollars) with a retail value almost twice that figure. Preliminary marketing analysis indicates that domestic and export demands for increased commercial salmon production will remain elastic in the foreseeable future although the domestic market may prove subject to periodic price depressions.

The extensive enhancement program aimed at both the user and public alike, would result in added social and economic benefits for residents of the province. Extra jobs would be created during 5 years of construction in the program (Table 2). Technological advances from the research and development phase of the program would result in new and improved approaches to fisheries management and enhancement.

Boosting the recreational potential

The recreational fishery would have an increased supply of large salmon, thereby improving quality, success, and interest in angling throughout the province. A current increase in demand for salmon recreational fishing has raised overall catch totals but with declines in harvest quality in terms of catch rate and the frequency of large salmon. The new fishery regimes involving both interception reduction and enhancement thrusts within the existing and newly opened watershed fishing areas would greatly increase the recreational harvest and fishing success rates. It is expected that the planned enhancement will contribute an additional 50,000 fish to the recreational fishery, or roughly a doubling of the existing catch.

The role of native peoples

Native involvement in salmonid enhancement could become important especially, in remote areas where opportunities for improved income and employment are low. Dialogue and cooperation between government and native groups concerning the aboriginal rights issue could also be expected to improve as a result of participation in such joint ventures. The Labrador native Naskaupi and Inuit people of Labrador have already expressed interest in developments of new freshwater fisheries.

Public involvement

Salmon enhancement presents an excellent opportunity for the conservation-minded public to become involved in the actual planning and conduct of its own projects and enhancement thrusts will draw heavily on volunteers and community groups.

This approach will greatly assist DFO in the design and operation of projects as well as educate residents regarding their role in environmental preservation, conservation and protection, and resource development.

Involvement of communities in long-term enhancement ventures would improve fishing, generate new income, as well as provide new employment, manpower training, and regional development. Conservation associations, rod and gun clubs, and other volunteer organizations will be encouraged to get involved in the planning of small stream projects designed to inform and educate about resource and government related programs. Of course such activities will also provide major contributions to restoring, maintaining, or improving salmonid habitat and the fish populations.

Education

As part of the public education thrust students in secondary school science courses would be exposed to a special enriched curriculum focused on the salmon resource. The object would be to instill an early awareness to the role of salmon in the ecosystem and the mutual dependence of man and the resource and to use this as a model which would apply to the understanding of important marine species as well.

Federal-Provincial cooperation

Commitment of the federal government to enhancement of salmon could have significant consequences for alternative usage of provincially administered resources of water, forestry, and minerals. Hence, there is a need for federal-provincial cooperation and negotiation throughout the program.

A Newfoundland federal-provincial memorandum of understanding towards planning an extensive enhancement proposal would be forwarded for consideration by the ministers responsible. More formalized arrangements covering cooperation between the two governments will be developed when it is decided to implement the plan.

Three federal and six provincial agencies have jointly helped with the design of the salmon enhancement program through representation on the CORE and Technical Planning Groups. Canada Employment and Immigration (CEIC) is actively exploring new employment training approaches through financial and other support of a community fisheries enhancement demonstration project in St. Mary's Bay, Avalon Peninsula. The Department of Regional Economic Expansion (DREE) has advised on regional development impacts of the proposed program with the Department of Indian and Northern Affairs (DINA) consulting on directions required for native people.

The provincial agencies have reviewed enhancement matters pertaining to industrial water use, environment, rural development, fisheries, tourism, education, and intergovernmental affairs. For example, the Provincial Department of Fisheries and Memorial University of Newfoundland have considered with DFO the development of cooperative arrangements for an emerging aquaculture industry. The Department of Rural, Agricultural and Northern Development has supported the planning of public enhancement projects within communities through 49 local development associations. Many of these associations have already submitted enhancement proposals which the provincial Department is willing to support.

Salmon enhancement information is being reviewed by the two departments responsible for use in secondary and school science curricula and for park interpretation programs.

THE ENHANCEMENT PLAN AND ITS STRATEGIES

The salmon enhancement program would be implemented over a 10 year (1982-91) period. The approach would be one of incorporating a mix of low, intermediate, and high technology strategies which have been assessed as sound. These would be gradually blended with improved approaches demonstrating feasibility through research and piloting.

Planning groups determined biological and engineering feasibilities through modelling exercises on watershed production potential, fishery management, and harvesting regimes. Strategy options were next developed along with basic cost production flows through to post-evaluation stages. Alternatives were next subjected to a general socio-economic framework of criteria relating mainly to national income generation but also to employment, regional development, and native/environment well-being. Benefit:cost analysis was conducted on the series of most appropriate enhancement options.

Five major enhancement strategies were developed for the program.

Colonization

"Colonization" involves the provision of fish passage at total salmon migration obstructions while 5-7 year stockings proceed on the newly opened areas to ensure rapid buildup to maximum production. This low technology strategy will initially be the major thrust of the new enhancement program. The plan envisages that in 1983, three colonization projects for salmon would begin on the Terra Nova and Humber rivers in Newfoundland, plus the Canairiktok River in Labrador. Test stocking would continue on one of the tributaries of the headwaters of the Exploits River, stocking of the remaining Exploits tributaries and construction of fishways would be completed during 1985-89. Additional projects would be more fully described for implementation during the second year of implementation and would be dependent on increased budget allocations; these would require complete fish passage and stocking investigations during the first year.

Annual production potential of Atlantic salmon colonization projects is estimated to be 129,000 adults providing an annual harvest of 94,000 adults or 203 tonnes to commercial fishermen and 9,500 fish to sportsmen. The mix of projects has acceptable benefit to cost ratios (Table 3). New conservation and protection costs relating to management and harvesting of enhanced stocks were received just prior to completion of this document and will be incorporated in future revised socio-economic evaluations and be included in new benefit-cost analyses.

Pond rearing

Promising experimental research suggests a second strategy, "pond rearing". This strategy refers to the continuous planting of swim-up fry into lakes or ponds to achieve increased salmon production. It is proposed that a pilot

project be initiated during the first year at Black Brook, near Halls Bay. The facilities envisaged would also enable testing stocking of partially grown (fed) young salmon. As well, it would serve as a model for refining public involvement approaches to salmon enhancement training and education. Following these strategy refinements, five additional projects would be initiated between the second and fifth years and would involve development of 11 streams within western, northern, and central areas of the island.

For the projects identified, the estimated production is 320,800 adult salmon which could provide an annual yield of 513 tonnes (216,000 adults) to the province's commercial fishermen and 33,000 fish for the sports angler. Benefit to cost ratios are more favourable than for the colonization strategy due to higher harvesting rates, reduced start-up periods, and the lack of expensive fish passage facilities.

Fish culture

The third enhancement strategy proposed, which is designed for both the development of public fisheries and private sea farming ventures, is intensive fish culture; although present investigations suggest this is promising in some areas, further research is required to perfect this approach. During the first two years of the program the provincial government will consider participating in the construction of a modular type plant at Bay d'Espoir on Newfoundland's south coast which in the first phase would serve an emerging aquaculture industry as well as provide salmonids for research purposes. DFO would then consider a second phase in the third year to support public fisheries enhancement. Hatchery production at Bay d'Espoir appears promising because of its ground and surface water supply as well as an industrial waste heat source which can be used to accelerate early juvenile growth.

Adaptation of existing technology for Atlantic salmon farming to Newfoundland waters will require development of a flexible modular-type rearing facility. Hatchery production would initially produce over 140,000 adult salmon or almost 500 metric tonnes of landings in sea farms located in the Bay d'Espoir coastal area, plus another 120,000 salmon from annual stocking of six major rivers on the south coast and five on the Avalon Peninsula. It is anticipated that output at such a plant could be combined to include compensatory stocking resulting from the damaging effects of hydroelectric water diversion, production of smolts for commercial fish farming, and fry, fingerling and smolt production for enhancement or sea ranching activities along the south coast of Newfoundland. Provincial agencies are optimistic that a fish culture station at Bay d'Espoir could eventually produce up to 200,000 one-year smolts for private fish farmers.

Provincial agencies are now confident that, with their experience, 200,000 one-year smolts could be produced at the hatchery. These could be used for the economic production of salmon with direct long-term employment generation in the adjacent coastal area. DFO interests in the multi-purpose hatchery would focus primarily on enhancement of public fisheries: initially 1.3 million fry would be planted to increase production in south coast rivers. Eventually 100,000 fall fingerlings and 50,000 one-year smolts would support intensive fisheries in metropolitan areas such as on the Avalon Peninsula.

Stock remedial activities

Within the fourth strategy of the enhancement program, regulatory controls for increased river spawning escapements would be combined with stream clearance, spawning or nursery habitat improvements, and stocking activities to restore or maintain runs to numerous small watersheds of the province. A public involvement thrust would include as key ingredients: education-training on enhancement through DFO community and technical advisors, grants or employment contracts; and most importantly, a demonstrated interest and commitment of the public to enhancement.

A total of seven public project proposals have been identified and submitted by various development associations and conservation groups as part of this aspect of the enhancement program. This mix of volunteer/community projects on the Newfoundland-Labrador streams will utilize low level investments to maintain or improve Atlantic salmon runs while at the same time, providing increased employment and regional development.

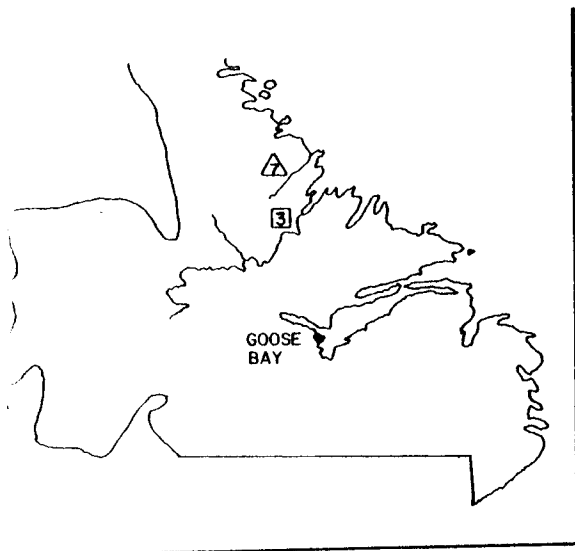
Pacific salmon introductions

A further possible strategy relates to the possibility of the eventual introduction of Pacific salmon species to the province. However, if we are to ensure stability of existing stocks of salmonids, and the effectiveness of the approach, extensive research is advocated. Feasibility investigations could commence in 1985 and 1986 with the first pilot projects in 1987.

RECAP

A total of 21 projects have been identified using one or more enhancement strategies and involving nearly 50 river systems throughout Newfoundland and Labrador (Figure 1). Implementation of colonization, public enhancement, and sea farming projects, along with completion of pond ranching pilot projects would be emphasized during the first two years of the program. The first full scale pond ranching projects would then come on stream in the 3rd year, while refinements to the DFO component of the Bay d'Espoir hatchery projects proceed on the south coast rivers. In the fourth year the south coast hatchery projects would be initiated as would the first research and feasibility investigations into Pacific salmon introductions.

An enhancement program would create greater economic stability and diversity, as well as social well-being for the provincial society through improved employment or investment and through environmental and resource preservation thrusts. By the end of the outlined ten year program, salmon landings should expand by nearly 1500 metric tons within commercial fisheries or aquaculture facilities and recreational fisheries should increase by another 50,000 adult salmon. Forty-five million dollars would be invested over a decade with the direct employment of an estimated 250 full-time or seasonal employees each year during the start-up phase plus the creation of an additional 200 long-term jobs during the operations phase of the program. The present ten year program could be expanded so as to contain additional projects to allow even greater increases in salmon production and benefits than outlined in this plan (Tables 1-3).



□ COLONIZATION PROJECTS

1. EXPLOITS R.
2. TERRA NOVA R.
3. CANAIRIKTOK (LAB.)
4. HUMBER R.

○ POND RANCHING PROJECTS

1. BLACK BROOK
2. ROBINSONS R.
3. INDIAN BAY BROOK
4. GANDER BAY BROOK
5. TORRENT R.
6. SOUTH BROOK

△ PUBLIC INVOLVEMENT PROJECTS

1. SALMON COVE, (C.B.)
2. SALMON COVE, (T.B.)
3. HICKMANS HARBOUR
4. PORTLAND CREEK, (G.N.P.)
5. DEER LAKE
6. ROMAINE RIVER
7. HUNT RIVER, (LAB.)

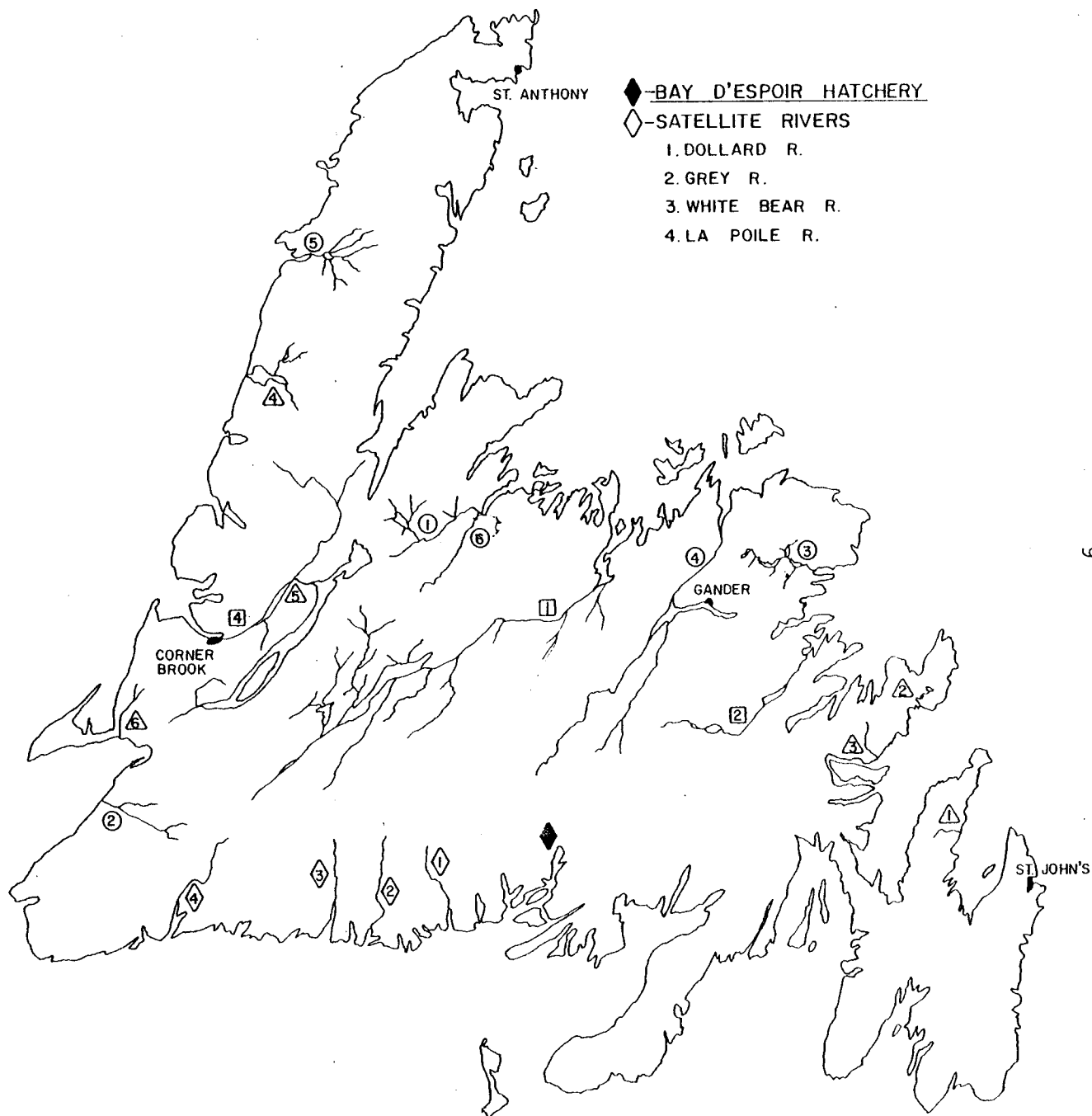


Figure 1. A total of 21 projects throughout Newfoundland and Labrador will almost double the province's production of Atlantic salmon by the 1990's.

Table 1. Summary table outlining total annual production and harvest flows from an implemented Salmon Enhancement Program of twenty projects, 1982-2006.

Strategy	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/00	01/05	06/07
Colonization - Pond Ranching											
Total Production (No.)	22600	39500	67100	93600	219170	334320	374440	408300	412800	466300	495600
Commercial Harvest (kg)	31800	61700	95042	143054	308503	538911	614930	668745	678825	728176	814153
Recreational Harvest (No.)	3000	4700	7855	9672	22949	29242	32110	35833	35923	40014	42526
Intensive Fish Culture (Provincial):											
Sea Farming											
Total Production (No.)	145407	145200	145200	145200	145200	145200	145200	145200	145200	145200	145200
Commercial Harvest (kg x 1000)	496280	496280	496280	496280	496280	496280	496280	496280	496280	496280	496280
River Stocking											
Total Production (No.)	18000	36000	51000	51000	51000	58000	121000	121000	121000	121000	121000
Commercial Harvest (kg x 1000)	29330	58661	83103	83103	83103	94509	197167	197167	197167	197167	197167
Recreation Harvest (No.)	1975	3950	5596	5596	5596	6364	13278	13278	13278	13278	13278
Public Projects:											
Total Production (No.)			6152	7996	7996	7996	7996	7996	7996	7996	7996
Commercial Harvest (kg x 1000)			6878	12072	12072	12072	12072	12072	12072	12072	12072
Recreational Harvest (No.)			693	734	734	734	734	734	734	734	734
Total:											
Total Production No.	186007	220700	269452	297796	423366	545516	648636	682496	686996	740496	769796
Commercial Harvest (kg x 1000)	557410	616641	681303	734509	899958	1141772	1320449	1374264	1384344	1433695	1519672
Recreational Harvest (No.)	4975	8650	14144	16002	29279	36338	46122	49845	49935	54026	56538

Table 2. Summary table outlining total annual capital operation and person-year costs for implementing an Atlantic Salmon Enhancement Program of twenty projects, Newfoundland-Labrador 1982-2006 (\$1981).

Strategy	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	95/96	96/97 etc.
Total DFO Projects:												
Person Year Equivalents	47.9	55.2	53.8	60.7	57.9	63.6	60.9	60.9	61.2	63.5	69.6	71.6
DFO FTC (included above)	13.0	15.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Capital (x \$1000)	857.3	937.1	2496.7	2766.8	3130.0	575.0	950.0	1170.0	135.0	170.0	690.0	140.0
O/M (x \$1000)	531.0	669.0	667.5	871.3	963.6	1041.9	922.0	922.0	903.3	1025.7	1024.5	1044.5
	2394.2	2765.1	4294.2	4913.1	5309.6	2952.9	3151.0	3371.0	2323.3	2528.7	3166.5	2688.5
Total - Sea Farming Projects:												
Person Years												
Capital (x \$1000)		2750.0	92.0									
O/M (x \$1000)		113.0	245.0	690.0	1212.0	1212.0	1212.0	1212.0	1212.0	1212.0	1212.0	1212.0
		2863.0	337.0	690.0	1212.0	1212.0	1212.0	1212.0	1212.0	1212.0	1212.0	1212.0
Grand Total - Program:												
Person Years Equivalents	47.9	55.2	53.8	60.7	57.9	63.6	60.9	60.9	61.2	63.5	69.6	71.6
(x \$1000)	(1005.9)	(1159)	(1130)	(1275)	(1216)	(1336)	(1279)	(1279)	(1285)	(1333)	(1462)	(1504)
Capital (x \$1000)	857.3	3687.1	2588.7	2766.8	3130.0	575.0	950.0	1170.0	135.0	170.0	680.0	140.0
O/M (x \$1000)	531.0	782.0	912.5	1561.3	2175.6	2253.9	2134.0	2134.0	2115.3	2237.7	2236.5	2256.5
	2394.2	5628.1	4631.2	5603.1	6521.6	4164.9	4363.0	4583.0	3535.3	3740.7	4378.5	3900.5

Table 3. Table of sample benefit/cost analyses¹ for seven enhancement projects summarizing the most probable set of management/enhancement options.

Project	Total potential production	Benefit:Cost Analysis	
		Standard calculation	50% Labour credit
Exploits	66,000	0.95	1.17
Humber	17,100	1.17	1.41
Terra Nova	7,300	0.94	1.15
Canairiktok	36,500	1.20	-
Black Brook	35,600	1.41	1.72
Torrent River	56,700	1.82	2.25
South Brook	22,100	1.10	1.43
Project Aggregate	241,300	1.25	1.55

Assumptions:

1. 25 percent interceptions reduction within existing commercial fishery.
2. 10% discount levels in calculations.
3. \$5.40/kg commercial value; \$10.80/kg recreational value for enhanced fish.

Note:

¹For detailed rationale on the above assumptions/analysis see Discussion Paper, Appendix G - (a) and Project Benefit:Cost Analysis which follow.

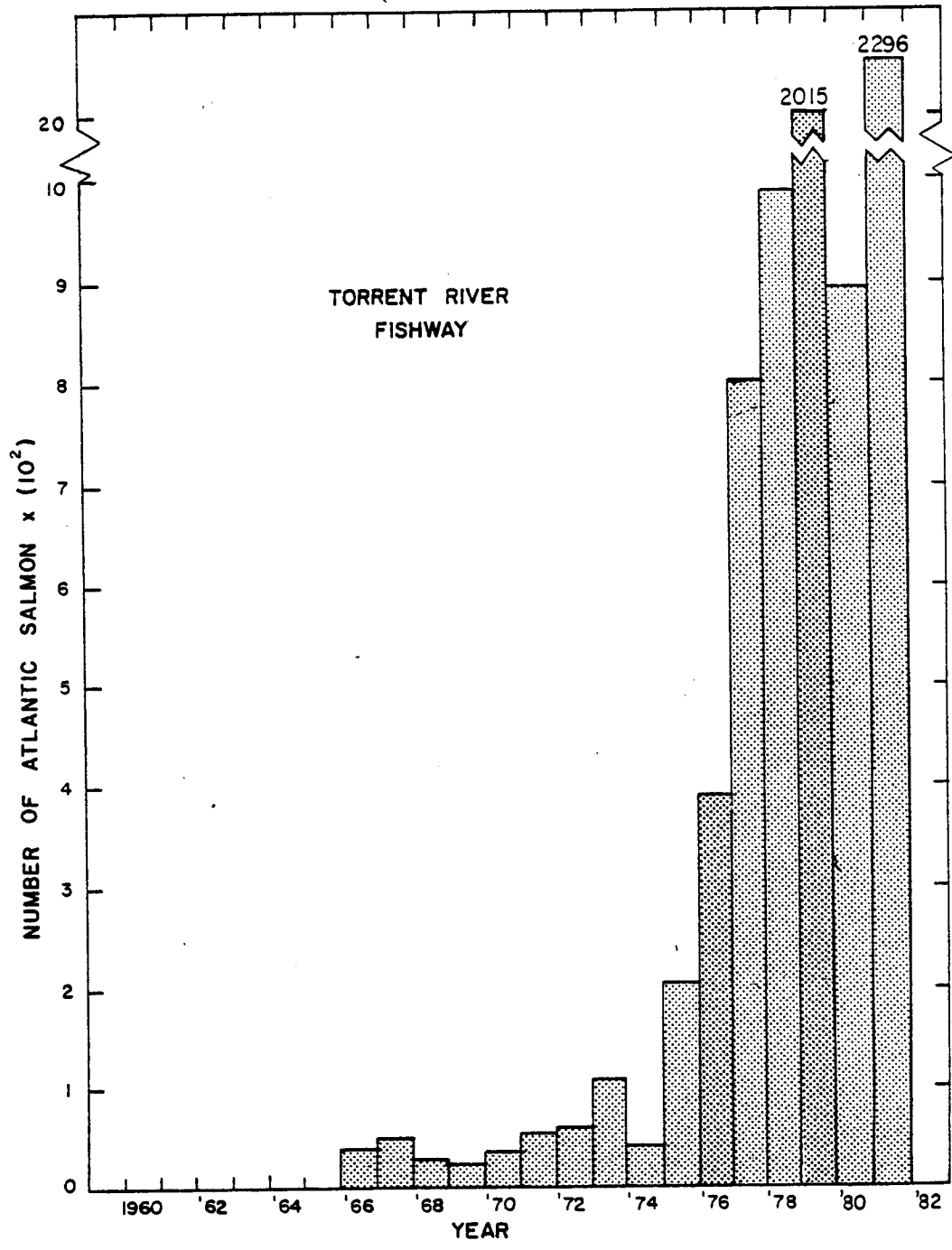
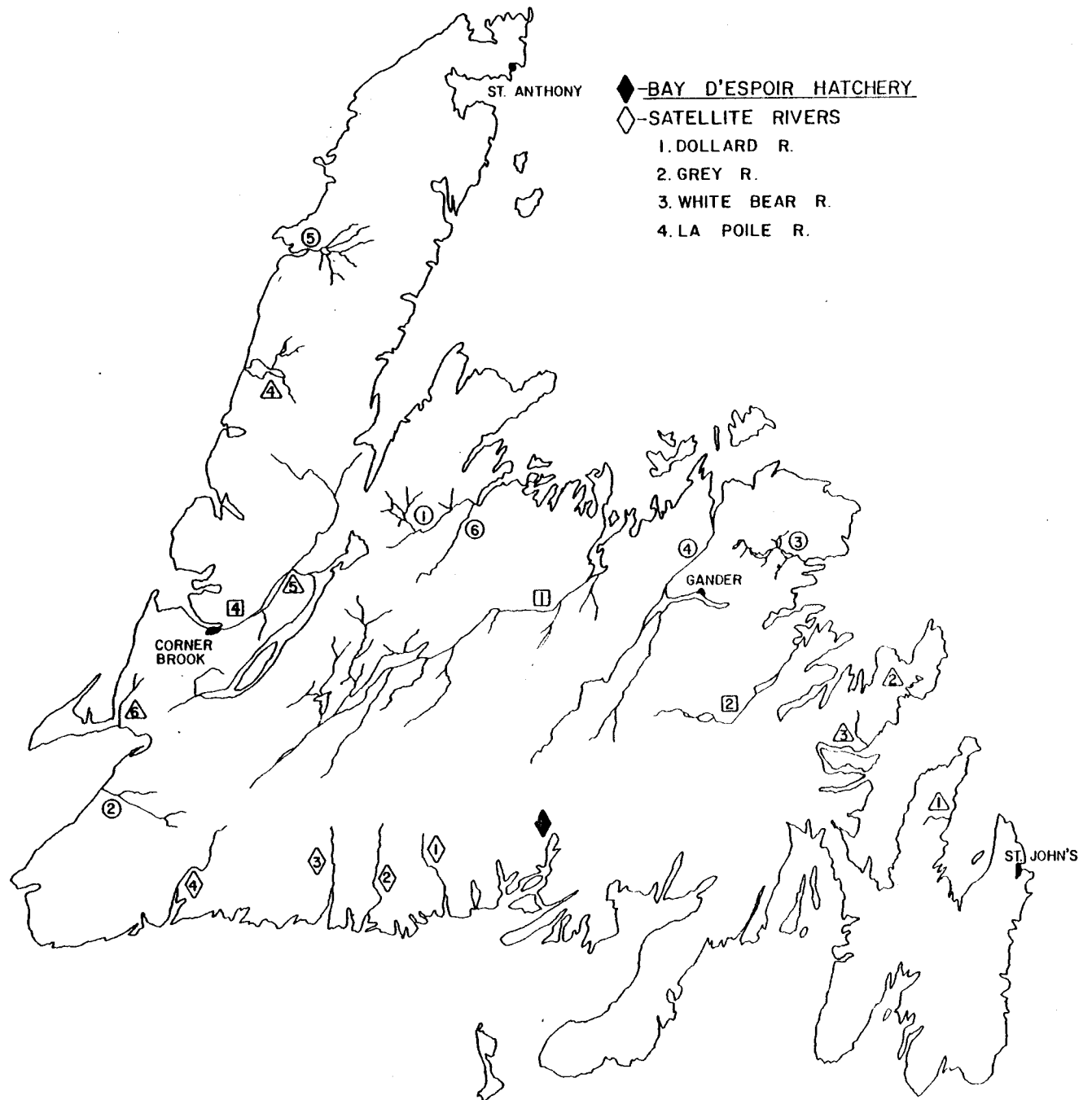
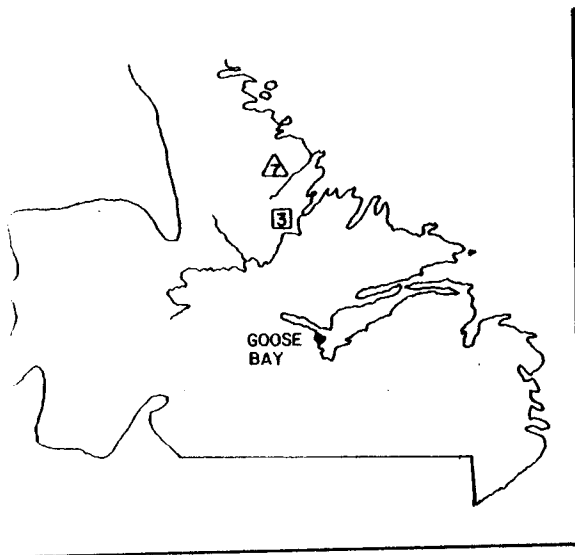


Figure 1. In 1966 a fishway was constructed in Torrent River on Newfoundland's west coast and spawning adult salmon were transplanted above the fishway from 1972 to 1976; salmon returns to this system subsequently reached unprecedented highs. This technique and modifications to it form the basis of one of Newfoundland's enhancement strategies for expansion of Atlantic salmon stocks.



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6. ROMAINE RIVER
7. HUNT RIVER, (LAB.)

Figure 2. A total of 21 projects throughout Newfoundland and Labrador will almost double the province's production of Atlantic Salmon by the 1990's.



Figure 3. Hundreds of miles of fertile salmon habitat extending deep into Newfoundland's wilderness areas will be made accessible through an extensive salmon enhancement program.

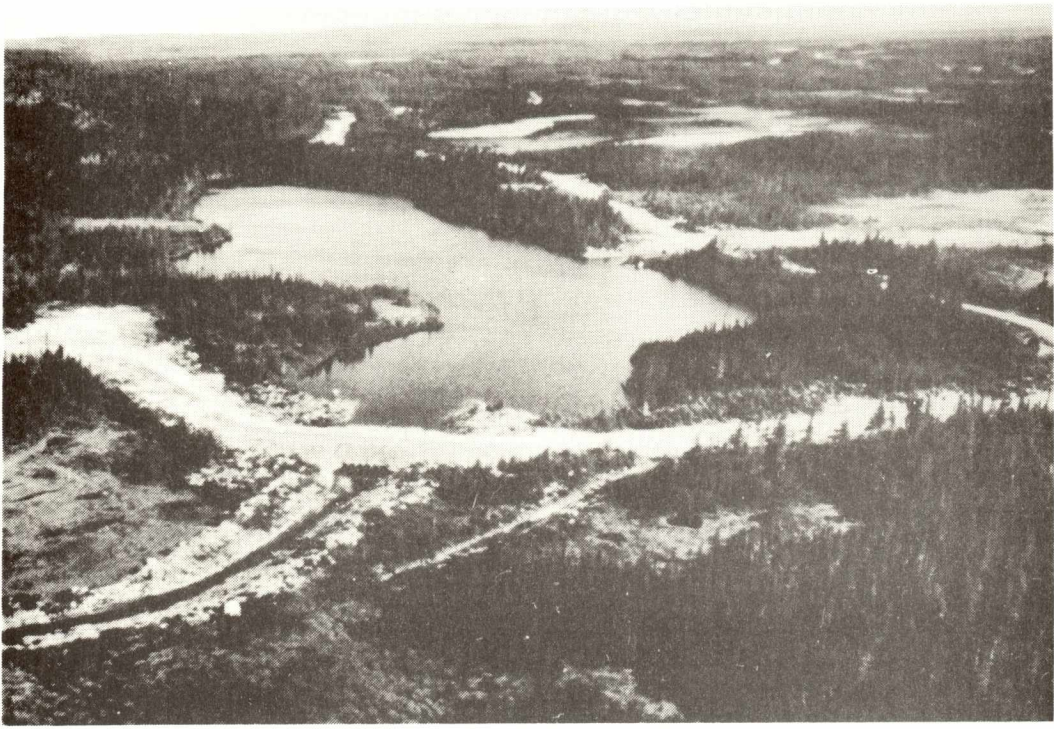


Figure 4. Recent experiments indicate that many hundreds of Newfoundland's small lakes or ponds have the potential of naturally rearing salmon from the time they hatch until they migrate to sea; this "pond rearing" constitutes a major part of the Newfoundland enhancement program.



Figure 5. Medium-level technology egg incubators will be installed directly in this stream and enable hatching of about two and one-half million fry for distribution to fertile but inaccessible rearing habitat. This technology is ideal for systems with inadequate spawning habitat.



Figure 6. Numerous waterfalls in Newfoundland's wilderness areas are impassable to upstream migrating salmon. Many miles of fertile habitat would be available to expanded populations of salmon by installation of a fish ladder on the far left-hand side of this remote Labrador waterfall.



Figure 7. "Low level technology", such as stream clearance, is used to make inaccessible spawning and rearing habitat accessible to Atlantic salmon. Important increases in salmon populations can be achieved through such simple procedures.



Figure 8. The first year or so of some of the projects will involve detailed on-site surveying to select suitable locations for stream improvements or installation of specialized facilities (fishways, incubation chambers, accommodations, etc.).

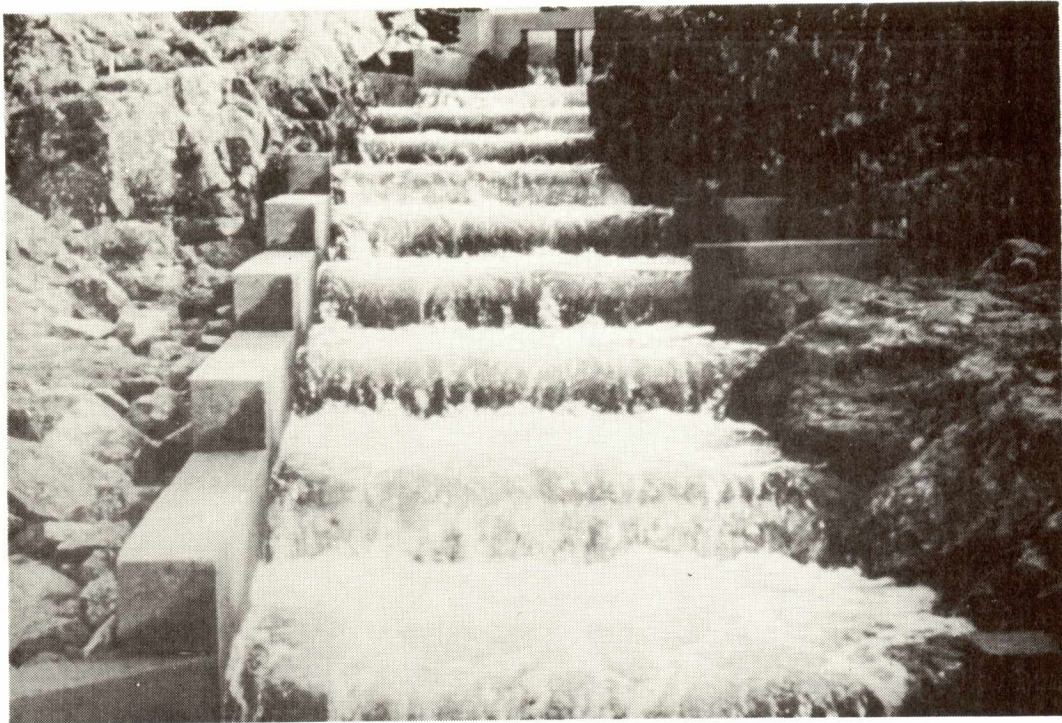


Figure 9. "Medium level technology" is required to allow salmon populations to expand into areas above more difficult obstructions. Results from the construction of this fishway (see Fig. 1) serve as a model for the future of many salmon enhancement schemes in Newfoundland.

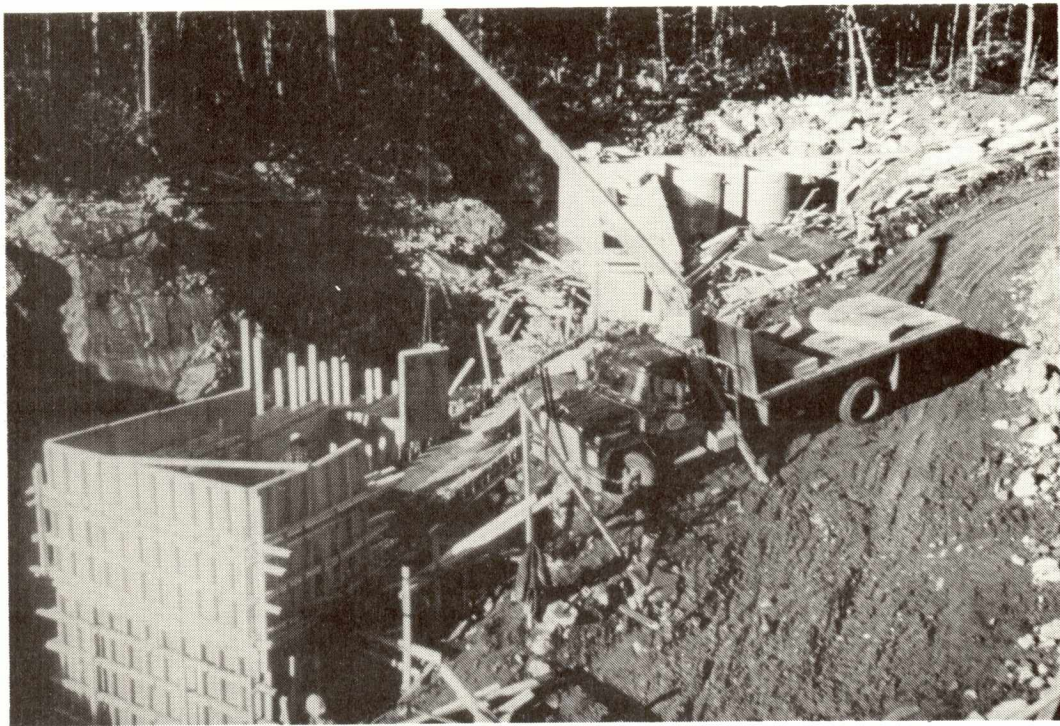


Figure 10. Labour intensive segments occur early in the life of some of the projects thereby contributing to relief of unemployment and associated social problems. Design and placement of this salmon collection facility proved to be a key element in the success of the Exploits River Development Project.

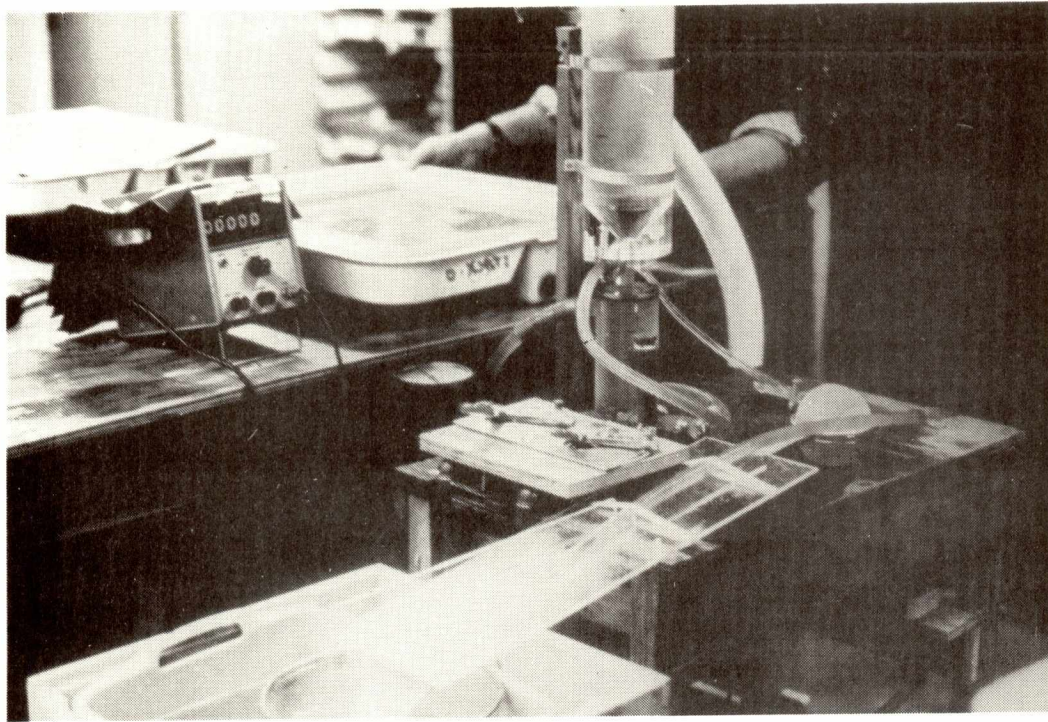


Figure 11. While the main thrust of the Newfoundland enhancement program is the application of existing and proven approaches which are economically sound, new means are continually being sought to reduce costs further.



Figure 12. Following techniques already proven for Pacific salmon, trials are already underway to greatly improve survival and growth of Atlantic salmon fry by feeding them in semi-natural rearing areas before being released into the wild.

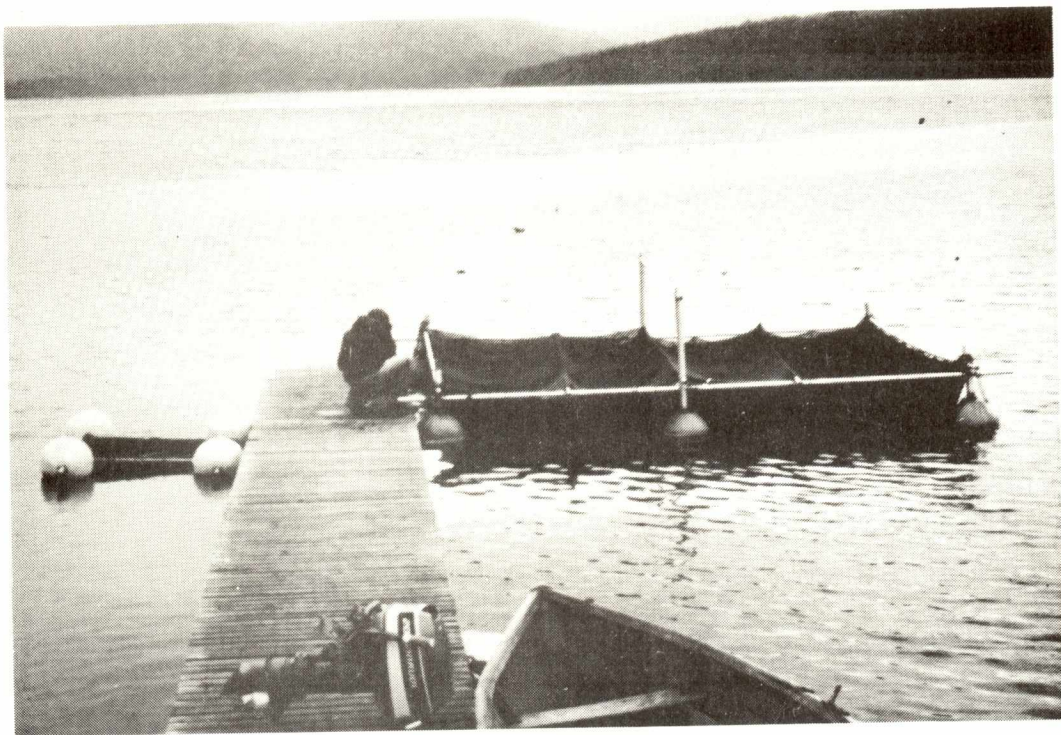


Figure 13. Results of recent experiments performed by Memorial University's Marine Sciences Research Laboratory indicate that cage culture of salmonids in long sheltered bays along Newfoundland's south coast may be a viable enterprise if a hatchery were constructed in the area to provide a source of "starter fish".



Figure 14. Newfoundland's experience with community involvement projects has demonstrated that low level technology can be effectively transferred to the private sector to establish or rebuild depleted salmon stocks in rivers near important communities.



Figure 15. Additional protection of new and expanded salmon populations has been incorporated into Newfoundland's salmon enhancement program.

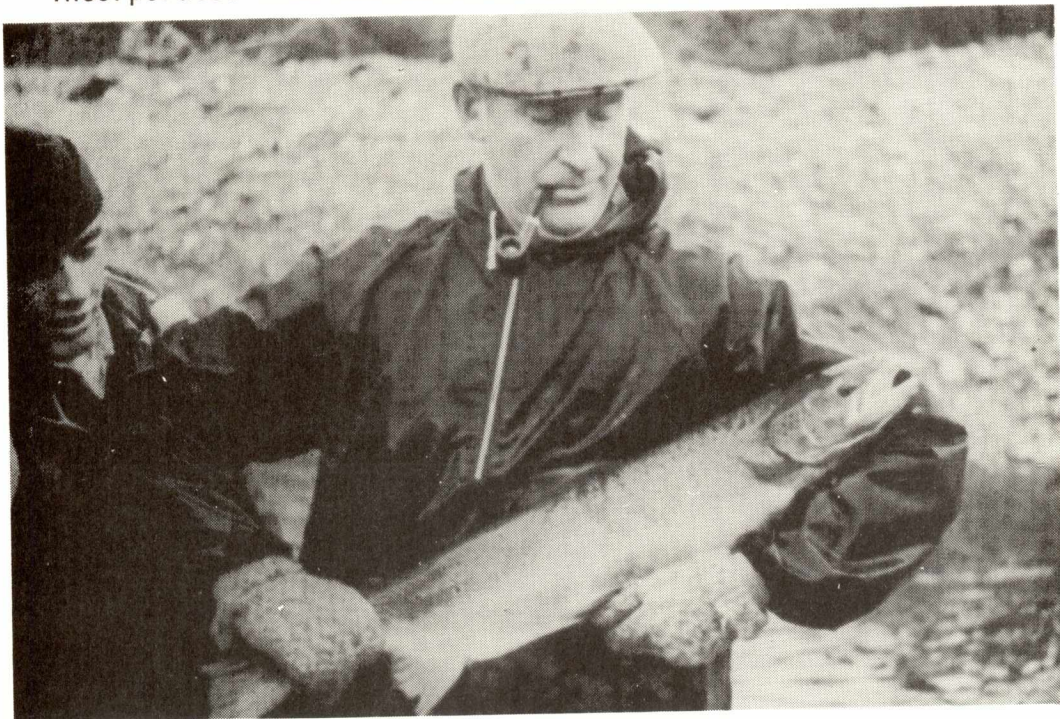


Figure 16. Newfoundland's salmon enhancement program is oriented toward the maintenance of the existing ratio between grilse and large salmon. However, where possible, selective mating of the larger salmon will be fostered to help counteract selective pressures by the fisheries against survival of these salmon.